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

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- U.S. open-end actively-managed domestic bond mutual fund managers create positive precision-adjusted alpha (t-alpha), as evidenced by benchmark-adjusted bootstrap simulations of monthly fund returns net of expenses (1999-2016)
- Selection skill is the source of risk-adjusted outperformance over the long-run
- For the top 50% performing bond funds:
  - Precision-adjusted alpha is positive and economically significant and selection always contributes to outperformance
  - Economic value (EV) is greatest for large funds (with AUM>$750M) at 40.8 bps of AUM; 19 bps for governments and 18.2 bps for corporates
  - For large bond funds, timing detracts from performance though this is more than offset by selection
  - For governments and corporates, timing contributes to performance
- Timing - not selection - is the source of bond fund outperformance among top decile of performance funds over short-term 3-year horizons
  - However, selection skill mitigates what would otherwise be even poorer performance among the lowest decile of such funds over short-term 3-year horizons

- Motivation: bonds offer better chance of observing fund manager skill than equities
  - Bond markets are larger; many bonds have issue-specific terms/embedded options, trade OTC, and are illiquid; governments vary in duration and convexity and corporates in credit risk; portfolios can be managed for timing (expectations about interest rates, term structure, and spreads)
- Prior bond mutual fund literature suggests managers do not/barely cover costs
  - Blake et al. (1993), Elton et al. (1995), Ferson et al. (2006) find US bond fund managers on average generate negative/zero risk-adjusted performance net of expenses
- Recent equity (and some income mutual fund literature) advocate bootstrapping
  - Kosowski et al. (2006) suggest fund alphas exhibit heterogeneity in risk-taking, parametric tests bias against finding outperformance, and corrections for precision of alpha are necessary given true alpha uncertainty
  - Finding outperformance also depends on identification of benchmark models that capture all common variation in fund returns across funds and over time (but none do)
  - Joint sampling of fund and explanatory factor returns addresses potential correlation in alpha and heteroskedasticities in benchmark residual errors and factor returns
  - Kosowski et al. (2006) bootstrap by funds (mostly equities, some income), but Fama and French (2010) bootstrap by periods (equities) to avoid bias [(Fama and French (2010) p.1925]

1. Introduction - Approach

- Use Fama and French (1993) 5-factor bond returns model and Chen et al. (2010) motivated 12-factor bond returns model (with factors for timing and conditioning on public information) to estimate actual and simulated precision-adjusted alpha on gross and net returns
  - Fama and French (1993) 5-factor model is:

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

Note that TERM and DEF proxy for economic shocks to the term structure of interest rates, and default risk

  - Chen et al. (2010) motivated12-factor model is:

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

where MKLIQ is 3-month non-financial commercial paper rate – 3-month Treasury Bill yield, PRC/DIV is an equity market valuation factor measured as 1-month lag demeaned Price/Dividend ratio for the CRSP VW index, and EQVOL is 1-month lag demeaned CBOE implied volatility (VIX-OEX). Potential non-linearities (squares) were considered but LAR LASSO procedure selected 10 factors and we added back HML and SMB

- 5-factor model allows assessment of combined effects of selection and timing skill on bond fund risk-adjusted performance; 12-factor model shows whether excess returns are from selection; difference reflects timing

- Apply bootstrap approach of Fama and French (2010) to 571 consolidated U.S. open-end actively managed domestic bond mutual funds Jan 1999-Dec 2016
- We show distribution of precision-adjusted true alpha is fat tailed, parametric tests bias against finding outperformance and positive (negative) precision-adjusted alpha is less (more) likely to indicate statistical significance
- We also show inferences from bootstrap simulations are robust to uncertainty about true alpha
- Top 50% of performing bond funds generate significant positive precision-adjusted alpha on returns net of expenses, including governments and corporates, regardless of AUM
- For governments, outperformance is greatest in short (0-5 year) average duration funds, and for corporates among BBB average credit rated funds
- For short 3-year windows for the top 10% of funds, we find positive precision-adjusted alpha using 5-factor model for all sample funds, governments, corporates, and fund sizes (AUM), and timing is the source of outperformance, not selection
- However, for short 3-year windows for the bottom 10% of funds, selection mitigates what would be even worse performance

- Using annualized median SE of actual alpha and the difference between actual vs. average simulated precision-adjusted alpha to calculate annualized excess alpha on AUM at each percentile, we find:
  - For top half of performing funds, EV is greatest for large funds, at 40.8 bps of AUM, and 19 and 18.2 bps for governments and corporates
  - For top 5% of funds, EV from selection is highest for large funds at 59.8 bps of AUM
  - Timing detracts from performance for large bond funds: for top half at -22.5 bps and for top 5% -34.2 bps
  - Timing adds to governments and corporates: for top 5% governments at 21 bps and corporates at 22.3 bps

- Chen et al. (2010) is the closest study to ours, but their study focuses on timing and non-linear factors in bond returns. Our study covers 1999 to 2016, theirs from 1962 to 2007. We use the Fama and French (1993) 5-factor model to describe common variation in return rather than assign bond funds to style benchmarks. We bootstrap simulated returns across months as in Fama and French (2010) rather than bootstrap residual returns to address cross-correlations in returns when models do not capture all common variation. In the process, we demonstrate managers possess investment ability more likely related to selection than timing.
- Cici et al. (2010) examine changes in quarterly holdings of domestic fixed-coupon non-convertible corporate bonds that have traded prices in 746 corporate bond mutual funds from 1995-2007. Monthly returns are used to compute the attribution of quarterly holding returns to selection, timing, and style. At the fund level, quarterly holding return is the sum of VW returns from selection, timing, and style.
  - Over their period, the combined contribution of selection and timing to annualized quarterly holding returns are small that suggests quarterly changes in holdings are few and significant annualized quarterly returns are attributable to style.
  - For investment grade funds, selection contributes 27 bps to annualized quarterly holding returns, whereas for speculative, selection and timing contribute -47 bps and 49 bps. Given quarterly holdings returns reflect short-term trades in OTC markets dominated by sophisticated informed institutional investors, these results are unsurprising.

- We focus on long-term total returns from all fund holdings rather than short-term returns from traded bonds. Our results corroborate Cici et al. (2012)'s finding active management is more important for investment grade than speculative bond funds. Only investment grade funds exhibit positive precision-adjusted alpha net of expenses - from timing for AA and selection and timing for BBB average rated funds.

2. Sample - Description

- Our sample: US open-end actively managed domestic bond mutual fund monthly returns from CRSP Survivorship-Bias-Free Mutual Fund Database over the 216 month period January 1999 through end Dec 2016. Funds are consolidated using Database variable CRSP_CL_GRP (available starting August 1998). Observations for mutual funds with multiple classes are consolidated into a single mutual fund month observation, like Kosowski et al. (2006) and French (2008). For each fund, we estimate consolidated fund returns by summing VW returns of each share-class, whether load, no-load, or institutional, where value weights are based on proportion of each share class to total net assets at month start.
- 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 Bonds (ICQY)
- We merge CRSP Mutual Funds and Morningstar Direct data to obtain additional information on benchmarks. Average effective duration is used as a proxy for maturity in the literature, and average credit rating as a proxy for credit default risk. Unlike the literature, we retain funds that have missing average duration or credit rating because they could be systematically different in their use of derivatives to hedge interest rates or default risk

2. Sample – Descriptive and Summary Statistics

- Table 1 - Descriptive statistics
  - Our requirement for 12 observations and 5 years' data reduces the number of potential bond funds by 36% overall (including 32% governments and 42% corporates)
  - Total number of funds at beginning (1999) and end (2016) is almost unchanged (316 to 319), but there is an 18% increase in number of governments and 24% decline in number of corporates
  - Average AUM increased 61% from $671 million to $1.081 billion (in 2016 dollars)
- Table 2 - Summary stats on monthly gross/net returns and 5-factor correlations
  - Table 2 Panel A shows, as expected, mean (median) returns and standard deviations are higher for corporate than government bond funds, governments with higher average duration, and corporates with lower average credit rating
  - Differences between mean and median returns suggest bond mutual fund returns are positively skewed.
  - Returns on governments are also positively skewed overall, but negatively on intermediate (5-10 years) and long (10-30 year) average duration government bond funds
  - Returns on corporates are negatively skewed for all but the highest (AAA) average credit rated corporate bond fund. AAA funds are positively skewed

- Bootstrap Approach
  - To test whether realized (actual) alphas in fund returns are nonzero, we bootstrap simulated returns
  - Bootstrap simulated returns have identical properties to actual returns except each fund's actual alpha is set to 0
  - For 5- and 12-factor models we estimate each fund alpha using monthly returns Jan 1999-Dec 2016 to proxy true alpha
  - For each fund, estimated alpha is subtracted from monthly returns to obtain demeaned monthly returns
  - Each simulation run is a random sample of demeaned monthly returns with replacement for 216 months, bootstrap estimates each fund's alpha using 5- and 12-factor models dropping funds lacking sufficient # of observations
  - Each simulation run produces a cross-section of bootstrapped precision adjusted alphas (t-alpha)
  - Our simulation has 10,000 runs, each with the same number of months (like Fama and French (2010))
  - Simulations capture cross-correlation of fund returns and their effects on distribution of precision-adjusted alphas
  - Joint sampling of fund and explanatory returns captures correlated heteroskedasticity of explanatory returns and model residual errors
  - Funds may not be in sample entire period, so distribution of precision-adjusted alpha depends on number of months funds are used in simulation through its degrees of freedom
  - Distributions of precision-adjusted alpha for funds oversampled in simulation run 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 caused by differences in residual variance and number of months funds are in a simulation run
  - Over- and under-sampling of fund returns within a simulation run tend to balance over 10,000 runs used for inferences
  - Setting true alpha to zero for net returns assumes managers have sufficient skill to cover costs; setting true alpha to zero for gross returns assumes managers have enough skill to merely cover costs except those reported as expenses

3. Bootstrap (contd.)

- Table 4 reports simulated vs. actual precision-adjusted alpha at each percentile across the sample of all bond mutual funds sorted by precision-adjusted alpha
  - Columns 1 to 4 show 5-factor gross returns

	5-Factor Gross Returns			
Pct	Sim	Actual	%Sim<Act	p value
1	-2.58	-1.84 ‡	85.1	0.034 [a]
2	-2.22	-1.57 ‡	82.4	0.059 [a]

  - At the 1st percentile, average simulated precision-adjusted alpha of -2.58 is worse than the actual precision-adjusted alpha of -1.84, and 85.1% of simulated observations are worse than actual
  - Result suggests active fund management reduces magnitude and likelihood of negative precision-adjusted alpha
  - Parametric p-value of 0.034 suggests precision adjusted alpha of -1.84 is statistically insignificant yielding incorrect inference about the value of active fund management

20	**-0.96**	**0.48 ‡**	**99.6**	**0.316**

  - At the 20th percentile, actual precision-adjusted alpha of 0.48 exceeds average simulated precision-adjusted alpha of -0.96, and 99.6% of simulated observations are less than actual
  - Parametric p-value of 0.316 again fails to identify actual better than simulated precision-adjusted value
  - Active bond fund management adds value but parametric statistics fail to detect outperformance
  - At the 50th through 99th percentiles, both simulation and parametric statistics are in agreement that bond fund returns exhibit positive precision-adjusted alpha
  - Magnitude of actual is always higher than simulated and significant for 1st through 99th percentiles; active management (due to a combination of selection and timing) always adds value

3. Bootstrap (contd.)

- Table 4 (contd.):
  - Columns 9 through 12 show 5-factor net returns

	5-Factor Net Returns			
Pct	Sim	Actual	%Sim<Act	p value
1	-2.58	-3.27 †	16.9	0.001 [a]
2	-2.22	-2.44	33.6	0.008 [a]

  - For the 1st percentile, average simulated precision-adjusted alpha of -2.58 is worse than the actual precision-adjusted alpha of -3.27, and only 16.9% of simulated observations are worse than actual
  - At this percentile, the parametric p-value correctly identifies actual as bad performance
  - Even net of expenses, active bond fund managers add value (from selection skill and timing)
  - Negative (positive) precision-adjusted alpha is often more (less) likely to be statistically significant, leading to false inferences

3. Bootstrap (contd.) – Table 4

Panel A: All Actively Managed Bond Mutual Funds: 1999-2016

	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]

For net returns, % simulated less than actual is 80% or better for 5-factor (12-factor) model for 10-99th (30-99th) percentiles, consistent with simulation and timing as sources of risk-adjusted outperformance; even parametric stats suggest 60-99th percentile outperformance

3. Bootstrap (contd.)

- Table 4 (contd.):
  - Columns 5 through 8 show 12-factor gross returns, and 13 through 16 show 12-factor net returns
  - Results for all bond mutual funds suggest that after controlling for timing, selection skill generates meaningful precision-adjusted alpha
  - For gross returns, actual precision-adjusted alpha exceeds simulated in the 20th to 99th percentiles
  - For net returns, actual exceeds simulated in the 30th to 99th percentiles
  - Parametric statistics understate performance
  - Statistically significant negative precision-adjusted alpha in the 1st through 5th percentiles for gross returns, and 1st through 10th percentiles for net returns, falsely imply poor selection performance
  - Statistically insignificant positive precision-adjusted alpha in the 10th t0 40th percentiles for gross returns, and 20th to 60th percentiles for net returns, fail to detect good performance
- Figures 1 and 2 show cumulative probability and density functions of estimated simulated and actual precision-adjusted alpha at each percentile across all bond mutual funds for the 5- and 12-factor models using gross and net returns
- Figure 2 shows bond fund managers possess skill from selection and timing (5-factor model) and skill from selection (12-factor model) even on a returns net of expenses basis…

3. Bootstrap (contd.)

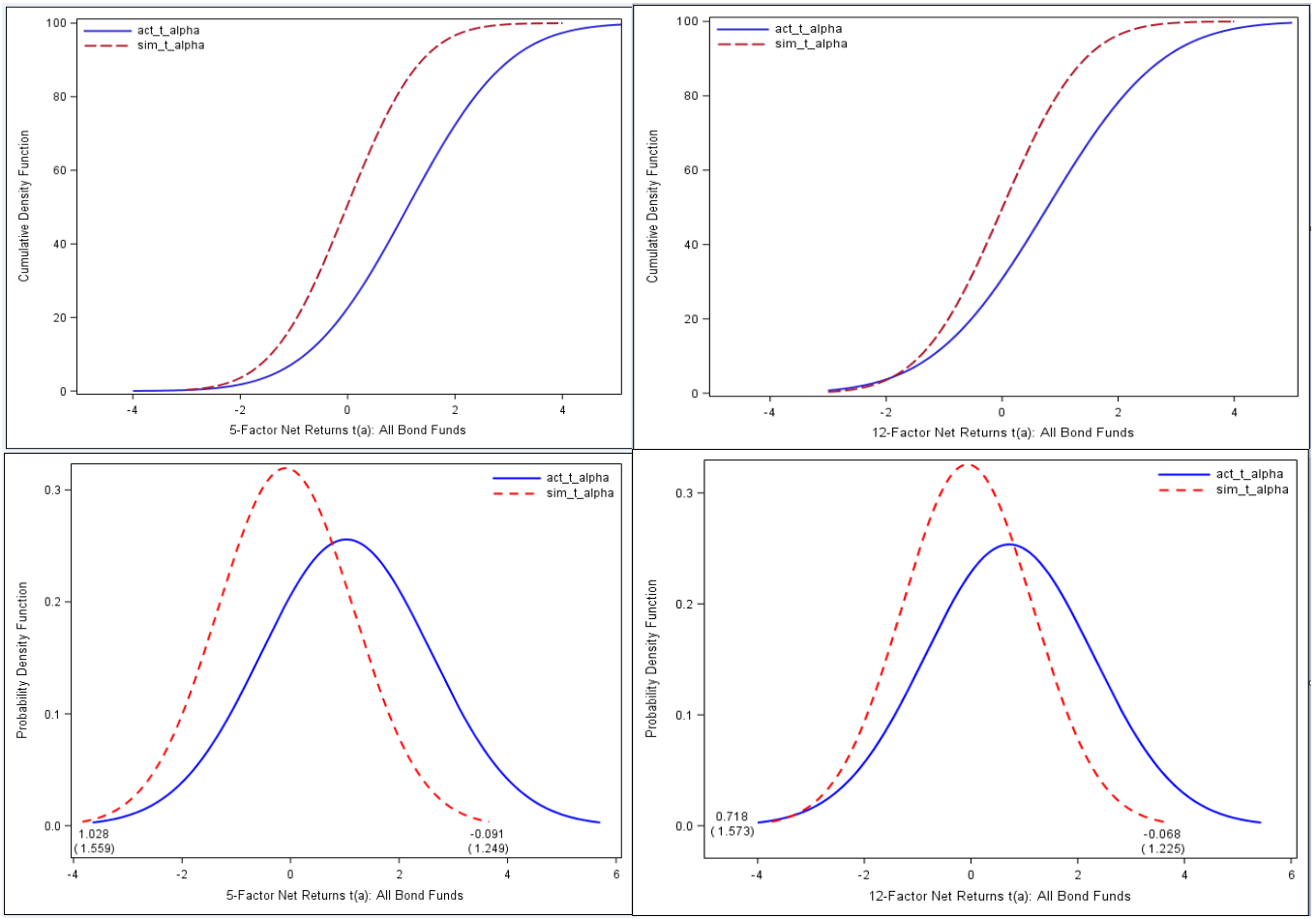

Figure 2: Simulated vs. Actual Cumulative and Probability Density Functions of t(α) using 5- and 12-factor model of returns net of expenses for all sample bond funds

3. Bootstrap (contd.) – Table 5

- Table 5 – shows precision-adjusted alpha estimates for simulated vs. actual net returns for all bond funds at different annual standard deviations of injected alpha
  - Panel A for 5-factor shows cross-section of simulated precision-adjusted alpha approximates actual precision-adjusted alpha at lower and upper tails of the distribution at threshold annual σ of 0.50% and 1.25%
  - Injected annual σ of 0.75% is necessary to make simulated precision-adjusted alpha worse than actual in the lower tail
  - % 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 in the lower tail
  - In upper tail, injected annual σ of 1.75% is necessary to make simulated appear better than actual
  - % simulated less than actual ranges from 47.8% to 4.1% at the 90th to 99th percentiles, consistent with simulated precision-adjusted alpha being more likely to be higher than actual at the upper tail
  - Panel B for 12-factor model also suggests cross-section of simulated precision-adjusted alpha approximates actual at lower and upper tails of the distribution at threshold annual σ of 0.50% and 1.25%
  - Same injected annual σ of 0.75% is necessary to make simulated worse than actual in the lower tail
  - % simulated less than actual ranges from 82.6% to 75.1% at the 1st to 10th percentiles, again consistent with simulated being more likely to be less than actual in the lower tail
  - At the upper tail, same injected annual σ of 1.75% is necessary to make simulated appear better than actual
  - The percent simulated less than actual ranges from 70.4% to 18.8% at the 90th to 99th percentiles, again consistent with simulated precision-adjusted alpha being more likely to be higher than actual in the upper tail
  - For 5-factor model, 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%, and for 12 factor model is 19.68%
  - Combined monthly standard errors for 5- and 12-factor models are 7.7 and 21 x monthly standard error of actual alpha
  - Our bootstrap simulations have considerable power

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3. Bootstrap (contd.) – Table 5 (Panel A example)

Injected annual σ of 0.75% is necessary to make simulated precision-adjusted alpha worse than actual in the lower tail, 1.75 better in upper tail

Table 4

All Actively Managed Bond Mutual Funds

			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

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).

In lower tail, % 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 in the lower tail

In upper tail, % simulated less than actual ranges from 47.8% to 4.1% at the 90th to 99th percentiles, consistent with simulated precision-adjusted alpha being more likely to be higher than actual in the upper tail

4. Asset Specialization and Fund Size (contd.) – Table 6

Asset Specialization – government vs. corporate, and within government, short (0-5 year), intermediate (5-10 year), long (10-30 year), or missing average effective duration, and within corporate average credit rating (AAA, AA, B, and LG). Fund Size - small ($5M to $250M AUM), mid-size ($250M to $750M), and large (>$750M)

Two lowest percentiles of govts show negative precision-adjusted alpha

For corporate bond mutual funds, significant positive precision-adjusted alpha from 20th to 99th percentile

	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	-1.32	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

For corporate bond mutual funds, significant positive precision-adjusted alpha from 30th to 99th percentile. Comparing 5- and 12-factor results for corporates, we conclude selection as well as timing are important in corporate bond mutual fund performance

For governments, significant positive precision-adjusted alpha from 20th – 99th percentile

For governments, comparison of magnitudes from 5- vs. 12-factor model suggests selection is relatively more important

4. Asset Specialization and Fund Size (contd.) – Table 7

All Actively Managed 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

For small, mid-size, and large funds, there is 5-factor positive precision-adjusted alpha in the top decile+ of all sample bond mutual funds

For small, mid-size, and large funds, there is 12-factor positive precision-adjusted alpha in the top decile of all sample bond mutual funds, suggesting some selection skill but also timing

4. Asset Specialization and Fund Size (contd.) – Table 8

	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
Actively Managed 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
Actively Managed 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

Precision adjusted alpha in most of top decile of all sizes governments and especially corporate bonds suggests skill, especially large funds

For all but the top percentile of small corporate funds, selection skill matters; for mid-size and large corporates, timing is more important

- Actual and average simulated precision-adjusted alpha for governments by short, intermediate, long, and missing average effective duration are reported in Appendix Table 1
  - Short duration governments have positive precision-adjusted alpha in 90th to 99th percentile in the 5-factor model & 90th to 97th percentile in 12-factor model; selection and timing are important
  - Intermediate, long, and some missing duration governments have negative precision-adjusted alpha in 90th to 99th percentiles; selection detracts from performance
  - Much of top decile of funds generally do not show positive or negative precision-adjusted alpha in 5-factor model, suggesting timing mitigates some of damage of poor selection among intermediate, large, and missing duration government bond funds
- Similar results for corporates by credit rating are in Appendix Table 2
  - Only top decile of corporate bonds in the AA, BBB, and No Rating categories consistently generate positive precision-adjusted alpha in 5-factor model
  - Only top decile of BBB rated funds have significant + precision-adjusted alpha in 12-factor model
  - Selection and timing are important for BBB rated corporate bond funds
  - For AA corporate bond funds, only timing contributes to outperformance
  - In bottom decile of funds, all ratings have positive precision-adjusted alpha from the 5-factor model, and AAA, A, BBB, Low Grade, and No Rating bonds show it from the 12-factor model, so selection skill mitigates otherwise even poorer performance among such funds

- Most literature on performance persistence in mutual funds (e.g., Carhart, 1997) focuses on short-run returns to draw conclusions about manager performance (Kosowski et al., 2006; Fama and French, 2010)
  - To check robustness of our 18-year performance results to short-term rolling estimation horizons, we partition our sample into 6 non-overlapping contiguous periods of 36 months
  - Using our 5- and 12-factor models, 3-year actual alphas are estimated for each bond mutual fund
  - Estimated alpha is subtracted from monthly returns for each 3-year 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 period
- Table 9 reports simulated and actual precision-adjusted alpha by percentile for all actively managed bond mutual funds, by size, and by government vs. corporate…

5. Short-Run Performance (contd.) – Table 9

3-Year $t(\alpha)$ by Actively Managed 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

Short-run 5-factor positive precision adjusted alpha exists in top decile of all bond funds, governments, and corporates, more for small and large funds, but 12-factor negative precision-adjusted alpha exists in top decile in many cases. Timing, not selection, creates value for top decile funds (selection sometimes detracts). Selection matters only in the lower decile of all types of funds, mitigating effects of bad timing

- Economic Value (EV) from Active Bond Mutual Fund Management
  - To estimate annualized excess alpha from active bond fund management, we multiply difference between actual and average simulated precision-adjusted alpha in prior tables by annualized median standard error of alpha
- Table 10 shows EV from 5-factor (selection and timing) and 12-factor (selection) models
  - EV is aggregated across percentiles…
  - For 5-factor model, annualized excess alpha is combined contribution of selection skill and timing
  - For 12-factor model, annualized excess alpha is the contribution of selection skill
  - 5-factor minus 12-factor reflects the contribution of timing
  - At each percentile, annualized excess alpha is then applied against AUM to compute total economic value (EV) from active bond fund management

6. EV (contd.) – Table 10

Percentile	5-Factor Net Returns: No of Funds	5-Factor Net Returns: Ave AUM ($M)	5-Factor Net Returns: EV/ AUM (bps)	12-Factor Net Returns: Ave AUM ($M)	12-Factor Net Returns: EV/ AUM (bps)	5-Factor Net Returns: No. of Funds	5-Factor Net Returns: Ave AUM ($M)	5-Factor Net Returns: EV/ AUM (bps)	12-Factor Net Returns: Ave AUM ($M)	12-Factor Net Returns: EV/ AUM (bps)
	All Actively Managed Bond Mutual Funds					Actively Managed Bond Mutual 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*
	Actively Managed Government Bond Funds					Actively Managed 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*

- Overall = cumulative EV from 1st to 99th percentile
- Positive (negative) EV indicates actual precision-adjusted alpha better (worse) than average simulated precision-adjusted alpha reflecting value of active bond fund management
- For the top 50% of large funds, selection adds an average of $2,667 million x **40.8 bps** = **$8.1 million**, more than offset -12.5 bps of AUM loss (= -$3.2 million at average AUM of $2,563.5 million) attributable to poor timing
- For the top 50% of all bond funds: EV = **30.2 bps** from both, 19.7 bps from timing, and 10.5 bps from timing (for an average $2.7 million from both, $1.5 million from selection and $0.9 million from timing)

6. EV (contd.) – Table 10

Percentile	No of Funds	5-Factor Net Returns Ave AUM ($M)	5-Factor Net Returns EV/ AUM (bps)	12-Factor Net Returns Ave AUM ($M)	12-Factor Net Returns EV/ AUM (bps)	No. of Funds	5-Factor Net Returns Ave AUM ($M)	5-Factor Net Returns EV/ AUM (bps)	12-Factor Net Returns Ave AUM ($M)	12-Factor Net Returns EV/ AUM (bps)
	All Actively Managed Bond Mutual Funds					Actively Managed Bond Mutual 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*
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Top										
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Overall	559	751	*25.8*	746	*16.0*	162	2,333	*23.5*	2,276	*35.0*
	Actively Managed Government Bond Funds					Actively Managed Corporate Bond Funds				
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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*

- Only bottom decile of actively managed government bond funds show negative selection and timing (EV is -4.7 bps of AUM for both selection and timing, -1.7 bps for selection only, so EV is -4.7-(-1.7) = -3.0 bps for timing)
- Highest selection plus timing, and selection, in bps of AUM, are also highlighted in yellow

7. Conclusion

- Paper examines whether bond mutual fund managers possess selection and/or timing skill using bootstrapped returns of 571 bond mutual funds (Jan 1999 - Dec 2016)
- Estimate selection and timing, selection, and difference (timing) using the 5-factor Fama and French (1993) bond model and a Chen et al. (2010) inspired 12-factor model
- EV created by bond fund managers from selection and timing is substantial…
  - For the top 50% of large funds, selection adds an average of $2,667 million x **40.8 bps** = **$8.1 million per fund**, more than making up for an average -12.5 bps of AUM loss (i.e., at an average AUM of $2,563.5 million, this would be -$3.2 million) attributable to poor timing
  - For the top 50% of all bond funds: EV = **30.2 bps** from both, 19.7 bps from timing, and 10.5 bps from timing (for an average $2.7 million from both, $1.5 million from selection, and $0.9 million from timing)
  - Only the bottom decile of actively managed government bond funds show negative selection and timing (EV is -4.7 bps of AUM for both selection and timing, -1.7 bps for selection only, so EV is -4.7-(-1.7)= -3.0 bps for timing)
  - The top 5% of corporate bond funds show the greatest selection and timing skill (as measured by bps of AUM), at 43.5 bps
  - The top 5% of large bond funds show the greatest selection skill by this measure at 59.8 bps (for an average of $4,664 million x **59.8 bps = $27.9 million**)
- In short-run, timing rather than selection is source of bond fund outperformance among top 10% performing funds, but selection mitigates poor performance of bottom decile funds
- Conclude managers show positive precision-adjusted alpha from selection and timing

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8. Bond Index Funds are growing but do not replace actively managed bond funds – and parallel bootstrapping methodology applied to bond index funds generates no precision-adjusted alpha