Modeling Active Management in the Japanese Bond Market

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The bond market in Japan has undergone significant development and change in recent years. A broad bond index—the Nomura-BPI—has been accepted as representative of the market and as the performance benchmark for active management since the late 1980s. Nevertheless, non-government market sectors were plagued by illiquidity, low spread levels, and volatility until the 1990s. The expansion of investment opportunities beyond Japanese government bonds (JGB) suggests that active managers now have the opportunity to add value by sector selection and rotation in addition to more traditional attempts to time interest rate changes.

We use a simulation methodology in order to develop estimates of excess returns, tracking errors, and return distributions for managers with differing levels of skill taking bets of different sizes away from the broad market benchmark. Expectations of actual manager performance will depend upon the size of the bets actual managers take and the level of skill they are expected to display.

We compare the simulation results with actual fixed-income manager performance and conclude with a comparison to simulated U.S. opportunities.

I. METHODOLOGY

The simulation method builds upon research on skill assessment in actively managed portfolios and the effect of a common currency in the European fixed-income market (see Fjelstad [1999] and Fox [1999]). We have expanded the methodology to allow more complex investment behavior, specifically, simultaneous active decisions in any number of dimensions.

A simulation procedure allows for decomposition of total return by source of contribution. We focus on two main sources: sector rotation and duration. For data limitation reasons, we cannot simulate yield curve or security selection strategies.

II. SIMULATING THE STRATEGIES

To simulate active manager performance, it is necessary to:

- Identify a market proxy or benchmark.
- Define and model the major components of the active management style that will be implemented in the Japanese funds.
- Select reasonable skill levels and bet sizes.

Identifying the Benchmark

The accepted benchmark for the Japanese bond market is the Nomura-BPI (Bond Performance Index). This index is composed of six main sectors: Government, Municipal, Government Guaranteed, Bank Debentures, Corporate, and Yen-Denominated Bonds.

As always with fixed-income, we face the problem that all securities held in the benchmark cannot necessarily be bought. Active managers often do not have complete freedom or the opportunity to invest in all securities or even, in some markets, all sectors. The problem of liquidity is particularly important in the Japanese market, and we have attempted to account for it by structuring some cases with liquidity constraints.

An additional issue is the mismatch of quality constraints between manager assignments and the benchmark. At present, most Japanese investors require that managers not hold bonds that are rated below A, yet the Bank Debenture sector of the Nomura-BPI includes all bank debentures rated BBB or better. The data necessary for us to assess the impact of this quality mismatch on excess return and residual risk are not available.

Defining Active Management Strategies

We assume that the style of active management in Japan will have elements of sector rotation (SR) and active duration (AD), as in active management styles in the United States and Europe. Confining ourselves to these two main strategies, we examine several cases to explore the individual contributions of SR and AD, as well as the combined effect. Additionally, we attempt to capture supply and liquidity effects by applying constraints on the positions in available assets.

Modeling Active Management

Sector Rotation. Benchmark weights are defined as the proportion of total market value in each sector in every month. Using monthly time series of weights and returns from February 1984 through December 1999, we model active management by altering the weights in each sector according to the allowable bet sizes. We simulate the active strategy over January 1997-December 1999.

We determine by the skill level how often our fictional manager picks the sector with the higher return over the next month. We perform 1,000 simulations for each case, and derive the average excess return, tracking error, and excess return distribution from the performance of these 1,000 managers.

The returns to one active SR manager over one month are expressed as:

$$r_p = r_b + \sum_{i=1}^{6} \tau_i r_i \tag{1}$$

where

r_p = return to active portfolio;
r_b = return to benchmark (Nomura-BPI);
τ_i = SR tilt size in sector *i;* and
r_i = return to sector index *i*.

We define market sectors differently as one way to assess the impact of liquidity constraints on active management. For some cases, we combine the six sectors of the benchmark into two: a broad government sector combining Japanese government bonds, Municipals, and Government Guaranteed sectors, and a corporate sector combining Bank Debentures, Corporate, and Yen-Denominated Bonds. For other cases, to explore the full potential of sector rotation, we separate out all six sectors and allow the simulated managers to invest in all of them.

Active Duration. The active duration managers are assumed to select between being short or long duration relative to the Nomura benchmark. We model the duration decision using the Government Short and Government Long indexes.

For example, to be long duration relative to the benchmark, the manager sells the Government Short Index and uses the proceeds to purchase the Government Long Index. The amount required is determined by the desired duration bet and the difference in duration between the short and long indexes.

As with sector rotation, we use 16 years of monthly returns, starting in February 1984, but the results report simulated active management from 1997 through the end of 1999. How often the 1,000 managers pick the sector with the highest return over the next month is determined by the skill level. Average excess return, tracking error, and the distribution of excess return are calculated as with sector rotation.

The expression for the returns to one active duration manager over one month is:

$$r_p = \tau_D \left(r_{GL} - r_{GS} \right) \tag{2}$$

where

τ_D = AD tilt size;
r_{GL} = return to the Government Long Index; and
r_{GS} = return to the Government Short Index.

Choice of Tilt. All active positions are selected simultaneously using mean-variance optimization. The inputs to the decision are the expected excess return of each sector and the expected covariance of excess return among all the sectors. To avoid selecting an exact forecasting model specification in the simulations, we impose the condition only that the forecasts be unbiased.

To examine the impact of SR and AD decisions on performance, we adopt an incremental approach. The exact cases are shown in Exhibit 1. The specific process is explained more fully in a technical appendix.

EXHIBIT 1
Cases

	Sector Specification	Duration Specification
Case 1 **Two-Way SR Only**	Two sectors: government and non-government Tilts fixed in magnitude: 5%, 10%, 15%, and 20% away from benchmark weights	Duration-neutral
Case 2 **AD Only**	Sector-neutral	Tilts fixed in magnitude: 0.25, 0.5, 1.0, 1.25, and 1.5 years away from benchmark duration
Case 3 **Two-Way SR and AD**	Two sectors: government and non-government Tilts fixed in magnitude: 5%, 10%, 15%, and 20% away from benchmark weights	Tilts fixed in magnitude: 0.25, 0.5, 1.0, 1.25, and 1.5 years away from benchmark duration
Case 4 **SR Only**	All sectors Maximum tilt size determined by benchmark weights; bets anywhere between zero and limit	Duration-neutral
Case 5 **AD Only**	Sector-neutral	Maximum tilt size is one year away from benchmark duration; bets anywhere between zero and limit
Case 6 **SR and AD**	All sectors Maximum tilt size determined by benchmark weights; bets anywhere between zero and limit	Maximum tilt size is one year away from benchmark duration; bets anywhere between zero and limit
Case 7 **Constrained SR and AD**	All sectors Tilt limits reflect liquidity/supply constraints: <u>Sector</u> <u>Upper</u> <u>Lower</u> JGB 35% -65% GovGuar 5% -5% Muni 7% -7% Corporates 2% -2% BankDeb 2% -2% YenDenom 0% 0%	Maximum tilt size is one year away from benchmark duration; bets anywhere between zero and limit

SR: Sector rotation. AD: Active duration.

Selecting Skill Levels

We estimate the distribution of active return, average excess return, and tracking error from SR and AD using skill levels of 0.0001, 0.001, 0.01, 0.05, and 0.10. The skill level is the approximate squared correlation between a manager forecast and the realized return for a particular sector. If the decision is two-way (e.g., selecting government or corporate only), these would correspond roughly to correctly selecting the highest-returning sector 50%, 51%, 55%, 60%, and 65% of the time, respectively.

These skill levels should produce a reasonable range of expectations of manager performance. Additional detail is provided in the technical appendix.

III. OVERVIEW OF RESULTS

We focus on the most important relationships and results of the simulations. Full results for all bet sizes and skill levels are available from the authors upon request.

Case 1

The first case focuses on the two-way sector rotation decision: government versus non-government. The subsectors of Government, Municipal, and Government Guaranteed are combined at market weight to represent the total government portfolio, and the subsectors of Bank Debentures, Corporate, and Yen-Denominated are combined at market weight to represent the total non-government portfolio.

In any one period, the active decision is constrained to be an exact absolute deviation from benchmark weight. We simulate the impact on excess return of bet sizes of 5%, 10%, 15%, and 20% away from benchmark weights.

Exhibit 2 displays the results of the 10% bet size at all skill levels, and Exhibit 3 shows the results of a 20% bet size. All positions taken are neutralized to benchmark duration, so that these results reflect only sector decision impact.

Over the simulation period, the opportunity to add value from a binary government/non-government decision was very limited. For a bet size of 20%, at the highest skill level, the mean annualized excess return is only 3 basis points (bp). The spread across skill levels is minimal, as is the dispersion in the distribution for each skill level.

Note that even at significant levels of skill, information ratios (IR) are low. For a given strategy, IRs are sensitive primarily to changes in the skill level, not the bet size or level of risk.

EXHIBIT 2

Excess Return Distribution—Two-Way Sector Rotation Only: Fixed Tilt Size of ±10%

	Skill Level				
	0.0001 (50%)	0.001 (51%)	0.01 (55%)	0.05 (60%)	0.10 (65%)
Mean	-0.005	-0.001	0.005	0.012	0.014
MIN	-0.177	-0.249	-0.175	-0.185	-0.194
5%	-0.112	-0.114	-0.104	-0.099	-0.096
10%	-0.097	-0.087	-0.080	-0.076	-0.072
25%	-0.056	-0.044	-0.041	-0.037	-0.034
50%	-0.006	-0.002	0.004	0.011	0.015
75%	0.043	0.045	0.047	0.058	0.057
90%	0.086	0.083	0.094	0.103	0.098
95%	0.115	0.103	0.119	0.130	0.114
MAX	0.205	0.190	0.228	0.215	0.190
Avg TE	0.114	0.114	0.114	0.114	0.114
Avg IR	-0.044	-0.006	0.047	0.107	0.123

EXHIBIT 3

Excess Return Distribution—Two-Way Sector Rotation Only: Fixed Tilt Size of ±20%

	Skill Level				
	0.0001 (50%)	0.001 (51%)	0.01 (55%)	0.05 (60%)	0.10 (65%)
Mean	-0.010	-0.001	0.010	0.023	0.028
MIN	-0.353	-0.499	-0.349	-0.371	-0.389
5%	-0.224	-0.227	-0.207	-0.197	-0.193
10%	-0.195	-0.174	-0.161	-0.152	-0.144
25%	-0.111	-0.089	-0.081	-0.073	-0.068
50%	-0.012	-0.003	0.008	0.021	0.030
75%	0.086	0.090	0.094	0.116	0.115
90%	0.172	0.165	0.188	0.207	0.196
95%	0.230	0.206	0.239	0.261	0.228
MAX	0.410	0.380	0.456	0.430	0.380
Avg TE	0.228	0.228	0.228	0.228	0.228
Avg IR	-0.044	-0.006	0.047	0.107	0.123

Case 2

Next we focus on the active duration decision. The simulated portfolios have neutral weight with respect to the benchmark sectors. In the results displayed in Exhibit 4, the active decision is constrained to be exactly a one-year absolute deviation from benchmark duration.

EXHIBIT 4

Excess Return Distribution—Active Duration Only: Fixed Tilt Size of ±1 Year

	Skill Level				
	0.0001 (50%)	**0.001 (51%)**	**0.01 (55%)**	**0.05 (60%)**	**0.10 (65%)**
Mean	-0.010	0.070	0.206	0.491	0.810
MIN	-1.660	-1.516	-1.402	-1.293	-0.950
5%	-0.931	-0.860	-0.780	-0.472	0.055
10%	-0.749	-0.639	-0.563	-0.215	0.239
25%	-0.434	-0.332	-0.199	0.123	0.514
50%	-0.025	0.068	0.227	0.523	0.824
75%	0.405	0.487	0.617	0.898	1.110
90%	0.753	0.800	0.925	1.160	1.357
95%	0.918	0.954	1.075	1.334	1.491
MAX	1.684	1.505	1.820	1.912	1.798
Avg TE	0.972	0.973	0.970	0.963	0.949
Avg IR	-0.010	0.073	0.217	0.522	0.868

EXHIBIT 6

Excess Return Distribution—Two-Way Sector Rotation and Active Duration—Fixed Tilt Sizes of ±20% and ±1 Year AD Skill of 0.01 (55%)

	Skill Level				
	0.0001 (50%)	**0.001 (51%)**	**0.01 (55%)**	**0.05 (60%)**	**0.10 (65%)**
Mean	0.214	0.227	0.214	0.225	0.246
MIN	-1.430	-1.494	-1.791	-1.445	-1.283
5%	-0.782	-0.761	-0.763	-0.792	-0.685
10%	-0.580	-0.545	-0.565	-0.555	-0.517
25%	-0.177	-0.168	-0.213	-0.178	-0.170
50%	0.231	0.238	0.258	0.243	0.266
75%	0.608	0.620	0.650	0.643	0.620
90%	0.963	0.969	0.933	0.951	0.988
95%	1.175	1.162	1.089	1.152	1.169
MAX	1.652	1.798	1.943	1.933	2.153
Avg TE	0.991	0.992	0.991	0.993	0.988
Avg IR	0.221	0.234	0.220	0.229	0.254

Consistent with the results of studies in other markets, the impact of active duration on excess return can be substantial in the presence of skill. At minimal levels of skill, the mean excess return is approximately zero. At a skill level of 0.01 (55%), however, the mean excess return increases to 21 bp.

EXHIBIT 5

Excess Return Distribution—Two-Way Sector Rotation and Active Duration—Fixed Tilt Sizes of ±10% and ±1 Year AD Skill of 0.01 (55%)

	Skill Level				
	0.0001 (50%)	**0.001 (51%)**	**0.01 (55%)**	**0.05 (60%)**	**0.10 (65%)**
Mean	0.226	0.228	0.210	0.207	0.224
MIN	-1.323	-1.463	-1.839	-1.378	-1.347
5%	-0.777	-0.733	-0.766	-0.792	-0.690
10%	-0.568	-0.522	-0.563	-0.530	-0.537
25%	-0.139	-0.169	-0.214	-0.187	-0.173
50%	0.257	0.238	0.257	0.231	0.254
75%	0.598	0.623	0.638	0.632	0.617
90%	0.946	0.960	0.923	0.935	0.966
95%	1.150	1.140	1.081	1.139	1.157
MAX	1.657	1.737	1.936	1.872	2.019
Avg TE	0.971	0.971	0.971	0.972	0.970
Avg IR	0.234	0.239	0.221	0.222	0.244

Active duration tracking error is constant across skill level, and is nearly four times the value of the sector rotation tracking error. Active duration strategies in the absence of skill raise tracking error by a substantial amount while adding nothing in terms of excess return.

With a skill level of 55%, however, the IR of this strategy is much higher than that of sector rotation at the same level of skill. A manager skilled in active duration can add substantial value.

Case 3

Case 3 combines the results of Case 1 and Case 2 in a simultaneous decision. In the results displayed in Exhibit 5, the active sector decision is constrained to exactly a 10% absolute deviation from benchmark weight, and the active decision is constrained to be exactly a one-year absolute deviation from benchmark duration. Duration skill is fixed at 0.01 (55%).[1] Exhibit 6 displays the results when the sector bet size is increased to 20%.

The active decisions in the simulated portfolios combine as we would expect. Excess return, tracking error, and information ratio outcomes are clearly dominated by the active duration component. Sector rotation contributes very little to the excess return and only slightly diversifies the active duration component.

EXHIBIT 7

Excess Return Distribution—Sector Rotation Only: Tilt Limits Determined by Benchmark Weights

	Skill Level				
	0.0001 (50%)	0.001 (51%)	0.01 (55%)	0.05 (60%)	0.10 (65%)
Mean	-0.036	-0.017	0.018	0.098	0.191
MIN	-0.999	-1.108	-1.011	-0.828	-0.759
5%	-0.533	-0.508	-0.495	-0.375	-0.278
10%	-0.399	-0.388	-0.370	-0.258	-0.187
25%	-0.228	-0.209	-0.176	-0.095	0.004
50%	-0.028	-0.023	0.020	0.097	0.193
75%	0.173	0.172	0.224	0.292	0.379
90%	0.324	0.359	0.394	0.459	0.554
95%	0.417	0.473	0.487	0.536	0.644
MAX	0.890	1.004	0.916	0.846	1.114
Avg TE	0.518	0.511	0.503	0.492	0.480
Avg IR	-0.028	0.012	0.083	0.226	0.431

EXHIBIT 8

Excess Return Distribution—Active Duration Only: Tilts Bounded by ±1 Year

	Skill Level				
	0.0001 (50%)	0.001 (51%)	0.01 (55%)	0.05 (60%)	0.10 (65%)
Mean	0.037	0.134	0.388	0.834	1.115
MIN	-1.549	-1.400	-1.357	-0.710	-0.470
5%	-0.860	-0.727	-0.522	-0.003	0.406
10%	-0.688	-0.537	-0.298	0.244	0.568
25%	-0.342	-0.243	0.023	0.588	0.848
50%	0.042	0.137	0.412	0.861	1.126
75%	0.428	0.490	0.753	1.145	1.410
90%	0.739	0.803	1.045	1.391	1.623
95%	0.932	0.984	1.211	1.498	1.759
MAX	1.753	1.483	1.712	1.914	2.186
Avg TE	0.929	0.927	0.927	0.910	0.894
Avg IR	0.042	0.147	0.427	0.933	1.268

Case 4

In case we focus again only on the sector rotation component of returns, but allow all six sector decisions to occur simultaneously. In any one period, there can be an active position in each of the six sectors. The only constraints are that the tilts are self-financing and that there are no net short positions. Results are displayed in Exhibit 7.

From an excess return perspective, the ability to select among six sectors compared to two is beneficial. The median return exhibits a greater degree of variation across skill levels, although a fairly significant level of skill (60%) is required for a significant positive impact and for a reasonable information ratio.

Tracking error also increases over the two-way fixed bet size results displayed in Exhibits 2 and 3.

Case 5

In Case 5 we focus only on the active duration component of returns and force the sector component to be benchmark-neutral. In any one period, there can be an active duration bet of no more than one year. This differs from Case 2 in that the size of the duration bet is not fixed.

The results presented in Exhibit 8 indicate that flexibility in degree of duration bet improves the ability to add value through active duration decisions. At the skill level of 0.01 (55%), we see an 18 bp increase in mean excess return over the fixed bet size.

The average tracking error is also slightly lower than in the fixed tilt case. This results in a more attractive IR at even moderate skill levels.

Case 6

Case 6 combines the sector rotation and active duration components of return, allowing a simultaneous decision across all six sectors and duration. In any one period, there can be a benchmark weight-constrained active position in each of the six sectors and an active duration bet of no more than one year.

The results in Exhibit 9 show that, as in the combination of Case 1 and Case 2, the combined effect of sector rotation and active duration is roughly additive in excess return.

EXHIBIT 9

Excess Return Distribution—Sector Rotation and Active Duration SR Benchmark Weight/AD up to ±1 Year: AD Skill of 0.01 (55%)

	Skill Level				
	0.0001 (50%)	**0.001 (51%)**	**0.01 (55%)**	**0.05 (60%)**	**0.10 (65%)**
Mean	0.302	0.368	0.422	0.489	0.534
MIN	-1.510	-1.353	-1.449	-1.083	-1.866
5%	-0.726	-0.670	-0.653	-0.462	-0.384
10%	-0.508	-0.449	-0.418	-0.289	-0.184
25%	-0.126	-0.049	0.021	0.066	0.165
50%	0.321	0.406	0.452	0.494	0.513
75%	0.734	0.805	0.829	0.890	0.914
90%	1.066	1.111	1.184	1.256	1.265
95%	1.268	1.311	1.387	1.405	1.473
MAX	2.020	2.361	2.038	2.238	2.320
Avg TE	1.057	1.067	1.047	1.052	1.049
Avg IR	0.297	0.362	0.412	0.473	0.518

EXHIBIT 10

Excess Return Distribution—Sector Rotation and Active Duration Liquidity-Constrained Sector Tilts AD up to ±1 Year: AD Skill of 0.01 (55%)

	Skill Level				
	0.0001 (50%)	**0.001 (51%)**	**0.01 (55%)**	**0.05 (60%)**	**0.10 (65%)**
Mean	0.353	0.392	0.375	0.370	0.373
MIN	-1.464	-1.164	-1.466	-1.089	-1.742
5%	-0.510	-0.530	-0.516	-0.490	-0.412
10%	-0.341	-0.329	-0.317	-0.309	-0.262
25%	0.008	0.002	0.012	0.022	0.022
50%	0.361	0.436	0.382	0.383	0.361
75%	0.733	0.762	0.757	0.743	0.708
90%	1.002	1.061	1.041	1.023	1.026
95%	1.176	1.208	1.221	1.218	1.186
MAX	1.957	2.064	1.776	1.903	1.773
Avg TE	0.925	0.927	0.923	0.93	0.926
Avg IR	0.389	0.431	0.413	0.407	0.413

Case 7

As in Case 6, in Case 7 we combine the sector rotation and active duration components of return, allowing a simultaneous decision across all six sectors and duration. Now, however, the sector positions are constrained to reflect supply and liquidity effects that are present in the non-government sectors.

Maximum active positions in the Government sector are determined by the benchmark weight. The Municipal and Government Guaranteed sectors are constrained to have active positions no larger than the end-of-sample market weight. The Bank Debentures and Corporate sectors are constrained to have active positions of no more than 2%. There can be no active position in the Yen-Denominated sector.

With the exception of sampling variation, the constraints remove all sector effects (*see Exhibit 10*). Illiquidity in non-government sectors removes the opportunity to add measurable value through sector rotation. These results suggest that the value added in Case 6 comes primarily from the Bank Debenture, Corporate, and Yen-Denominated sectors.

IV. COMPARISON OF SIMULATION RESULTS WITH ACTUAL MANAGER RETURNS

Exhibit 11 presents actual manager performance for the Russell Japan Fixed-Income Universe. The time period is identical to the simulation period of January 1997 through December 1999. In the comparisons, we focus on the combined strategy simulations in Exhibits 9 and 10.

For the universe, the distribution of actual returns has lower mean and is left-skewed compared to the simulated performance distributions. Additionally, the range of outcomes in the actual returns is narrower than the range in the simulations.

A key feature of the outcomes is that while actual tracking errors are lower than the simulated values in the unconstrained case, the actual average information ratios are considerably lower as well. Only the upper quartile of managers achieves excess returns and information ratios that suggest investment skill.

What can we conclude from a comparison? At first glance, it might seem that managers on average exhibit zero overall skill. What this comparison more likely illustrates is that there are substantial market- and index-related issues that affect performance. Illiquidity increases the cost of trades, a feature we are not able to capture.

EXHIBIT 11
Japan Fixed-Income Universe IQ1997-4Q1999

	Excess Return	Tracking Error	Information Ratio
Mean	-0.137	0.686	-0.261
Min	-0.802	0.195	-1.821
5%	-0.505	0.209	-1.336
10%	-0.489	0.291	-0.943
25%	-0.347	0.359	-0.426
50%	-0.088	0.548	-0.155
75%	0.082	0.862	0.123
90%	0.118	0.954	0.289
95%	0.229	1.152	0.380
Max	0.466	2.844	0.662

The illiquidity may cause managers not to take seemingly attractive positions because of prohibitive direct transaction costs or the non-negligible probability that it may not be possible to close out a position.

Lack of transparency in index constituents places undue emphasis on manager security selection, again a feature we are not able to capture. Without being able to see what is in the index, the manager is left to guess at the starting point for the active decision. This creates additional sources of tracking error and potential return slippage.

V. COMPARISON OF SIMULATED VALUES IN JAPAN AND THE U.S.

The simulated outcomes for Japan and the U.S. are very similar at the total strategy level. In the single-strategy simulations, there are differences in the market potential. Exhibits 12–17 mirror Cases 1–6, and present side-by-side values for Japan and the U.S.

Over the 1997-1999 window, both markets are characterized by a difficult environment for outperforming the benchmark using sector rotation strategies. Looking at Exhibits 12 and 15, it appears there may be more opportunity in sector rotation in the U.S. market.

The average excess returns are slightly higher and the range of outcomes is significantly wider in the U.S. market. Two-way sector rotation with fixed tilt sizes, however, reduces average excess return in the U.S. market to levels very near that in Japan.

EXHIBIT 12
U.S. and Japan Excess Return Distribution Two-Way Sector Rotation Only: Skill of 0.05 (60%), **Fixed Tilt Size of ±20%**

	Japan	U.S.
Mean	0.023	0.033
MIN	-0.371	-0.675
5%	-0.197	-0.368
10%	-0.152	-0.290
25%	-0.073	-0.138
50%	0.021	0.034
75%	0.112	0.209
90%	0.207	0.353
95%	0.261	0.420
MAX	0.430	0.721
Avg TE	0.228	0.411
Avg IR	0.107	0.081

EXHIBIT 13
U.S. and Japan Excess Return Distribution Two-Way Active Duration Only: Skill of 0.01 (55%), **Fixed Tilt Size of ±1 Year**

	Japan	U.S.
Mean	0.206	0.081
MIN	-2.103	-1.223
5%	-1.170	-0.576
10%	-0.844	-0.434
25%	-0.299	-0.193
50%	0.341	0.086
75%	0.926	0.356
90%	1.387	0.594
95%	1.613	0.726
MAX	2.731	1.299
Avg TE	0.970	0.681
Avg IR	0.217	0.129

There is an advantage in both markets to varying bet size and diversifying the non-government bets across multiple sectors. This advantage is greater in the U.S. market, generating higher excess returns with lower tracking error, leading to a slightly higher average information ratio.

EXHIBIT 14

U.S. and Japan Excess Return Distribution Two-Way Sector Rotation and Active Duration—Fixed Tilt Sizes of ±20% and ±1 Year: AD Skill of 0.01 (55%)

	Japan	U.S.
Mean	0.225	0.113
MIN	-1.445	-1.635
5%	-0.792	-0.661
10%	-0.555	-0.488
25%	-0.178	-0.203
50%	0.243	0.111
75%	0.643	0.441
90%	0.951	0.710
95%	1.152	0.864
MAX	1.933	1.591
Avg TE	0.993	0.794
Avg IR	0.229	0.123

EXHIBIT 15

U.S. and Japan Excess Return Distribution Sector Rotation Only—Skill of 0.05 (60%) **Tilt Limits Determined by Benchmark Weights**

	Japan	U.S.
Mean	0.098	0.135
MIN	-0.828	-1.080
5%	-0.375	-0.405
10%	-0.258	-0.286
25%	-0.095	-0.082
50%	0.097	0.140
75%	0.292	0.361
90%	0.459	0.552
95%	0.536	0.655
MAX	0.846	1.139
Avg TE	0.492	0.565
Avg IR	0.226	0.256

EXHIBIT 16

U.S. and Japan Excess Return Distribution Active Duration Only—Skill of 0.01 (55%) **Tilt Bounded by ±1 Year**

	Japan	U.S.
Mean	0.388	0.164
MIN	-1.357	-1.102
5%	-0.522	-0.462
10%	-0.298	-0.327
25%	0.023	-0.093
50%	0.412	0.165
75%	0.753	0.429
90%	1.045	0.649
95%	1.211	0.775
MAX	1.712	1.337
Avg TE	0.927	0.645
Avg IR	0.427	0.255

EXHIBIT 17

U.S. and Japan Excess Return Distribution Sector Rotation and Active Duration SR Benchmark Weight/AD up to ±1 Year SR Skill of 0.05 (60%) **and AD Skill of 0.01** (55%)

	Japan	Japan—Liquidity-Constrained	U.S.
Mean	0.488	0.370	0.299
MIN	-1.083	-1.089	-1.664
5%	-0.462	-0.490	-0.520
10%	-0.289	-0.309	-0.328
25%	0.066	0.022	-0.029
50%	0.494	0.383	0.304
75%	0.890	0.743	0.632
90%	1.256	1.023	0.921
95%	1.405	1.218	0.921
MAX	2.238	1.903	2.110
Avg TE	1.052	0.930	0.853
Avg IR	0.473	0.407	0.362

The duration-only strategies appear to be more effective in Japan than in the U.S. over this time period. Simulated outcomes for duration strategies in the Japan market, presented in Exhibits 13 and 16, have significantly higher average excess returns and wider ranges of outcomes.

In the Japanese market over our simulation period, returns to the long end of the curve were significantly higher than returns to the short end. This gives greater opportunity to increase investment returns by timing interest rates. In the U.S., returns to the short and long portions of the government market were almost equal over the period, giving less opportunity to add value through active bets versus the benchmark.

The active duration component of the combined strategy is the source of the simulated active management value in the Japanese market shown in Exhibits 14 and 17. The U.S. market during this period did not offer active managers much opportunity to add value through active duration bets, although U.S. managers had slightly greater opportunities in sector rotation.

All comparisons need to be conditioned on the radically different economic environments in Japan and the U.S. during this time period. Extraordinary conditions persist in Japan, and the events over the last three years have changed the structure of the market.

VI. CONCLUSION

Any generalizations derived from a study over a short time frame are clearly conditional on the market conditions of the time. Nevertheless, consistency of the results of a number of studies across fixed-income markets over different time horizons allows us to make some general observations.

Active duration strategies offer greater potential for excess returns, but also result in substantial tracking error. Intense and skilled manager research is necessary to identify managers with skill in duration betting, to ensure excess returns at a level to compensate for increased tracking error.

Sector rotation strategies in the investment-grade markets, as represented by broad market indexes, offer much smaller potential excess returns. Market illiquidity means this potential in Japan is even lower than in the U.S. For managers skilled in sector rotation to add any meaningful excess returns, they need to be able to invest opportunistically in sectors outside the investment-grade domestic market.

TECHNICAL APPENDIX
Simulation Methodology

We present the essential components and intuition of the simulation methodology. For a complete description of the methodology, see Fox [2002].

A hypothetical manager constructs a portfolio by selecting among N assets. For each of the N assets, the manager knows the unconditional distribution of the asset's past return. Additionally, for each N asset, the manager makes a forecast of the one-period-ahead return. The manager's forecast represents proprietary skill and is a signal of the future return.

Mathematically, the model is as follows:

$$\begin{aligned} r_{t+1}(t+1) &= \mu + \eta_{t+1}(t+1) \\ R_t(t+1) &= r_{t+1}(t+1) + \varepsilon_{t+1}(t+1) \end{aligned} \tag{A-1}$$

where $r_{t+1}(t + 1)$ is the time $t + 1$ return, observed at time $t + 1$; μ is the unconditional expectation of $r_{t+1}(t + 1)$; $R_t(t +1)$ is the manager's forecast of the time $t + 1$ return, made at time t; and $\varepsilon_{t+1}(t + 1)$ is the forecast error of the time $t + 1$ return, observed at time $t + 1$. We assume that the error terms η and ε are normally distributed and independent of each other:

$$\begin{aligned} &\eta_{t+1}(t+1) \sim N(0, \Sigma) \\ &\varepsilon_{t+1}(t+1) \sim N(0, \Sigma_\varepsilon) \\ &E\left[\eta_{t+1}(t+1)\varepsilon_{t+1}(t+1)\right] = 0 \end{aligned} \tag{A-2}$$

We also assume that the quantities μ and Σ are known to all participants, and Σ_ε is known only to the manager.

How does the manager's view of the future change after making the forecast? To determine that, we need to compute the conditional distribution of asset returns, where the conditioning information is the forecast. Under our assumptions, the returns and forecasts are jointly normally distributed as:

$$\begin{bmatrix} r \\ R \end{bmatrix} \sim N\left(\begin{bmatrix} \mu \\ \mu \end{bmatrix}, \begin{bmatrix} \Sigma & \Sigma \\ \Sigma & \Sigma + \Sigma_\varepsilon \end{bmatrix}\right) \tag{A-3}$$

Conditioning the asset return distribution on the forecast results in the conditional distribution:

$$\begin{aligned} r|R &\sim N(M, S) \\ M &= \mu + \Sigma(\Sigma + \Sigma_\varepsilon)^{-1}(R - \mu) \\ S &= \Sigma - \Sigma(\Sigma + \Sigma_\varepsilon)^{-1}\Sigma \end{aligned} \tag{A-4}$$

The conditional mean and covariance are adjusted values of the unconditional mean and covariance. The adjustments are based on two quantities: the signal-to-noise ratio, and the excess return of the forecast over the unconditional mean. In the model, the signal-to-noise ratio is determined by the size of Σ_ε, which is the degree of precision of the manager's forecast.

When Σ_ε is very large, the manager has unreliable information, and the conditional mean and covariance are close to the unconditional values. As Σ_ε becomes very small, the signal becomes very precise, and the manager has nearly perfect foresight.

A convenient simplification is to define the precision of the forecasts relative to the underlying asset volatility. Let the scalar K be the measure of precision, so that $\Sigma_\varepsilon = K\Sigma$.[2] Now, the conditional mean and covariance are given by:

$$M(K) = \mu + \Sigma(\Sigma + K\Sigma)^{-1}(R - \mu)$$
$$S(K) = \left(\frac{K}{K+1}\right)\Sigma \qquad \text{(A-5)}$$

When K is very large, the forecasts are based on no information, and the signal of future returns is discounted. In this case, the mean and covariance are close to the unconditional value. When K is very small, the forecasts are extremely precise, and the conditional values approach perfect foresight.

Portfolio Decision

In formulating the way the manager chooses deviations from benchmark weights, we are choosing the risk objective function. To develop intuition for the underlying relationships, we assume investor preferences are defined by a tracking error/excess return trade-off.

Mathematically, the manager solves the following:

$$\min_{\tau} \frac{1}{2}\tau' S(K)\tau$$
$$\text{s.t.} \quad \tau' M(K) = \overline{\alpha}$$
$$\tau' i = 0 \qquad \text{(A-6)}$$

where the values of $M(K)$ and $S(K)$ are the functions of the manager's skill level K as defined in Equation (A-5). The optimal tilts are linear functions of frontier constants and target excess return, $\overline{\alpha}$:

$$\hat{\tau} = \frac{\overline{\alpha}}{D(K)}\left[C(K)S(K)^{-1}M(K) - A(K)S(K)^{-1}i\right] \qquad \text{(A-7)}$$

where

$$A(K) = M(K)' S(K)^{-1} i$$
$$B(K) = M(K)' S(K)^{-1} M(K)$$
$$C(K) = i' S(K)^{-1} i$$
$$D(K) = BC - A^2 \qquad \text{(A-8)}$$

and i is a vector of ones.

ENDNOTES

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[1]We fix the AD skill level at 55% for reporting results for the combined cases. That skill level allows us to demonstrate the differential impact of AD versus SR skill without increasing the returns to the AD portion so much that we obscure comparisons of the impact of the strategies on excess returns.

[2]Note that $1/K$ is the signal-to-noise ratio, and $1/(1 + K)$ is the R^2 for the regression of the forecasts on the realized returns.

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