

**ON BEATING YOUR BENCHMARK:  
EVIDENCE FROM THE CANADIAN BOND MARKET**

by

Cory D. Custer  
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## APPROVAL

**Name:** Cory D. Custer  
**Degree:** Master of Business Administration  
**Title of Thesis:** On Beating Your Benchmark:  
Evidence from the Canadian Bond Market  
**Supervisory Committee:**

---

**Dr. Robert R. Grauer**  
Senior Supervisor  
Endowed Professor, Faculty of Business Administration

---

**Dr. Andrey D. Pavlov**  
Supervisor  
Assistant Professor of Finance

**Date Approved:**

*December 7, 2004*

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## **ABSTRACT**

This paper presents evidence of the predictability of monthly fixed-income sector returns using Canadian bond market data from July 1994 to September 2004. To measure the economic value of this predictability I use a dynamic mean-variance optimization methodology that is designed to approximate the investment decision an active sector-rotation bond manager faces each month. Optimal out-of-sample portfolios of the 18 sub-indices of the Scotia Capital Bond Universe are formed on a monthly basis using the sub-indices' average yield to maturity as naïve mean-return estimator. The value of the of the yield-to-maturity estimator is assessed using ordinary least-squares regression as well as the information ratio of an investment strategy that invests in the optimal portfolios. Results are presented and analyzed in a performance attribution framework designed to identify the sources of excess return.

## **DEDICATION**

To Pascha and Bianca, whose love and support make it all worthwhile.

## **ACKNOWLEDGEMENTS**

I would like to express my deep gratitude to Stephen Burke who has been both a teacher and coach. His gift of time and his dedication have made this project possible. I would also like to thank Rob Grauer and Andrey Pavlov for their classroom instruction as well as their supervision on this project.

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# 1 INTRODUCTION

Portfolio managers should employ active strategies only to the extent that they believe market inefficiencies exist and that they have the ability to exploit those inefficiencies. Essentially this means that a manager possess the ability to forecast future security returns and translate those forecasts in portfolio decisions that result in excess risk-adjusted performance. But how predictable do security returns need to be for managers to outperform their benchmarks? The purpose of this paper is to shed some light on this question. Using recent historical data from the Canadian bond market I find that an active portfolio strategy using a naïve forecasting signal is able to potentially add significant value for investors. My results provide a possible explanation why the vast majority of intuitional investors use active managers and further suggest that managers could benefit from even weak forecasting signals.

Much research has been devoted to determining the extent to which bond markets are efficient and therefore, to what extent returns are predictable. Although the results from these studies are generally mixed, most investors do not believe that bond markets are perfectly efficient and therefore returns are, at least to some degree, predictable. This conclusion is supported by the fact that the “average institutional investor has approximately 85% of its fixed-income assets managed actively and while only 15% is indexed” (Dopfel, 2004, p. 35).

The vast majority of studies that find predictability of fixed-income securities use structural models and employ econometric techniques. A few of the more-widely cited

authors are: Ilmanen (1997) who finds a set of four widely available instrumental variables which are able to forecast 10% of the monthly variation in long-term bond returns; Elton, Gruber and Blake (1995) who develop a factor model that is successful forecasting bond returns; and finally, Chang and Huang (1990) who use an asset pricing model to successfully price corporate bonds.

However, even if researchers are able to find statistically valuable predictors of future returns, investors and portfolio managers are ultimately concerned with the economic value of forecasts. While many studies implicitly assume the two measures of value will lead to comparable results, this is not necessarily the case. For example, Leitch and Tanner (1991) have suggested that summary statistics for least-squares regression analysis may be inappropriate for measuring the economic value of forecasts. In addition, Grauer (2002), using a portfolio selection model, has shown that measuring the statistical value of mean return forecasts can lead to very different conclusions than measuring the economic value of those same forecasts.

In spite of this apparent discrepancy between statistical and economic significance, relatively few studies focus on the latter. Even fewer still attempt to measure economic value using models of portfolio choice. There are, however, a few notable exceptions. Klemkosky and Bharati (1995) for instance, study the performance of asset allocation portfolios using stock and bond market forecasts based on observable economic variables. Kandel and Stambaugh (1996) test the economic value of stock-return predictability by examining its impact on an investor's portfolio decision. Fleming, Kirby, Ostdiek (2001) investigate the economic value of volatility timing by comparing the performance of dynamic volatility timing strategies with the performance

of buy-and-hold mean-variance efficient portfolios formed using the unconditional means, variances and covariances. Finally, Grauer (2002) examines the predictability of stock returns and he compares the statistical value of several mean estimators to their economic value using a portfolio selection model.

In addition, there are two papers of this type that focus solely on fixed-income securities. The first, Iwanowski (1996), solves a number mean-variance fixed-income sector allocation problems using the unconditional means, variances and covariances. Although he makes no attempt to forecast returns per se, he finds several out-of-sample solutions that outperform the Lehman Brother Broad Investment Grade Index while taking approximately the same amount of risk. While the focus of his paper is not on the predictability of returns, his results suggests that there may be some economic reward in trying to do just that. The second is de La Bruslerie (2004). In his paper de La Bruslerie attempts to discover if there is a relationship between the ability to forecast interest rates and the realization of excess portfolio returns. He employs Monte Carlo simulations in models of active domestic and international bond allocation strategies and finds a number of strategies that lead to excess return with a level of forecasting ability that is in line with the skill level of actual managers cited by other authors.

Iwanowski's and de La Bruslerie's results would seem to indicate that there may be economic value in using forecasts that require average or below average levels of skill. Although not specifically in the context fixed-income portfolio management, this conclusion is certainly support by Barton Waring who writes "...how much skill is needed [to exploit market inefficiencies]? As it turns out, not much" (Waring, 2003, p. 27).

Using data from the Canadian bond market, this paper contributes to the literature that attempts to answer the question: Can active bond managers deliver excess returns? It proceeds as follows. Section 2 presents a model of active long-only portfolio management and describes the inputs employed in its use. Section 3 describes the data used to perform the investigation. Section 4 presents simple statistical measures of the value of a naïve forecasting signal and presents an argument in favour of the information ratio as an appropriate measure of value added. Section 5 presents the results of an investment strategy designed to approximate an active sector rotation fixed-income investment management. Section 6 evaluates the performance of the strategy using a simple performance attribution framework. Finally, Section 7 concludes.

## 2 OPTIMAL ACTIVE PORTFOLIO SELECTION

The portfolio decisions made by an active sector-rotation bond manager can be modelled using the following dynamic quadratic programming problem. In each period the manager chooses the weights  $\mathbf{x}_p = (x_1, x_2, \dots, x_n)$  of the portfolio components to maximize the following objective function:<sup>1</sup>

$$\boldsymbol{\mu}_p^T (\mathbf{x}_p - \mathbf{x}_{bm}) - \frac{\lambda}{2} [(\mathbf{x}_{bm} - \mathbf{x}_p)^T \boldsymbol{\Sigma} (\mathbf{x}_{bm} - \mathbf{x}_p)] \quad (1)$$

subject to

$$\mathbf{1}^T \mathbf{x}_p = 1 \quad (2)$$

$$x_{p_i} \geq 0 \text{ for all } i \text{ portfolio components} \quad (3)$$

$$\mathbf{x}_p^T \mathbf{D} = \text{Modified duration of the benchmark} \quad (4)$$

where

$\boldsymbol{\mu}_p$  = the vector of expected returns,

$\mathbf{x}_{bm}$  = the vector of component weights in the benchmark,

$\mathbf{D}$  = a vector the modified durations of the sub-indices,

$\lambda$  = the investor's aversion to active risk,

$\boldsymbol{\Sigma}$  = the variance-covariance matrix of historical returns,

$^T$  = the matrix transpose operator,

$\mathbf{1}$  = a vector of ones.

---

<sup>1</sup> To keep the notion simple I have dropped the subscript  $t$  denoting time.

Constraint (2), the budget constraint, ensures that the portfolios are fully invested by imposing the requirement that weights of the components sum to one, while constraint (3) imposes the restriction of no short sales. Constraint (4) ensures that the portfolio is duration-neutral. The purpose of this constraint is two-fold. First, it replicates a risk-controlled, sector-rotation strategy in which the bond portfolio manager avoids attempting to forecast interest rate levels and instead focuses his effort on adding value through forecasting relative sector excess returns. Second, it facilitates the performance attribution analysis performed later in this paper by eliminating the duration effects which could potentially dominate the analysis and make it difficult to assess the value of the forecasting signal.

I employ this model, and a more tightly constrained version of it, to approximate the investment decisions that an active sector-rotation bond manager faces each month. Using historical data from the Canadian fixed-income market, optimal portfolios are formed for each month of a sample time period using only the information available on that date. The components of the optimal portfolios are the 18 sub-indices of the Scotia Capital Universe Bond Index.<sup>2</sup>

Expected excess returns and volatility inputs used in the model are generated using very naïve forecasts. Expected excess returns are estimated using the average yield to maturity for each sub-index. In other words, it is assumed that yield spreads relative to the benchmark remain constant from one month to the next and therefore relative returns

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<sup>2</sup> While in practice most active bond managers attempt to add value through security selection, the focus of this paper is on the predictability of sector excess returns.

are equal to the yield of each sub-index in excess of the yield of the benchmark.<sup>3</sup> While this is admittedly a rather simplistic approach, if returns are predictable using this naïve estimator, results should only improve when using more sophisticated estimation techniques. Expected excess risk is estimated each month using the unconditional variances and covariances from the previous 60-months. I use  $\lambda = 1$  for the level of active risk aversion. This choice is arbitrary and using other values does impact the general conclusions presented here.

To measure excess risk and return an equal-weighted portfolio of the 18 sub-indices of the Scotia Capital Bond Universe is used as a benchmark. While this may not be an obvious choice of benchmarks, it was chosen for two reasons. First and foremost, since by design the component weights of the benchmark are known, I was able to perform the detailed performance attribution analysis presented later in this paper. Second, the specification of the model dictates that active, or benchmark relative, excess return and risk (tracking error) should be the only performance measures of concern to active managers following a benchmark tracking strategy. Therefore, as long as it is generally representative, the choice of benchmarks is arbitrary.<sup>4</sup>

Once formed, portfolios are held for one month and returns are recorded. Strategy returns are calculated each month using the optimal portfolio weights found in Equation (1). The realized return,  $r_t$ , of the strategy at time  $t$  is given by:

$$r_t = \mathbf{r}_t' \mathbf{x}_{p t} \tag{5}$$

where:

---

<sup>3</sup> See Uysal, Trainer, and Reiss (2001) who use average yields as return estimates in order to compare mean-variance optimization with scenario analysis for bond portfolio management.

<sup>4</sup> Using the more widely followed Scotia Capital Universe Bond Index I find quantitatively similar results.



$\mathbf{r}_t$  = The vector of realized sub-index returns at time t, and

$\mathbf{x}_{p,t}$  = The vector of component weights in the portfolio at time t.

The process is repeated for each month in the sample. Implicit in this methodology is that proceeds from each month are reinvested. In addition, no restrictions on turnover or adjustments for transaction or market impact costs are made. Finally, it is also assumed that all individual securities are held in the exact proportion they represent in the underlying the sub-index and that changes are made costlessly as index additions and deletions are made.

### 3 DATA

For this investigation I use Canadian investment grade bond data from Scotia Capital for the period July 1989 to September 2004. Scotia Capital segments its Universe Bond Index into 18 sub-indices using three term-to-maturity categories (Short, Mid, Long) for three the government bond sectors (Canada, Provincial, Municipal) and three rating categories for investment grade corporate bonds (AA, A and BBB.) Table 1 shows summary statistics for the 18 sub-indices.

**Table 1 Summary Statistics for the 18 Sub-Indices of the Scotia Capital Universe Bond Index**

Reported are the average monthly returns (Mean) and standard deviations (Std Dev) of monthly returns for the 18 sub-indices of the Scotia Capital Universe Bond Index, an equal-weighted benchmark and the 30-day Canada Treasury bill. The numbers presented are percentages and cover period July 1994 to September 2004 (123 months). All data are from Scotia Capital.

	Canada			Provincial			Municipal		
	Short	Mid	Long	Short	Mid	Long	Short	Mid	Long
Mean	0.59	0.74	0.89	0.61	0.76	0.94	0.64	0.78	0.92
Std Dev	0.78	1.45	2.19	0.8	1.43	2.15	0.84	1.46	2.04
	AA			A			BBB		
	Short	Mid	Long	Short	Mid	Long	Short	Mid	Long
Mean	0.62	0.78	0.9	0.64	0.8	0.9	0.67	0.85	1
Std Dev	0.81	1.4	2.04	0.77	1.35	2.02	0.9	1.43	2.18
	Equal-Weighted Benchmark			Canada 30-Day T-Bill					
Mean	0.78			0.34					
Std Dev	1.37			0.12					

Scotia provides monthly total return and average yield to maturity time series data for each of the sub-indices beginning in February 1986. However, the modified duration time series is only available starting July 1994. Therefore, the portfolio formation period for this investigation runs from July 1994 to September 2004 (123 months.)

Before presenting the results of this investigation it is worth noting a few general yield curve and yield spread characteristics for the period. As Figure 1 shows the yields for each of the three maturity categories generally fell over the period of investigation. Notably, however, from January 1999 to December 1999 yields increased and the yield curve flattened completely in the last quarter of 1999.

**Figure 1 Yield to Maturity for the Government of Canada Bond Indices**

Average yield to maturity, measured in percent, is presented for the short-, mid- and long-term Government of Canada bond indexes for period July 1994 to September 2004 (123 months).

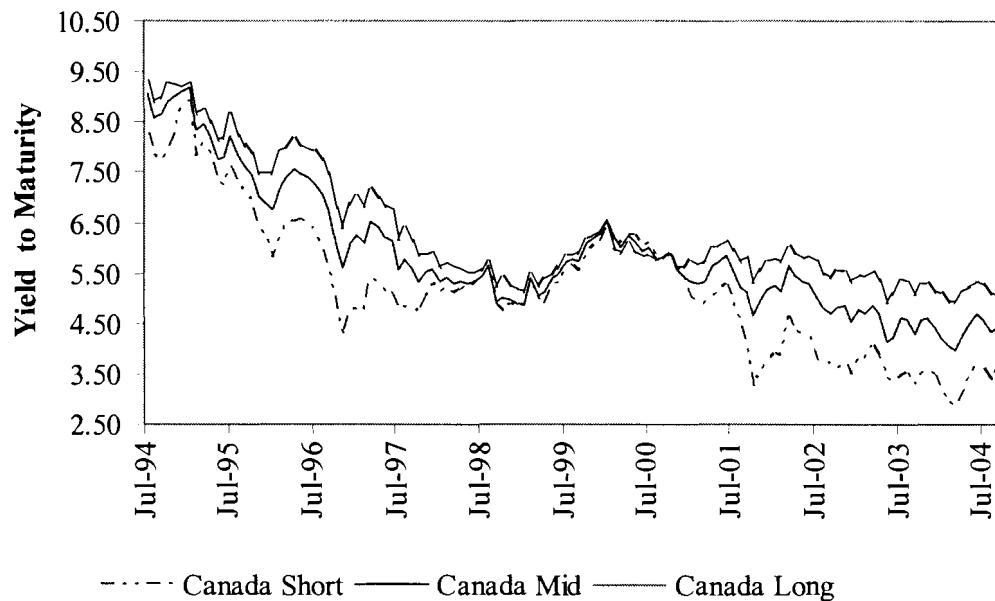
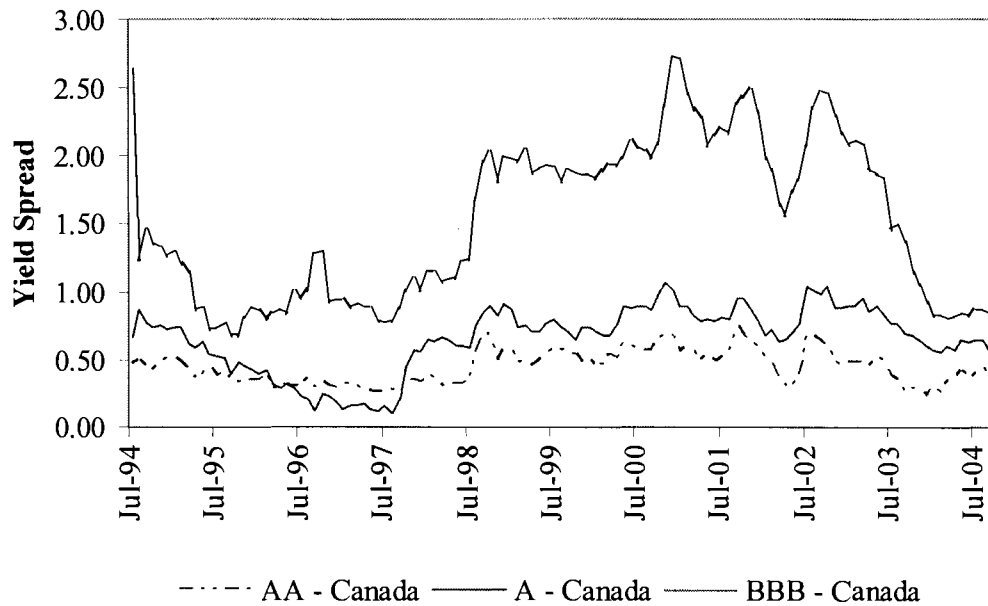


Figure 2 shows the yield spread over the mid-term Canada sub-index for the three mid-term corporate bond sub-indices, AA, A and BBB. Although some of the spread movement shown is due to general yield curve movement it gives a sense of how spreads evolved during the period.

**Figure 2 Corporate Bond Yield Spreads**

The yield spread of the three mid-term corporate bond sub-indices, AA, A and BBB, are presented for period July 1994 to September 2004 (123 months). The spread reported is the spread over the mid-term Canada yield and is given by the average yield of the mid-term corporate index minus the yield of the mid-term Government of Canada index.



## 4 MEASURING VALUE

To get a sense of how well the average yield to maturity predicts future bond returns I test the forecast using in-sample and out-of-sample linear regressions. Table 2 shows the results for the in-sample linear regressions of returns on lagged average yield to maturity. The results reveal no statistical value in the forecasts for all but one of the sub-indices, Mid A.

**Table 2 In-Sample Results of Yield to Maturity Forecasts.**

Reported are the results of the in-sample regressions of bond sub-index total monthly returns on lagged average yield to maturity. Regressions are performed using Ordinary Least Squares and the following model:  $\text{Return}_t = \alpha + \beta \text{Yield}_{t-1} + \varepsilon$ . The is period July 1994 to September 2004 (123 months).

		$\alpha$	<i>t-stat</i>	$\beta$	<i>t-stat</i>	$R^2$
<b>Canada</b>	<b>Short</b>	0.04	0.19	0.20	1.10	0.010
<b>Canada</b>	<b>Mid</b>	-0.02	-0.27	0.03	0.16	0.000
<b>Canada</b>	<b>Long</b>	0.12	1.34	0.17	0.80	0.005
<b>Provincial</b>	<b>Short</b>	0.00	-0.02	0.16	0.98	0.008
<b>Provincial</b>	<b>Mid</b>	0.01	0.17	0.11	0.50	0.002
<b>Provincial</b>	<b>Long</b>	0.09	0.70	0.18	0.78	0.005
<b>Municipal</b>	<b>Short</b>	0.02	0.09	0.19	0.86	0.006
<b>Municipal</b>	<b>Mid</b>	0.01	0.38	0.07	0.39	0.001
<b>Municipal</b>	<b>Long</b>	0.09	0.92	0.16	0.78	0.005
<b>AA</b>	<b>Short</b>	-0.06	-0.44	0.12	0.77	0.005
<b>AA</b>	<b>Mid</b>	0.00	0.27	0.10	0.60	0.003
<b>AA</b>	<b>Long</b>	-0.04	-0.30	0.29	1.35	0.015
<b>A</b>	<b>Short</b>	-0.03	-0.21	0.18	1.10	0.010
<b>A</b>	<b>Mid</b>	-0.06	-2.05	0.50	3.38	0.087
<b>A</b>	<b>Long</b>	-0.13	-0.69	0.29	1.47	0.018
<b>BBB</b>	<b>Short</b>	-0.12	-1.47	0.03	0.22	0.000
<b>BBB</b>	<b>Mid</b>	-0.01	-0.14	0.08	0.88	0.006
<b>BBB</b>	<b>Long</b>	-0.26	-0.62	0.26	1.22	0.012
<b>Average</b>		-0.02	-0.12	0.17	0.96	0.01

Table 3 shows that there is some improvement in the statistical value of yields as a predictor of bonds returns using 60-month rolling regressions. However, for most sub-indices the average R-squared is 0.05 or less. Two notable exceptions are the Mid-A and Mid-BBB with R-squareds of 0.07 and 0.11 respectively.

**Table 3 Out-of-Sample R-squareds of Yield to Maturity Forecasts.**

Reported are average R-squareds values using rolling 60-month periods. The R-squareds are calculated by squaring the correlation coefficient between bond sub-index total monthly returns and the lagged average yield to maturity. The 122 forecasts are formed using total return and average yield to maturity data for the period June 1989 to September 2004.

	<b>Canadas</b>			<b>Provincials</b>			<b>Municipals</b>		
	<b>Short</b>	<b>Mid</b>	<b>Long</b>	<b>Short</b>	<b>Mid</b>	<b>Long</b>	<b>Short</b>	<b>Mid</b>	<b>Long</b>
<b>R2</b>	0.02	0.01	0.01	0.02	0.03	0.01	0.01	0.03	0.02
	<b>AA</b>			<b>A</b>			<b>BBB</b>		
	<b>Short</b>	<b>Mid</b>	<b>Long</b>	<b>Short</b>	<b>Mid</b>	<b>Long</b>	<b>Short</b>	<b>Mid</b>	<b>Long</b>
<b>R2</b>	0.02	0.05	0.04	0.02	0.07	0.03	0.02	0.11	0.04

It is important to note that even though I am not explicitly attempting to forecast risk, by using a 60-month rolling window of historical variances and covariances I make implicit forecasts of risk. However, mean return estimates have been shown to dominate the mean-variance optimization process. See Best and Grauer (1991). Therefore, this study focuses solely on return forecasts.

Regardless of how risk and return forecasts perform statistically, the true value of risk and return forecasts for use in active portfolio management is best measured by the economic value a portfolio manager would add by applying those forecasts to portfolio construction. The value-added through active portfolio management can be defined as:

$$VA = \alpha - \lambda\omega^2 \quad (6)$$

where  $\alpha$  is the active return,  $\omega$  is the active risk and  $\lambda$  is the investor's aversion to active risk (Kahn, 1996, p. 70). By defining value-added in this fashion, the economic value of an investment strategy can be evaluated using a measure of performance that does not depend on individual preferences. This measure is called the information ratio and is defined as:

$$IR \equiv \frac{\alpha}{\omega} \quad (7)$$

I use the information ratio of the strategies to determine the economic value of the results. The information ratio owes its importance to the fact that "all investors, regardless of preferences, will agree that the highest information ratio manager can provide the most value. Information ratios determine value-added" (Kahn, 1996, p. 70). In practice, information ratios are frequently relied on to evaluate managers. Grinhold and Kahn (1999, p.125) call the information ratio "the key to active portfolio management."

## 5 INVESTMENT PERFORMANCE

In this section I present performance of two strategies. The first utilizes the model specified in equations (1) through (4). The second adds two additional constraints to the model. Table 4 below shows how the first strategy would have performed during the period July 1994 through September 2004. Excess return and tracking error for the strategy are approximately 37 bps and 93 bps per annum, respectively. The information ratio of the strategy is 0.40 and is significant at the 95% confidence level.

**Table 4 Absolute and Relative Performance of Ex-Ante Optimal Bond Portfolios.**

Panel A reports the absolute performance of the strategy, the equal-weighted benchmark and the 30-day Treasury bill for the period July 1994 to September 2004 (123 months). The annual return is the geometric average rate of return whereas the monthly return is the arithmetic average. The standard deviation is calculated using the monthly returns. All numbers are given as percentages. The Sharpe Ratio is calculated as  $(R_s - R_f)/\sigma_s$ , where  $R_s$  and  $R_f$  the average monthly return of the strategy and the 30-day T-bill, respectively, and  $\sigma_s$  is the deviation of the monthly strategy returns. Panel B reports the performance of the strategy relative to the benchmark. Excess return is defined as the  $R_s - R_{bm}$ . Tracking error is defined as the standard deviation of the excess return. Both numbers are reported as basis points per year. The information ratio (IR) is defined as the excess return divided by the tracking error. The t-statistic is calculated as  $\sqrt{T}$  (IR) and has a t-distribution with T-1 degrees of freedom where T = 123.

<b>Panel A: Absolute Performance</b>	<b>Strategy</b>	<b>Benchmark</b>	<b>T-Bill</b>
Annual Return	10.00	9.63	4.15
Monthly Return	0.81	0.78	0.34
Standard Deviation	1.42	1.37	0.12
Sharpe Ratio	0.33	0.32	

**Panel B: Relative Performance**

Excess return	36.9
Tracking error	93.1
Information Ratio	0.40
<i>t-Statistic</i>	4.4



While the relative performance numbers of the strategy appears quite small it is important to evaluate them in the context of what can realistically be expected of active bond managers. For example, Dopfel (2004) suggests that the active risk for institutional portfolios typically falls between 0.40% and 1.20%. Hersey (2001) looks at a study of 91 leading US fixed-income managers and finds that core-style managers have 35-70 bps benchmark excess return targets and tracking error targets of 75-100 bps. Furthermore, Goodwin (1998) looks at 39 US sector-rotation bond managers and finds information ratios of 0.26 and 0.40 for the mean and upper quartile, respectively. Finally, Kahn (1998, p. 72) states that “before expenses, a top-quartile manager appears to have an information ratio of 0.50.” Therefore, the strategy’s excess return, tracking error and information ratio appear to be roughly in line with the numbers reported in other studies.

Although the results for the strategy appear reasonable in magnitude, there are at least two reasons why they might be viewed with some scepticism. First, it is well established that using unconstrained mean-variance optimization to allocate portfolios of fixed-income securities will result in a large over weighting in the low-credit sectors of the market. Uysal, Trainer and Riess (2001, p. 71) suggest the reason for this is that “the relative yield advantage of corporates, mortgages, and other ‘spread’ sectors far exceeds those sectors’ default and liquidity costs, and the optimizer likes the extra yield.” Inspection of the portfolio weights for this strategy reveals that the average weight in corporate bonds was almost 80%, with 57.2% in BBB bonds alone, while the average weight in Canada bonds was only 3.6% for the period. Second, even with the duration-neutral constraint it is unlikely that a core bond manager would be given this much

latitude. Generally managers are given investment policies that restrict them from straying too far from their benchmarks.

Therefore, to address these issues I impose additional constraints designed to reflect a typical policy that would limit the size of individual and broad-sector active weights. The following two constraints are added to the problem:

$$x_{p,i} \leq 2.5x_{bm,i} \text{ for all } i \text{ portfolio components} \quad (8)$$

$$0.75 \mathbf{DD}_{bm,k} \leq \mathbf{x}^T \mathbf{DD}_{p,k} \leq 1.25 \mathbf{DD}_{bm,k} \text{ for all } k \text{ broad sectors}^5 \quad (9)$$

where:

$\mathbf{x}_p$  = the vector of component weights in the benchmark, and

$\mathbf{DD}_{bm,k}$  and  $\mathbf{DD}_{p,k}$  are the modified durations of the benchmark and portfolio,

given by:

$\mathbf{DD}_k = 1$  for each broad sector  $k$  or 0 otherwise.

Equation (8) disallows dramatic (greater than 250%) overweighting in any one of the 18 sectors. Equation (9) sets a range for the duration dollars in each broad sector of plus or minus 25% of the duration dollars of that sector in the benchmark. This constraint enforces a realistic amount of diversification while allowing managers to have some latitude in over or under weighting broad market sectors but ensures that each is represented. The motivation behind this constraint is to allow particular sectors to be over or under-weighted relative to the benchmark but enforce a greater level of diversification than the previous strategy by ensuring every sector of the index is represented in the portfolio.

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<sup>5</sup> The broad sectors are: Government, Provincial, Municipal, AA, A and BBB.

Table 5 shows the results of the strategy with the two new constraints imposed. As would be expected the addition of constraints on the optimization negatively impacts performance. The excess return of the strategy is now 29 bps per year compared to 37 bps. The additional constraints, however, reduce the tracking of strategy to less than one-third of its original value (93.1 bps to 27.5 bps per year.) The information ratio that results is 1.05, well above the 75<sup>th</sup> percentile of U.S. institutional bond managers, before fees, reported by Grinhold & Kahn (2000, p. 130).<sup>6</sup>

**Table 5 Absolute and Relative Performance of Ex-Ante Optimal Bond Portfolios.**

Panel A reports the absolute performance of the strategy, the equal-weighted benchmark and the 30-day Treasury bill for the period July 1994 to September 2004 (123 months). The annual return is the geometric average rate of return whereas the monthly return is the arithmetic average. The standard deviation is calculated using the monthly returns. All numbers are given as percentages. The Sharpe Ratio is calculated as  $(R_s - R_f)/\sigma_s$ , where  $R_s$  and  $R_f$  the average monthly return of the strategy and the 30-day T-bill, respectively, and  $\sigma_s$  is the deviation of the monthly strategy returns. Panel B reports the performance of the strategy relative to the benchmark. Excess return is defined as the  $R_s - R_{bm}$ . Tracking error is defined as the standard deviation of the excess return. Both numbers are reported as basis points per year. The information ratio (IR) is defined as the excess return divided by the tracking error. The t-statistic is calculated as  $\sqrt{T}$  (IR) and has a t-distribution with T-1 degrees of freedom where T = 123.

<b>Panel A: Absolute Performance</b>	<b>Strategy</b>	<b>Benchmark</b>	<b>T-Bill</b>
Annual Return	9.92	9.63	4.15
Monthly Return	0.8	0.78	0.34
Standard Deviation	1.4	1.37	0.12
Sharpe Ratio	0.33	0.32	

<b>Panel B: Relative Performance</b>	
Excess return	29
Tracking error	27.5
Information Ratio	1.05
<i>t-Statistic</i>	11.7

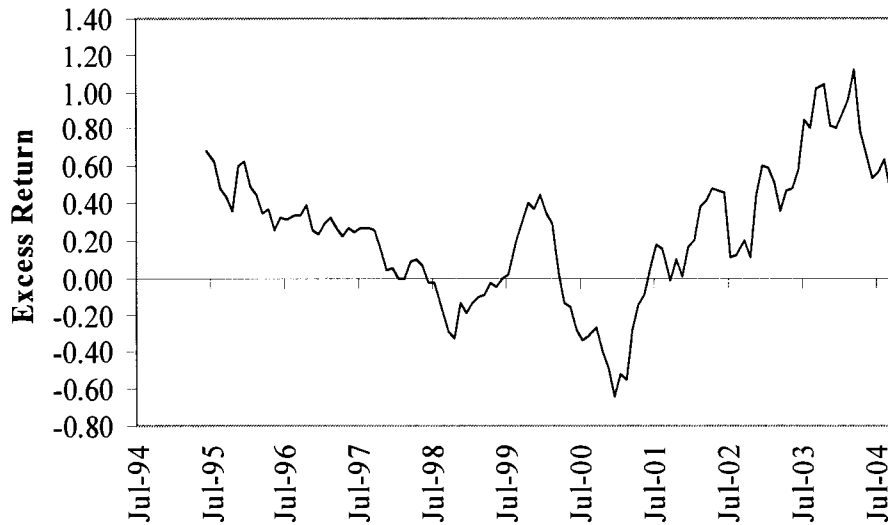
<sup>6</sup> As mentioned previously, I also ran the simulation using the more widely followed Scotia Capital Universe Bond Index as a benchmark. The results was 58 bps of excess return per year and an annual information ratio of 0.95.

To give some context to the seemingly small (29 bps) excess return I test the strategy using perfect foresight one-month-ahead forecasts. That is, rather than using previous month average yield to maturity to obtain current month return estimates for use in the optimization, I use the current month *realized* returns. Remarkably, the perfect foresight strategy would provide only about 91 bps of excess performance per year. This result is notable for two reasons. First, it demonstrates just how much impact investment policy constraints can have on maximum attainable returns. Second, it suggests that a sizable fraction (roughly 33%) of the excess return given by perfect one-month-ahead information can be obtained with a forecasting signal that only weakly predicts bond returns out of sample.

While investors generally reap the rewards of cumulative performance, it is unlikely that a manager would be retained if he under performed the benchmark for any sustained period of time. Therefore, I evaluate the strategy's performance on a yearly basis. Figure 3 shows the rolling 12-month average excess returns for the strategy. As can be seen from the figure there are two sustained periods of trailing 12-month under performance. During the second period, March 2000 to June 2001, the excess return hit a low of -0.65%, or -65 bps. This is over two standard deviations from the average excess return of the period of 29 bps. However, it is still well within the range for active managers noted previously.

### Figure 3 Rolling 12-Month Average Excess Return

Trailing 12-month excess returns of the strategy for the period July 1994 through September 2004 are shown in percent per year. Excess returns are calculated as the return of the strategy minus the return of the equal-weighted benchmark.



To provide some insight into the nature of the allocations being made, I analyze the composition of the optimal portfolios. Table 6 shows the average weight and standard deviation of the average weight of each of the portfolio components. In general portfolios tend to be “bullet” portfolios. That is, they over weighted mid-term bonds to the exclusion of short- and long-term bonds. The mid-term categories had an average weighting of 51% for the period.<sup>7</sup> This result seems to indicate that any loss in relative convexity from being in the bullet was easily compensated for by the gain in yield that results from being short convexity over time.<sup>8</sup>

The additional constraints result in portfolios that appear more reasonable in terms of the sector allocations that a manager might pursue. Although corporate bonds

<sup>7</sup> By definition the mid-term category weight in the equal-weighted benchmark is 33.3%

<sup>8</sup> See Tuckman (2002) for a discussion of the trade off between convexity and yield.

are still clearly preferred to governments and there is still a significant over weighting in BBB bonds, the weights are still reasonable at only 137% and 164% of benchmark, respectively. In addition, there are only three components, the three short-term government bond categories, that receive zero or near zero average weights. The standard deviations of the components weights indicate that in some instances there is a substantial variation in weighting. However, investigation of the time series of the portfolio compositions along the dimensions of maturity category and broad-sector reveals that in all cases the optimal portfolios are actually quite stable over time. Appendix 1 contains a graph of the time series along each of these dimensions.

**Table 6 Average Portfolio Weights**

Average weights and the standard of average weights for the period July 1994 to September 2004, where the components weights are presented in percent. Portfolio optimizations are performed monthly for the entire period, 123 in total. Since the benchmark is equal-weighted 5.6 is a neutral weighting and 13.9, or 250% of the benchmark weight, is the maximum allowable allocation to a single component. Borrowing and lending as well as short sales are prohibited.

	Canada			Provincial			Municipal		
	Short	Mid	Long	Short	Mid	Long	Short	Mid	Long
<b>Mean</b>	0	5.6	3.9	0	6.5	3.7	0.3	6.9	4.7
<b>Std Dev</b>	0	5.4	2.9	0	5.3	2.8	1.0	5.8	3.7
	AA			A			BBB		
	Short	Mid	Long	Short	Mid	Long	Short	Mid	Long
<b>Mean</b>	2.2	11.0	5.0	6.7	11.8	4.3	13.3	9.5	4.6
<b>Std Dev</b>	3.2	5.1	4.0	6.6	3.9	3.0	1.8	4.5	2.4

## 6 PERFORMANCE ANALYSIS

In this section I investigate the sources of the excess return for the more highly constrained strategy. Total excess return for the strategy can be decomposed along three dimensions: Curve, credit and curve-credit interaction.<sup>9</sup> Curve refers to excess return that results from the positioning of the portfolio along the yield curve, whereas credit refers to the excess return that results from credit quality selection. Curve-credit interaction is the result of the simultaneous effects of the curve placement and credit selection. In the context of this investigation excess return due to curve effects arise from the benchmark-relative over or under weighting of the short-, mid- and long-term to maturity categories and excess return due to credit comes from the benchmark-relative over or under weighting of the six broad-sector categories (Canada, Provincial, Municipal, AA, A, BBB).

Figures 4 and 5 show how benchmark relative exposure, or active weight, of the strategy along the dimensions of curve and credit evolved over the period.<sup>10</sup> Figure 4 shows that the strategy responded nicely to the movements in the shape of the yield curve. The optimal portfolios tended to be “bullets” during the period of curve flattening shown in Figure 1. This result is reflected in the strategy’s active weight in mid-term

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<sup>9</sup> As noted previously, by imposing the condition that the strategies are duration-neutral to the index there is no performance attributed due to duration effects (i.e. parallel shifts in the yield curve.)

<sup>10</sup> Active weight is defined simply as the weight of a component in the portfolio minus the weight of that component in the benchmark.

bonds relative to a change in the spread of a “butterfly” strategy. The butterfly spread is calculated as:

$$Y_M - [W_S \cdot Y_S + W_L \cdot Y_L] \quad (11)$$

where  $Y_S$ ,  $Y_M$  and  $Y_L$  are the average yields of the short-, mid- and long-term Canada sub-indices, respectively and  $W_S$  and  $W_L$  are the weights in the short- and long-term Canada sub-indices calculated as

$$W_S = \frac{D_M - D_L}{D_S - D_L} \quad (12)$$

and,

$$W_L = \frac{D_M - D_S}{D_L - D_S} \quad (13)$$

where  $D_S$ ,  $D_M$  and  $D_L$  are the durations of the short-, mid- and long-term Canada, sub-indices respectively.



**Figure 4 Butterfly Strategy Yield Spread versus Active Weight in Mid-Term**

The left-hand Y-axis measures the spread, in percent, of a butterfly strategy using Canada bonds. The butterfly spread can be interpreted as the yield of the duration neutral portfolio that is long the mid-term Canada sub-index and short the short- and long-term indices. The right-hand axis measures the active weight of mid-term bonds where active weight is calculated as the sum of the weights of the mid-term bonds in the strategy portfolios minus the weight of the mid-term bonds in the equal-weighted benchmark.

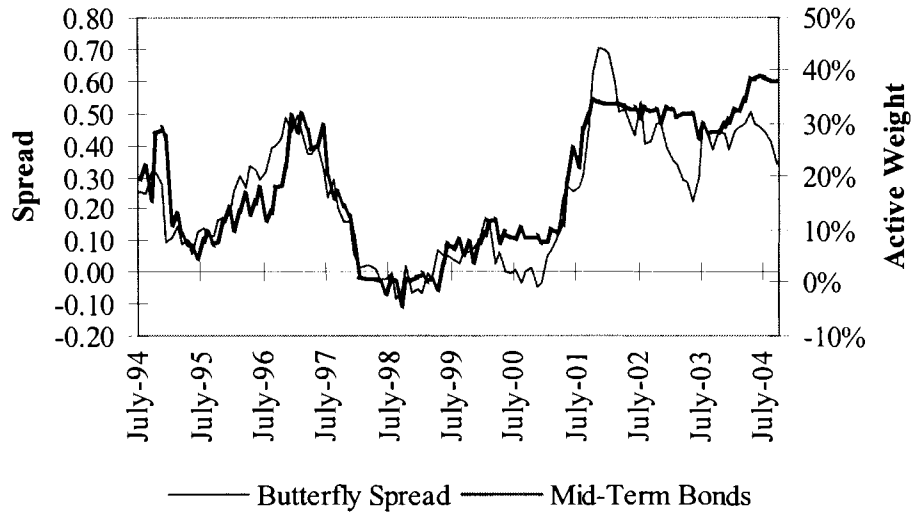
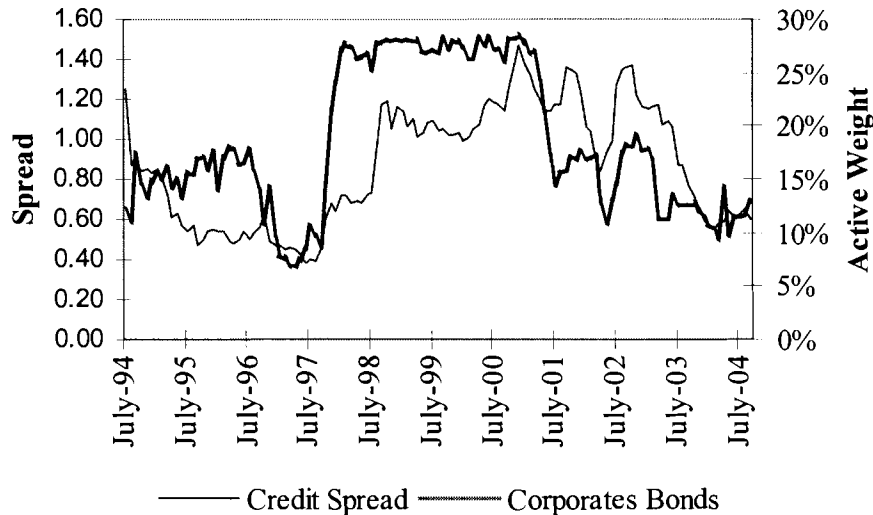


Figure 5 shows how the strategy responded to changes in corporate yield spreads over the mid-term Canadas. The corporate yield spread shown is the equal-weighted average of the three mid-term corporate bond sub-indices (A, AA, BBB) minus the mid-term Canada sub-index. Although the strategy's response to movements in credit spreads shown in Figure 5 does not appear to be as good as its response to curve movements as shown in Figure 4, some of the corporate spread is attributable to general yield curve movement as well as relative spread movement.<sup>11</sup> Nevertheless, it shows that increasing corporate spreads generally corresponded to increase in the active weight of corporate bonds and vice versa.

<sup>11</sup> This is due to the fact that the equal-weighted average of the three mid-term corporate sub-indices used to calculate the spread is not duration matched to the mid Canada sub-index.

**Figure 5 Credit Spread versus Active Weight in Corporate Bonds**

The left-hand Y-axis measures the credit spread. The credit spread is calculated as the equal-weighted average of the three mid-term corporate bond sub-indices (A, AA, BBB) yields minus the yield on the mid-term Canada sub-index. The right-hand axis measures the active weight of mid-term bonds where active weight is calculated as the sum of the weights of the mid-term bonds in the strategy portfolios minus the weight of the mid-term bonds in the equal-weighted benchmark.



Excess returns along the dimensions of curve, credit and curve-credit interaction can be broken down further and attributed to either bias or timing. Bias is the excess return that results from deviations in the portfolio weights from the benchmark weights on average over the whole period, whereas timing is the excess return resulting from the difference between the month-to-month portfolio weights and the average weight, or bias. Table 7 provides the results of a performance attribution designed to isolate the excess return along the dimensions of curve, credit, curve-credit interaction, timing, and bias. The equations used for the attribution are included in Appendix 2. As the table shows 1.61 bps, approximately 70%, of the 2.25 bps total average monthly excess returns is a result of bias. That means that a portfolio with component weights equal to average

component weights of the strategy portfolios over the period would have beaten the benchmark each month by 1.61 bps on average.

**Table 7 Performance Attribution Analysis**

Shown are the excess returns of the strategy attributable to each category. Excess returns are reported as bps per month and are the average values for the period July 1994 to September 2004. The equations used to perform the attribution analysis are given in Appendix 2.

	<b>Curve</b>	<b>Credit</b>	<b>Interaction</b>	<b>All-in</b>
<b>Timing</b>	0.49	0.37	-0.22	0.64
<b>Bias</b>	<u>0.68</u>	<u>1.14</u>	<u>-0.22</u>	<u>1.61</u>
<b>Total</b>	1.17	1.51	-0.44	2.25

It is frequently argued that excess returns due to bias are not excess returns at all but they are a result of increased risk that was taken systematically by the manager. As Dopfel (2004, p. 32) argues:

This is *not* what investors should be paying for. Investors have asked and paid for alpha (pure active risk exposure), but they have received beta (systematic exposure). Absent any improved system for portfolio construction, investors would be better off reproducing this performance (at lower cost) by holding a combination of index funds rather than active managers.

The case against including bias in the calculation of excess return is essentially based on the argument that the wrong benchmark is being used to evaluate the manager.<sup>12</sup>

“Managers may have a style, capitalization, or regional bias, which simply means that the investor needs to define the beta exposure consistently with the manager’s normal domain” (Waring, 2003, p. 25). The problem with this argument, however, is that those responsible for investment policy must be able to determine *ex ante* which systematic risk

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<sup>12</sup> See Kuenzi (2003) for a good discussion on the topic on benchmark selection from the investment manager’s perspective.

factors they should be exposed to and design a benchmark accordingly. However, since style biases typically only reveal themselves in hindsight, choosing the correct style-adjusted benchmark is likely to be very difficult.

## 7 CONCLUSION

This paper adds to the return predictability literature by investigating the economic value of bond return forecasts in a Canadian context. First, an investment strategy was developed to approximate that of an active sector-rotation bond manager making optimal portfolio decisions each month and whose objective it is to provide excess returns over a benchmark. Next, the strategy is tested out of sample using recent data from the Canadian investment grade bond market. Finally, the performance of the strategy is evaluated to determine how much excess return the strategy adds and to attribute the sources of those returns.

The investment strategy presented here relies on very naïve forecasts of expected excess risk and return. Expected excess returns are estimated using the average yield to maturity for each sub-index in excess of the average yield to maturity of the benchmark. Expected excess risk is estimated each month using the unconditional variance and covariance. While this is an overly simplistic approach, if returns are predictable results should only improve using more sophisticated estimation techniques.

I find that yield to maturity performs poorly as a predictor of future excess bond returns, in terms of the r-squared values, when tested using in-sample and out-of-sample linear regressions. However, I argue that even if estimators are statistically valuable predictors of future returns, investors and portfolio managers are ultimately concerned with the economic value of forecasts. Therefore, I suggest that the true value of risk and

return forecasts is best measured by the economic value a portfolio manager would add by applying the forecasts in realistic portfolio choice problem.

The strategy employed here performs well and achieves excess returns of nearly 30 bps per year and yields statistically significant information ratios over 1.0. Although, I make no adjustments for transaction or market impact costs, the risk and return numbers are all of a magnitude that is on par with what top quartile active managers have achieved before-expenses. In addition I show that the strategy performs well on a rolling 12-month basis and the portfolios weights are remarkably stable over time. Finally, I show that the strategy is able to achieve approximately 33% of the excess returns the could be obtained using perfect one-month ahead forecasts and identical problem constraints.

In spite of the apparent success of this strategy, however, performance attribution reveals that roughly 70% average monthly excess returns is a result of systematic bias. I recognize that many people suggest that bias is not “true” value-added and therefore, recommend that my results be viewed with some caution.

The objective of this paper has been to shed some light on the question of how predictable returns must be to help managers outperform their benchmarks. My results show that even naïve return forecasts that perform poorly in statistical tests can potentially be of economic value when used in portfolio choice. These results suggest a reason why the vast majority of institutional investors use active fixed income managers even though the results of academic studies on return predictability are inconclusive. If even weak return forecasting signals can be valuable to a manager attempting to beat a

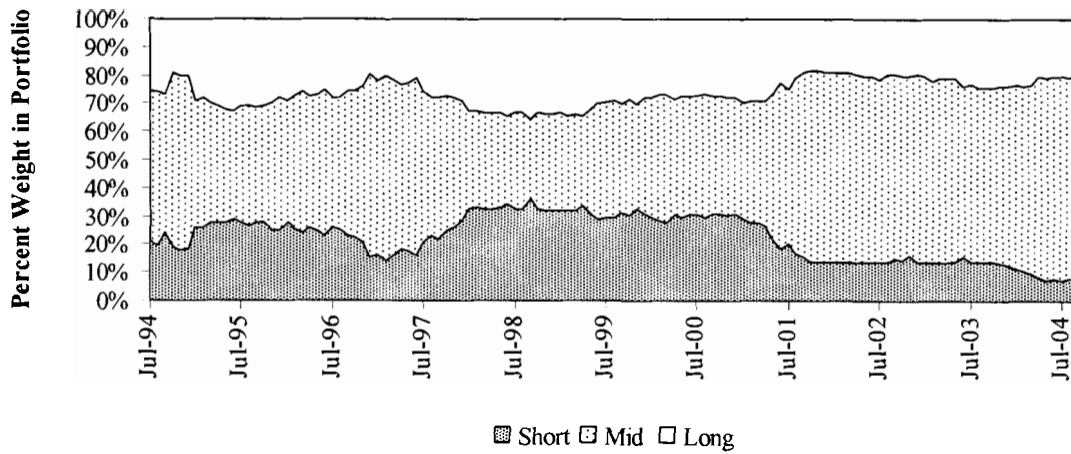
benchmark there is value to active management. Results of this sort have tremendous implications for determining appropriate investment policy, specifically in determining whether to utilize active strategies.

# APPENDIX 1

## PORTFOLIO COMPONENT WEIGHTS

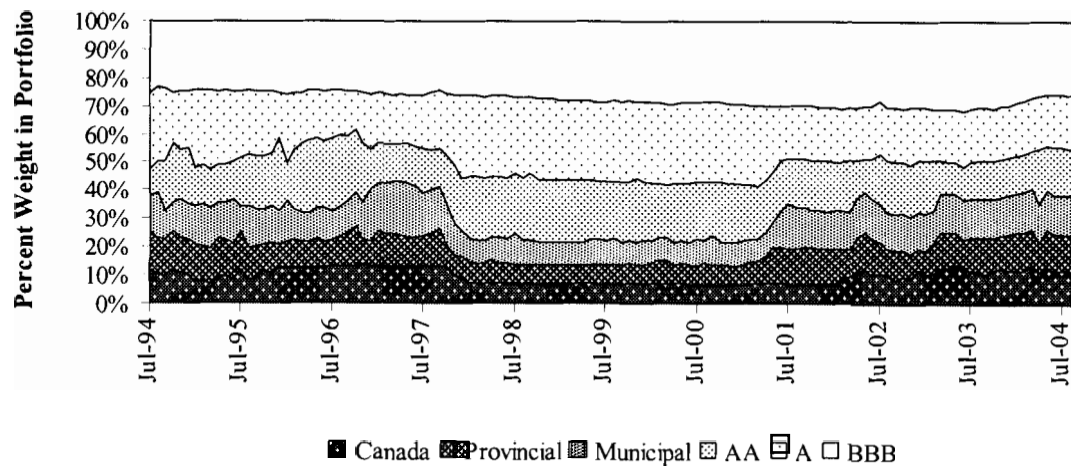
**Figure 6 Portfolio Component Weights – Term to Maturity Categories**

Presented are the optimal portfolio weights in each of the short-, mid- and long-term maturity categories for the period July 1994 for September 2004.



**Figure 7 Portfolio Component Weights – Broad Sectors**

Presented are the optimal portfolio weights in each of broad sector categories (Canada, Provincial, Municipal, AA, A, BBB) for the period July 1994 for September 2004.





## APPENDIX 2 PERFORMANCE ANALYSIS CALCULATIONS

### Total Excess Return

$$\text{All-in} = \sum_{i=1}^n (Rp_i - Rbm_i) \cdot (Wp_i - Wbm_i) \quad (\text{A1})$$

$$\text{Curve} = \sum_{i=1}^n Rbm_i \cdot (Wp_i - Wbm_i) \quad (\text{A2})$$

$$\text{Credit} = \sum_{i=1}^n Wbm_i \cdot (Rp_i - Rbm_i) \quad (\text{A3})$$

$$\text{Curve-Credit Interaction (Total)} = \text{All-in} - \text{Curve} + \text{Credit} \quad (\text{A4})$$

### Excess Return Due to Bias

$$\text{All-in} = \sum_{i=1}^n (Rp_i - Rbm_i) \cdot (\bar{W}p_i - Wbm_i) \quad (\text{A5})$$

$$\text{Curve} = \sum_{i=1}^n Rbm_i \cdot (\bar{W}p_i - Wbm_i) \quad (\text{A6})$$

$$\text{Credit} = \sum_{i=1}^n Wbm_i \cdot (\bar{R}p_i - Rbm_i) \quad (\text{A7})$$

$$\text{Curve-Credit Interaction (Bias)} = \text{All-in} - \text{Curve} + \text{Credit} \quad (\text{A8})$$

### Excess Return Due to Timing

$$\text{All-in} = \sum_{i=1}^n (Rp_i - Rbm_i) \cdot (Wp_i - \bar{W}p_i) \quad (\text{A9})$$

$$\text{Curve} = \sum_{i=1}^n Rbm_i \cdot (Wp_i - \bar{W}p_i) \quad (\text{A10})$$

$$\text{Credit} = \sum_{i=1}^n Wbm_i \cdot (Rp_i - \bar{R}p_i) \quad (\text{A11})$$

$$\text{Curve-Credit Interaction (Bias)} = \text{All-in} - \text{Curve} + \text{Credit} \quad (\text{A12})$$

where:

$Rp_i$  = Return on  $i^{\text{th}}$  component of the portfolio,

$\bar{R}p_i$  = Average return on  $i^{\text{th}}$  component of the portfolio,

$Rbm_i$  = Return of the  $i^{\text{th}}$  component of the portfolio,

$Wp_i$  = Weight of the  $i^{\text{th}}$  component in the portfolio,

$\bar{W}p_i$  = Average weight of the  $i^{\text{th}}$  component in the portfolio.

$Wbm_i$  = Weight of the  $i^{\text{th}}$  component in the benchmark

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