# Seasonality in Canadian Bond Returns: The Role of International Factors

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***Abstract***
*This paper provides evidence of seasonal variation in individual Canadian provincial government bond returns. For the period of 1983-2003, holding period returns appear to fall significantly in the month of March. A trading strategy that took advantage of this seasonality would have out-performed a buy-and-hold strategy. The seasonal variation in Canadian bond returns correlates with seasonal movements in US 10-year Treasury bond yields, but not with factors originating in Canada. The results reveal significant seasonality in a major bond market that has not been analyzed previously, provide evidence of seasonality in one market spilling over into another market, and illustrate the importance of incorporating international factors in analyses of seasonality.*

**JEL Classification**: G12, G14, G15

**Keywords**: seasonality, asset returns, bonds

***Résumé***
*La présente étude met en évidence les variations saisonnières dans les rendements des obligations des gouvernements des provinces canadiennes. Entre 1983 et 2003, les rendements des obligations ont baissé de façon significative en mars. Une stratégie commerciale qui profite de cette saisonnalité devrait avoir des performances supérieures à celles d'une stratégie d'achat à long terme. La variation saisonnière des rendements des obligations canadiennes est corrélée, non pas avec des facteurs canadiens, mais avec des mouvements saisonniers du taux de rendement des obligations de 10 ans du Trésor des États-unis. Nos résultats soulignent, pour la première fois, la grande saisonalité caractéristique du marché des obligations. Ils montrent aussi comment la saisonalité qui caractérise un marché peut avoir des répercussions sur un autre marché. Enfin, ils réaffirment la nécessité d'incorporer les facteurs internationaux dans les analyses de saisonnalité.*

**Mots-clés** : saisonalité, rendements des obligations, obligations

Numerous studies, using data for different countries and time periods, have found seasonal variation in asset returns.[1] While there has been considerable research on seasonality in equity and corporate bond returns, fewer studies examine seasonal variation in government bond returns. As a consequence, there is a less comprehensive understanding of the extent and causes of government bond return seasonality. This study contributes to the literature on the seasonality of government bond returns in two principal ways. First, it identifies a significant seasonal effect in the market for Canadian provincial government bonds, a sizeable government bond market that has not been previously examined. The excess holding period returns of Canadian provincial government bonds are shown to fall significantly in March. The magnitude of the decline in returns in March is such that a strategy of divesting bond holdings during March would outperform a buy-and-hold strategy by approximately 100 basis points annually on average, while also reducing the standard deviation of returns.

The second contribution of this study is to show that the seasonal variation in Canadian provincial government bond returns is associated with seasonal variation in US 10-year Treasury bond yields, and is not correlated with several domestic factors. The result provides evidence of seasonal spillovers across international asset markets and suggests that the importance of considering these linkages when analyzing seasonality. Neglecting

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foreign factors in studies of seasonality, particularly for small open economies such as Canada, may leave the seasonal pattern of returns unexplained, result in only a partial explanation of seasonal movements, or cause domestic factors to be mistakenly identified as the underlying causes of the seasonality.

There are several advantages to using Canadian provincial-level government bond data to investigate the existence of asset return seasonality and analyze the role of international factors as causes of this seasonality. Unlike equities or corporate bonds, provincial government bonds are subject to few types of risk other than interest rate risk since default risk is minimal and almost all foreign exchange risk can be hedged. As a result, it is not necessary to control for default-related movements in returns. Second, the market for Canadian provincial government bonds has considerable size and liquidity, and provincial governments have been active issuers in international bond markets (Kahn & Gulrajani, 1993). In 2002, the outstanding stock of Canadian provincial government bonds was C$256 billion (approximately US$210 billion) (Statistics Canada). Third, if a similar pattern of seasonal variation is found for the bonds of all ten provinces, the cause of this seasonality is more likely to be a factor that affects all issuers, rather than a factor that is province-specific. Making this distinction would not be possible if the bonds of only one issuer, such as the Government of Canada, were examined. Also, since there are ten Canadian provinces, there is likely to be greater sample variation than would be the case if the data were restricted to the bonds of a single issuer (such as the Canadian central government).

The study is organized as follows: The next section provides a discussion of the related literature. Following that, the Canadian provincial government bond data are described and then the seasonality of bond returns is examined using nonparametric and parametric methods. Next, simulations of alternative seasonal trading strategies are used to illustrate the magnitude and importance of the observed seasonal variation and then possible domestic and international determinants of seasonal movements in bond returns are investigated. The paper concludes with a brief summary and directions for future research.

## Related Studies of Seasonality in Government Bond Returns

A systematic seasonal pattern in asset returns is evident in data from as long ago as 1694 (Bouman & Jacobsen, 2002), and seasonality has been observed in many asset markets.[2] While this seasonality often cannot be attributed to a specific factor, explanations that have been suggested for seasonal movements in returns include tax-loss selling at the end of the tax year, seasonal risk variation, and the timing of summer vacations. Seasonality in government bond returns has been examined less intensively than seasonality in equity and corporate bond returns, and the evidence on the seasonality of government bond returns is mixed. For example, no significant evidence of seasonality is found for US Treasury bond yields in the studies of Chang and Pinegar (1986), Lavin (2000), Schneeweis and Woolridge (1979), and Smirlock (1985). However, some evidence of seasonality is found by Chan and Wu (1993, 1995); Clayton, Delozier, and Ehrhardt (1989); Fridson (2000); Mankiw, Miron, and Weil (1987); Miron (1986); Sealey (1977); Sharp (1988); and Wilson and Jones (1990). Clare and Thomas (1992) find a seasonal effect in UK government bond returns but do not find a seasonal effect for US, Japanese, or German bonds. Nonparametric tests in Smith (2002) provide evidence of seasonal variation in bond returns for France, but not for the US, UK, Japan, Germany, or Canada.

An indication that foreign factors may be important determinants of asset return seasonality is given by studies that, although they do not examine seasonality, document the cross-country correlation of bond returns, equity returns, or both (i.e., Barr & Priestly, 2004; Ilmanen, 1995; Longin & Solnik, 2001; Obstfeld & Taylor, 2004; Solnik, Boucrelle, & Fur, 1996; and Sutton, 2000). However, of the studies that attempt to identify the factors underlying seasonal movements in returns, most consider purely domestic causes. The only exceptions of which we are aware are Clark (1986), who provides some evidence that the disappearance of interest rate seasonality in the US after 1914 may have been part of a world-wide phenomenon, and the study of seasonality in Canadian equity market returns by Tinic, Barone-Adesi, and West (1987). Thaler (1987) and Clare, Psaradakis, and Thomas (1995) conjecture that foreign factors may, at least partly, be responsible for the seasonality of asset returns, a view that is consistent with the increased integration of international capital markets over the last three decades.

To our knowledge, the current study is the first to identify a seasonal pattern in Canadian provincial government bond returns and to link this seasonal pattern to movements in international factors. Using quarterly data, Athanassakos and Tian (1998) find that Government of Canada bond returns are significantly higher in the last quarter of the year, a phenomenon they attribute to the fourth quarter Canada Savings Bond campaign - a uniquely Canadian institution.[3] In one of the few studies that considers nondomestic country factors as part of the explanation for seasonality in returns, Tinic et al. (1987) cannot reject the possibility that the tax-related trading of US investors had an influence on the seasonality of Canadian *equity* market returns. While Tinic et al. do not examine bond markets, international factors may also be important determinants of Canadian bond market returns since, over the 1990s, there was an increased presence of nonresident investors in the Government of Canada bond market (Gravelle, 1999).

A common feature of studies of seasonality in bond markets is that they employ data on bond yield indices or on return series derived from indices.[4] The calculation of holding period returns using bond index data is not possible without making further assumptions. For example, in order to calculate holding period returns, Schneeweis and Woolridge (1979), and Wilson and Jones (1990) make assumptions about the coupon payments and time-to-maturity of the bonds included in the indices they employ. While bond yields can be used to determine the direction of a change in an asset's return, to assess the magnitude of the seasonal effect, it is necessary to calculate the actual holding period return. An important advantage of the provincial government bond data set employed in the current study is that it includes individual bond prices and coupons and this makes it possible to determine the holding period return for each bond.

## The Data

The empirical analysis uses monthly observations on a large sample of individual bonds issued by the ten Canadian provincial governments. The data, which are collected by the *Financial Post Corporation* and have not, to our knowledge, been used before, include end-of-month closing bid prices, yields, coupons, maturity dates, issue amounts, and various other bond characteristics. (See the Appendix for detailed notes on the data and the sources of the data). Only comparable bonds, in the sense of having no distinctly individual characteristics, other than price, yield, maturity date, province of issue, and coupon, were chosen from the universe of available bond data. The sample includes data on 313 provincial government bonds from which it is possible to calculate a total of 22,019 monthly holding period returns. Although bond data are available for every month during the January 1983 through December 2003 period, since the price for every bond is not available for every month, the sample is unbalanced, so the number of data points available for each bond and each month varies. The use of this unbalanced sample provides considerably more observations over a longer time span than would a balanced sample.

The data set has on average 1048 observations per year, with the number of observations per year varying from 429 in 1983 to 1579 in 2001. The average number of observations per bond is just over 70, while the number of observations for individual bonds ranges from one to 204. The average maturity of the bonds in the sample is 9 years; the average monthly holding period return is 9.81 percent (at an annual rate); the mean yield-to-maturity is 7.53 percent; the average coupon is 8.91 percent; and the average issue amount is approximately C$450 million.

The excess holding period return, at an annual rate, for bond b in period t (where a period is a month), $R_t^b$, is defined as the holding period return on bond b minus the yield on a one-month Government of Canada Treasury bill:

$$R_t^b = \left( \left( \frac{P_t^b - P_{t-1}^b}{P_{t-1}^b} \right) \times \left( \frac{365}{N_t} \right) + \frac{\text{coupon}^b}{P_{t-1}^b} \right) \times 100 - RTB_t , \quad (1)$$

Where $P_t^b$ is the end-of-month (clean) price of bond b, which has a \$100 face value; coupon$^b$ is the annual coupon payment for bond b; N is the number of days between price data points (the last business day of each month); and $RTB_t$ is the one month Government of Canada Treasury bill rate at the end of the previous month, also at an annual rate. This holding period return formula is the same as that used by Athanassakos and Tian (1998).[5]

Figure 1 depicts the average monthly excess holding period return (in percent at an annual rate) for the sample of provincial government bonds by month, as well as the average holding period return and the one-month Government of Canada Treasury bill yield. While the average monthly excess return from May through December is in the range of 5 percent or higher, the excess returns in February and April are barely positive, while the excess return for March is negative (-7.35 percent). The average March holding period return is more than 11 percent below the average return and it is the only month with, on average, either a negative excess return or a negative return.

## Nonparametric and Parametric Tests of Seasonality in Bond Returns

### *A nonparametric test of seasonality in bond returns*

An initial assessment of whether the seasonal differences illustrated in Figure 1 are statistically significant is undertaken using the nonparametric Kruskal-Wallis (KW) test (Zar, 1974). This test has been used previously to investigate seasonality in equity returns (Dimson & Marsh, 2001; Gultekin & Gultekin, 1983) and bond returns (Athanassakos & Tian, 1998; Schneeweis & Woolridge, 1979). As the KW test is based on the ranking of returns, it is less affected by extreme return values

**Table 1**

*Estimates of the seasonal component in excess holding period returns (deviations from the December return at an annual rate)*

| | | Regressors in addition to the monthly dummy variables | | | |
|---|---|---|---|---|---|
| | | Year dummies | Year and province dummies | Year and bond dummies | Year, bond dummies, and months to maturity |
| | (1) | (2) | (3) | (4) | (5) |
| January | -1.9170* (3.81) | -1.8231* (3.41) | -1.8301* (3.42) | -1.6912* (3.12) | -1.7484 (1.70) |
| February | -3.5405* (4.57) | -3.4051* (4.81) | -3.4131* (4.82) | -3.2826* (4.58) | -3.3346* (3.11) |
| March | -11.9154* (19.47) | -11.7738* (19.58) | -11.7805* (19.58) | -11.6672* (19.09) | -11.7141* (12.48) |
| April | -3.8461* (6.76) | -3.7286* (6.84) | -3.7368* (6.85) | -3.6280* (6.59) | -3.6696* (4.36) |
| May | 3.6275* (6.24) | 3.7133* (6.76) | 3.7089* (6.76) | 3.8129* (6.94) | 3.7765* (4.87) |
| June | -.5060 (1.11) | -.4214 (0.95) | -.4232 (0.96) | -.3335 (0.75) | -.3648 (.56) |
| July | .7057 (1.10) | .7569 (1.19) | .7564 (1.19) | .8265 (1.29) | .8004 (1.06) |
| August | 1.14998* (2.66) | 1.5598* (2.77) | 1.5572* (2.76) | 1.5943* (2.82) | 1.5735* (2.42) |
| September | 2.3881* (3.92) | 2.4250* (4.08) | 2.4230* (4.07) | 2.4460* (4.09) | 2.4304* (3.78) |
| October | 6.8133* (10.76) | 6.8130* (11.24) | 6.8127* (11.23) | 6.8528* (11.32) | 6.8424* (10.96) |
| November | -.5635 (0.98) | -.5772 (1.04) | -.5768 (1.04) | -.5692 (1.03) | -.5744 (1.03) |
| Joint test of significance of monthly dummies, $\chi^2$ (11) | 865.44 | 915.41 | 915.37 | 889.97 | 734.02 |
| $\overline{R}^2$ | 0.042 | .114 | .114 | .109 | .109 |

Notes: The numbers in brackets under the coefficient estimates are the absolute values of the t-statistics. All t-statistics and test statistics are calculated using a heteroscedasticity consistent variance-covariance matrix. An * indicates that a coefficient is significant at the 95 percent confidence level. There are 22019 observations.

than parametric tests. As well, this test involves less restrictive assumptions on the distribution process than parametric tests (Schneeweis & Woolridge).

The hypothesis tested using the KW test is that all 12 months have identical mean excess holding period returns. As the test statistic associated with this hypothesis is 804.62, while the 95 percent critical value is 19.68, the hypothesis of equal means is strongly rejected. When the observations for March are excluded from the sample, the hypothesis that the mean returns associated with the remaining 11 months are equal is also rejected, but the test statistic falls by a large amount (to 329.96). The test results do not appear to be driven by particular sub-samples of the data, as the hypothesis that all months have the same mean return can also be rejected for the following sub-samples: the bonds issued by each province; maturities longer than 107 months (the average maturity) or less than 107 months; issues of \$450 million or more and issues of less than \$450 million (the average issue size); observations for 1983-93 and observations for 1994-2003. Hence, the KW test results suggest that there exist systematic differences in holding period returns across months and that March may be an outlier.

*Parametric tests of seasonality in bond returns*

In this section, following numerous other studies, a parametric specification is employed to test for seasonality (e.g., Athanassakos & Tian, 1998; Barnhill, Joutz, & Maxwell, 2000; Chan & Wu, 1995; Chang & Pinegar, 1986; Clare et al., 1995; Fama and French, 1993; Lavin, 2000; Ogden, 2003; Schneeweis & Woolridge, 1979; Smirlock, 1985; Smith, 2002; Wilson & Jones, 1990). The advantage of the parametric approach is that it allows the seasonal effects to be estimated while controlling for other possible determinants of holding period returns. In addition, unlike the KW test, it yields estimates of the relative magnitudes of the seasonal effects.

The parametric representation of excess bond returns used here takes the form:

$$R^b_t = \gamma_0 + \gamma_N \, MAT^b_t + \sum_{m=1}^{11} \gamma_m \, D_{mt} + \sum_{y=1983}^{2002} \gamma_y \, D_{yt} + \sum_{p=1}^{P-1} \gamma_p \, D_p + \sum_{b=1}^{B-1-P} \gamma_b \, D_b + \epsilon_{bt}\,, \qquad (2)$$

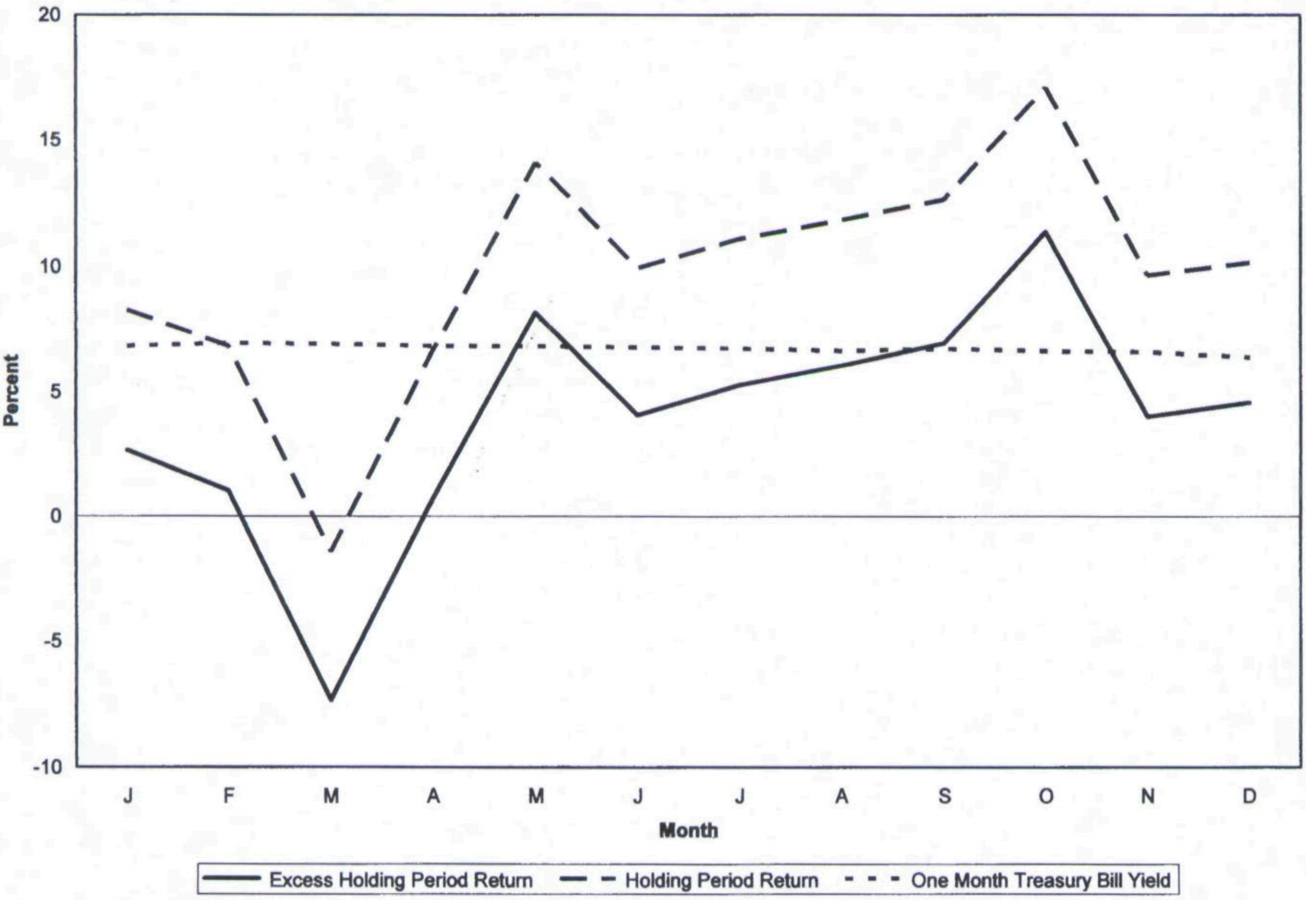
where $MAT^b_t$ is the number of months to maturity of bond b in period t; $D_{mt}$ is a monthly dummy variable that takes on a value of one if the month associated with period t is month m and zero otherwise; $D_{yt}$ is a dummy variable for year y; $D_p$ is a dummy variable for the issuing province (where P=10 as there are ten provincial governments); and $D_b$ is a bond specific dummy variable for bond b (where B=313, the total number of bonds).[6] The fixed effects account for factors that are common to months, bonds, provinces or years. For example, the year effects could account for the impact on bond returns of different states of the business cycle. The maturity variable, $MAT^b_t$, is included in equation (2) to allow the risk premium to vary across bonds with different maturities. The variable $\epsilon_{bt}$ denotes a mean zero random error that captures, for example, factors such as errors in bond pricing (MacKay, Prisman, & Tian, 2000, p. 255). The form of equation (2) is more general than many specifications used to test for seasonality in which returns are regressed only on monthly or quarterly dummy variables, with no attempt made to control for other factors (e.g., Lavin, 2000; Smirlock, 1985).

If holding period bond returns are unaffected by seasonal factors, the month coefficients ($\gamma_m$) should be individually and jointly insignificantly different from zero. Estimates of the $\gamma_m$ parameters for several variations of equation (2) are presented in Table 1.[7] These coefficient estimates represent the difference between the excess holding period return for each month and the return in December (the base month). The regression equation associated with the estimates of column (1) in Table 1 incorporates only the constant and eleven monthly dummy variables. The succeeding columns are associated with regressions that gradually add the other variables that appear in equation (2). As is evident from the results presented in this table, the estimates of the month coefficients, and their statistical significance, are robust to the addition of the different fixed effects and the maturity variable.

The results in Table 1 indicate that there is a significant seasonal effect, consistent with the pattern shown in Figure 1. Relative to December, excess returns tend to be negative in the January to April period, and are insignificant or positive over the rest of the year. The estimated coefficient for March is almost twice the size of the next largest coefficient in absolute value, and March has an average return that is 11.9 percent lower (at an annual rate) than the return in December.[8] These results provide evidence of significant seasonality in a major government bond market.

The coefficient estimate for March is robust to many different variations of the empirical specification in addition to those reported in Table 1. For example, the estimated March coefficient is always significant, and its value varies only slightly (from -11.52 to -11.83), if the regression equation is estimated with a lagged dependent variable, with the Fama and French (1993) term premium and default premium variables, or with the potential outlier years of 1987, 1997, and 2001 deleted from the sample.[9] Further, the coefficient on March remains significant and negative if the sample is split at the average maturity, the average issue amount, or at the mid-point of the sample (the estimated March coefficient varies only from -9.4 to -15.8 in these cases). When the holding period return regression is estimated separately for the bonds issued by each province, the coefficient for March is the only month coefficient that is significant for every province (and estimates of this coefficient vary little across provinces, from -8.1 to -13.4). Finally, if

*Figure 1.*
Average Returns 1983 – 2003 (percent at annual rates)




provincial credit rating dummy variables are added to the regression equation associated with the results in column 5 of Table 1, all the credit rating dummy variable coefficients are individually insignificant, and their addition to the model has no impact on the results.

### The Return to a Seasonal Trading Rule

The evidence of a large March effect presented in the previous section suggests that a seasonal trading strategy could increase the return on a bond portfolio. In order to investigate the potential benefits of a March-based trading rule, individual bond data are used to compare two competing trading strategies. The first trading strategy, Strategy A, involves buying a bond at the beginning of the year and holding it for the rest of the year. The alternative trading strategy, Strategy B, involves buying a bond at the beginning of the year, selling it at the end of February, purchasing a one month Treasury bill, buying the bond back at the end of March, and holding the bond for the balance of the year. To make the analysis manageable, these two strategies are compared using data for one bond issued by each province, where the bond chosen for each province is the bond for which the longest span of data is available.

As indicated by the results reported in Table 2, the activist trading strategy (Strategy B) yields, on average, an annual return that is 102 basis points greater than the return on the buy-and-hold strategy (which averaged 11.1 percent per annum).[10] In 9 of 10 cases, the activist average annual return exceeds the buy-and-hold return by at least 90 basis points, while in the tenth case the activist strategy yields an advantage of 36 basis points per year. The return advantage to the activist strategy is not due to a few outliers as the activist strategy yields an annual return that exceeds the buy-and-hold strategy in more than half the years for 9 of 10 provinces and in almost two-thirds of the

**Table 2**
*A comparison of seasonal and nonseasonal trading strategies*

Alternative trading strategies:

A: Buy a bond and hold it for a year.

B: Buy a bond, sell at the end of February and purchase a one-month Treasury Bill, re-purchase the bond at the end of March and hold the bond until the end of the year.

| Issuing province | Bond maturity date (coupon)† | Sample period | Average annual percentage points that B return exceeds A return†† | Percent of years B return exceeds A return | Percent by which standard deviation of strategy A returns exceeds that of strategy B |
|---|---|---|---|---|---|
| Alberta | 20010822 (10.25) | 12/91-12/00 | 1.215 | 67 | 9.5 |
| British Columbia | 20220819 (8.75) | 12/92-12/03 | 1.265 | 73 | 3.7 |
| Manitoba | 20130722 (8.5) | 12/93-12/03 | 1.107 | 70 | 3.7 |
| New Brunswick | 20111031 (10.125) | 12/91-12/03 | .937 | 67 | 4.1 |
| Newfoundland | 20100225 (9.375) | 12/87-12/03 | .971 | 56 | 7.7 |
| Nova Scotia | 20220130 (9.6) | 12/92-12/03 | 1.126 | 73 | 5.8 |
| Ontario | 20230908 (8.1) | 12/93-12/03 | 1.344 | 70 | 5.2 |
| Prince Edward Island | 19950315 (9.5) | 12/83-12/94 | .360 | 45 | 4.9 |
| Quebec | 20120210 (9) | 12/87-12/03 | .991 | 63 | 5.2 |
| Saskatchewan | 20041230 (9.625) | 12/86-12/03 | .936 | 59 | 5.2 |
| Average | | | 1.025 | 64.3 | 5.5 |

† For simplicity, the trading strategies are compared using only one bond for each province. The bond used in the simulation for each province is the bond for which the longest sample is available for that province.
†† The annual return for each trading strategy for each year is calculated, the annual returns for each trading strategy are averaged, and the difference between the two averages is reported. Note that transactions costs are not incorporated in the calculation.

years overall. An additional benefit to switching out of provincial bonds in March is that the standard deviation of the annual returns under this strategy is lower for every bond (by 5.5 percent on average). Thus, the results in Table 2 suggest that a seasonal trading strategy could increase the return and reduce the risk of a bond portfolio. Further, these results show that the magnitude of the seasonal effect is potentially large enough to be economically as well as statistically significant.

It is important to raise two caveats with respect to this trading strategy comparison. First, the activist strategy is not without risk. While it raises the average return and lowers the standard deviation of annual returns, it does not beat the buy-and-hold strategy in every year and, thus, is potentially beneficial only as a long-term strategy. Second, a seasonal trading strategy would involve increased transactions costs. However, evidence suggests that these costs are likely to be lower than the average gain of over 100 basis points from the activist strategy. According to data published recently in the *Globe and Mail*, the bid-ask spread on provincial bonds averaged 4.4 basis points and varied from 1 to 10 basis points.[11] These values are in line with the 8 basis point estimate of institutional investor US Treasury bond trading costs found by Chakravarty and Sarkar (2003).[12]

## Factors that Explain the Seasonal Pattern in Excess Holding Period Returns

Results from the previous sections indicate that there have been systematic seasonal movements in Canadian provincial government bond returns, with a particularly large negative and significant effect in March, and that portfolio managers may be able to exploit these factors to increase portfolio returns. In this Section, an attempt is made to identify the factors underlying these movements. This is done in two stages. In the first stage, monthly excess holding period returns are regressed on month, province, and bond dummy variables, as well as the maturity variable, for each individual year of the 21-year sample:

$$R^b_{ty} = \sum_{m=1}^{12} \gamma_{my} D_m + \sum_{p=1}^{P-1} \gamma_{py} D_p + \sum_{b=1}^{B_y-P-1} \gamma_{by} D_b + \gamma_{Ny} MAT^b_t + \epsilon_{bty},\ y=1983,...2003, \quad (3)$$

where $R^b_{ty}$ denotes the holding period excess return on provincial government bond b at time t in year y, $B_y$ is the number of bonds in the data set for year y, and the other variables are defined as above. These 21 regressions yield 251 estimates of the monthly dummy variable coefficients, one for each month from February 1983 through December 2003.

In the second stage, the 251 estimated monthly dummy variable coefficients are regressed on a vector of factors (Z) that may explain the seasonal movement in bond returns:

$$\hat{\gamma}_{my} = \alpha_0 + \alpha_1 Z_{my} + \sum_{y=1983}^{2002} \alpha_{2y} D_y + \sum_{m=1}^{11} \alpha_{3m} D_m + u_t, \quad (4)$$

where $\hat{\gamma}_{my}$ is the estimate of the month coefficient for month m of year y from equation (3), $Z_{my}$ is a vector of the values of the Z factors in month m of year y, and $\alpha_1$ is a vector of parameters. The year dummy variables are included in equation (4) to represent movements in $\hat{\gamma}_{my}$ that are common across years, while the 11 monthly dummy variables are included to capture seasonal variation that cannot be explained by Z. If movements in the components of Z cause seasonal movements in excess bond returns, the elements of $\alpha_1$ should be significantly different from zero.

The methodology outlined above is similar to that used in Campa and Goldberg (2005), although they analyze a very different phenomenon. An alternative approach is employed by Chan and Wu (1993, 1995) and Athanassakos and Tian (1998) to analyze the factors underlying seasonal movements in returns. They modify the holding period return equation (equation 2) to include as explanatory variables the elements of Z interacted with seasonal dummy variables. The coefficients on these interaction terms reflect the impact of the elements of Z on returns in each season. If they are significantly different across seasons, the elements of Z explain some part of the seasonal pattern in returns. This method was not used here, however, since it becomes cumbersome and more difficult to interpret as the number of seasons and elements in Z becomes large. Since Athanassakos and Tian (1998) use quarterly data and include only one variable in Z, they need to estimate and interpret only four interactive parameters. The current study employs monthly data and considers a Z vector with five elements, so use of the interactive method would have involved estimating and interpreting 60 interactive parameters.

### *Potential determinants of seasonal provincial bond return variation*

In order to estimate equation (4), it is necessary to identify possible determinants of seasonality in provincial government bond returns, the elements of the vector Z. Potential candidates include domestic and international factors that have a seasonal impact on the demand for provincial government bonds, but that are exogenous to provincial bond yields.

Given the large size of the provincial government bond market, the yields on other Canadian assets are

**Table 3**

*Regression of the seasonal holding period return coefficients on the potential determinants of seasonality*

| Explanatory variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| GOVSAV | –.0005 | –.0006 | | | | | .0001 |
| | (0.74) | (0.92) | | | | | (0.24) |
| ΔCSB | –14.732 | | | | | | –7.802 |
| | (0.66) | | | | | | (0.44) |
| ΔUSYL | –38.682* | –39.272* | –38.211* | –39.085* | –40.340* | | –38.405* |
| | (11.37) | (12.45) | (11.62) | (12.44) | (13.78) | | (10.93) |
| ΔUSYS | –2.086 | | –2.431 | | | | –2.521 |
| | (0.52) | | (0.62) | | | | (0.61) |
| REQ | .0437 | .0441 | .0463* | .0449 | | | .0465* |
| | (1.89) | (1.89) | (2.04) | (1.93) | | | (2.00) |
| $R^2$ | .652 | .651 | .650 | .650 | .639 | .287 | .628 |
| $\bar{R}^2$ | .593 | .596 | .595 | .597 | .586 | .186 | .587 |
| March Coefficient (t-statistic) | –4.89 | –5.15 | –3.05 | –3.06 | –3.25 | –11.38* | |
| | (1.08) | (1.16) | (.81) | (.81) | (.86) | (2.17) | |

Notes:
i) All estimated models also include a constant as well as year and 11 month dummies (December is the base month) except for the model of column 7 which excludes the month dummies.
ii) The dependent variable consists of all the coefficient estimates associated with the monthly dummy variables in regressions of the individual holding period return data on month, province and bond dummy variables, as well as a maturity variable, for each individual year from 1983 through 2003.
iii) The number of observations is 251.
iv) Variable definitions:
GOVSAV – real federal government saving,
ΔCSB – the percentage change in the real quantity of outstanding Canada Savings Bonds,
ΔUSYL – the first difference in the US 10-year constant maturity Treasury bond yield,
ΔUSYS – the first difference in the US 3-month Treasury bill yield,
REQ – the excess return on the Standard and Poor's 500 stock market index.

See notes to Table 1.

likely to be jointly determined with the yields on provincial government bonds. Due to this potential endogeneity, the yields on other Canadian assets cannot be used to explain the seasonal pattern in provincial bond returns. Two domestic factors that would be expected to be exogenous to provincial returns, and that may have important seasonal effects, are real federal government saving (GOVSAV) and the percentage change in the real quantity of outstanding Canada Savings Bonds (ΔCSB). The federal Government of Canada is the main issuer of bonds in Canada, so an increase in the government's borrowing requirements, as reflected in the level of government saving, would be expected to increase the total supply of government bonds. Changes in the outstanding quantity of Canada Savings Bonds (CSBs) may also affect bond supply. Athanassakos and Tian (1998) find, using quarterly data for the period 1963-90, that the return on federal government bonds is significantly higher in the last quarter of the year when CSBs are sold to the public. They argue that funds raised from CSB issues (which are not marketable) reduce the need for the central government to issue Treasury bonds, leading to a reduced supply of bonds in the fourth quarter. Since a reduction in supply leads to higher bond prices (lower yields) and, thus, higher holding period returns, to the extent that federal government Treasury bonds and provincial government bonds are substitutable, seasonal changes in federal government saving or the supply of CSBs could affect provincial bond returns.

Given the large size of the US market relative to that of Canada, US asset returns can be treated as exogenous to Canadian returns. Further, movements in US asset returns are likely to affect the demand for Canadian assets, as a consequence of the close financial links between Canada and the US, so the returns on three US assets are incorporated in equation (4). The first two of these, the first difference in the US 10-year constant maturity Treasury bond yield (ΔUSYL) and the first difference in the US 3-month Treasury bill yield (ΔUSYS), represent the yields on long term and short term US government assets, respectively. The first difference in the yield is used since it is the change in the yield that is the driving factor in the determination of holding period returns. To represent the influence of the US equity market on the demand for provincial bonds, the excess return on the Standard and Poor's 500 stock market index (REQ) is employed.

As noted by Fama and French (1993, p. 46), if a variable is to explain a seasonal effect, it should be characterized by seasonality. In regressions of the five variables described above on a constant and the 11 monthly dummy variables for the period 1983 to 2003, at least one monthly coefficient for each variable is statistically different from zero. Two additional variables that theory suggests may determine asset yields are the term premium and the default premium. Chen, Roll, and Ross (1986) and Fama and French argue that these variables are indicators of movements in risk that determine asset returns and find some evidence consistent with this view. However, since neither of these variables exhibited a significant seasonal pattern, they were not incorporated in the empirical analysis of this section.

*Empirical analysis of the determinants of bond return seasonality*

To estimate equation (4), the 251 estimated monthly dummy variable coefficients obtained by estimating equation (3) for each year of the sample are regressed on the five Z variables identified above as potential determinants of the seasonality of bond holding period returns (as well as month and year fixed effects). The estimates presented in Table 3 show that these variables explain a considerable proportion of the variation in the seasonal coefficients. Further, with the inclusion of the variables in Z, the March coefficient is small and insignificant. If the elements of Z are excluded from the estimating equation (so that it includes only a constant, month and year dummy variables), the adjusted R-squared value falls from close to .6 to under .2 and the March coefficient, alone among the month coefficients, becomes significant (see Column 6, Table 3). As well, the Z factors appear to explain most of the monthly seasonal variation since, if the monthly dummies are excluded from the regression equation (column 7 of Table 3), both the explanatory power of the regression and the estimated coefficients associated with the significant variables in Z remain almost unchanged.

The Table 3 results indicate that the two Canadian factors considered, the Canadian federal government saving variable, GOVSAV, and the change in the stock of Canada Savings Bonds, ΔCSB, do not have a significant impact on provincial government bond return seasonality.[13] In contrast, the coefficient associated with the change in the yield on the US 10-year Treasury bond, ΔUSYL, is highly significant in every case. This coefficient estimate appears robust as it remains essentially unchanged when other variables are added or removed from the estimating equation. The coefficient on ΔUSYL is negative, as expected, since an increase in the yield on US government bonds is expected to lead to a rise in the yield on Canadian provincial government bonds, and a fall in the holding period return. For similar reasons, the coefficients associated with the change in the US 3-month Treasury bill yield (ΔUSYS) and the return on US equities (REQ) are expected to be negative and positive, respectively. While both coefficients have the expected sign, only the REQ coefficient is (marginally) significant.

Two alternative methods that have been employed in the literature to analyze the contribution of various factors to the seasonality of returns yield results that are consistent with the findings presented in Table 3. The first of these involves including the elements of Z as explanatory variables in the holding period return equation (2). If this causes the estimates of the monthly dummy variable coefficients to fall or become insignificant, the elements of Z explain (at least partly) the seasonal movement in returns (see Clare & Thomas 1992 and Clare et al., 1995). If ΔUSYL is included in the specification of column 5 in Table 1, the estimated coefficient associated with the March dummy variable changes markedly, from -11.71 to -3.71, indicating that USYL is an important determinant of the March effect. An additional alternative methodology, employed by

**Table 4:**

*Estimates of seasonal yields across alternative bond types (difference from December in percentage points at an annual rate)*

| | Dependent Variable | | | | | |
|---|---|---|---|---|---|---|
| | Continuous yield in levels | | | First differences of continuous yield | | |
| Month | Government of Canada 5-10 year bonds[ab] 1 | US Treasury 10-year constant maturity[ac] 2 | Provincial bond data[d] 3 | Government of Canada 5-10 year bonds[ab] 4 | US treasury 10-year constant maturity[ac] 5 | Provincial bond data[d] 6 |
| January | .247 | .290 | .299* | .026 | .061 | .022* |
| | (1.14) | (1.33) | (10.79) | (.32) | (.88) | (2.08) |
| February | .320 | .264 | .341* | .139 | .074 | .077* |
| | (1.79) | (1.38) | (14.24) | (1.45) | (.84) | (6.45) |
| March | .449* | .372* | .504* | .201* | .185* | .199* |
| | (2.77) | (2.15) | (22.48) | (2.51) | (2.65) | (17.19) |
| April | .487* | .445* | .530* | .110 | .164* | .060* |
| | (3.26) | (2.80) | (25.39) | (1.37) | (2.35) | (6.12) |
| May | .429* | .443* | .444* | .014 | .074 | –.050* |
| | (2.92) | (2.79) | (21.96) | (.18) | (.77) | (5.21) |
| June | .381* | .326* | .406* | .024 | –.028 | –.001 |
| | (2.56) | (2.09) | (19.59) | (.32) | (.48) | (.06) |
| July | .390* | .327* | .341* | .080 | .092 | –.026* |
| | (2.62) | (2.21) | (16.60) | (1.13) | (.99) | (2.62) |
| August | .315* | .282 | .272* | –.003 | .014 | –.027* |
| | (2.19) | (1.81) | (13.53) | (.04) | (.20) | (3.06) |
| September | .309* | .160 | .214* | .066 | –.016 | –.021 |
| | (2.07) | (.96) | (11.01) | (.76) | (.20) | (1.94) |
| October | .112 | .083 | .023 | –.126 | .018 | –.154* |
| | (.73) | (.52) | (1.10) | (1.47) | (.22) | (16.19) |
| November | .072 | .079 | .039 | .032 | .088 | .052* |
| | (.43) | (.47) | (1.75) | (.39) | (1.28) | (5.60) |

Notes: The number in brackets under each coefficient estimate is the heteroscedastiscty corrected t-statistic.
Sample period: February 1983 - December 2003.

a The estimates are from a regression of the dependent variable on a constant, and month and year dummy variables (251 monthly observations).
b The data are last Wednesday of the month average yields of marketable bonds with 5 to 10 years to maturity (Cansim identifier V122486).
c The data are last business day of the month (Federal Reserve identifier TCM10Y).
d The estimates use the yields to maturity of the individual provincial bond data. The estimates are from a regression of the dependent variable on a constant, a measure of maturity, and month, year, province and bond dummy variables. These regressions use 22019 individual bond observations.

Fama and French (1993), is to estimate the holding period return equation with the arguments of Z included as explanatory variables and the monthly dummy variables deleted from the estimating equation. If, in a regression of the residuals from this regression on the monthly dummies, the monthly dummy variable coefficients are insignificant, then the elements of Z explain the seasonal pattern of returns. This approach also supports the importance of ΔUSYL since the inclusion of this variable in the returns regression causes the estimated March coefficient to change from –11 to –1.5 in a regression of the residuals on the monthly dummies. Although consistent with the results reported in Table 3, these alternative approaches are less satisfactory as it is unclear how they can be used to explicitly test the extent to which each element of Z contributes to an explanation of the seasonality of returns.

One of the purposes of this study is to identify the factors that cause seasonality in provincial government bond returns. The results presented above suggest that the change in the US 10-year Treasury bond yield is an important determinant of the seasonal variation in Canadian provincial government bond returns. This is not surprising as the 10-year Treasury bond yields and the yields on the individual provincial bonds employed here follow a similar seasonal pattern. Columns 2 and 5 of Table 4 present the average value of the level and change, respectively, of the US 10-year Treasury bond yield by month (relative to December). Columns 3 and 6 of Table 4 present the corresponding values for the individual provincial bond data while, for the purpose of comparison, columns 1 and 4 present the values for the average yield of Government of Canada bonds with from 5 to 10 years to maturity. Relative to their December values, the yields on all three types of bonds rise from January through April and then generally fall. The magnitude of the difference from the corresponding December value in the level of the yields for each of the three bonds is strikingly similar and all three reach a maximum in April (see columns 1 to 3 of Table 4). Further, columns 4 through 6 show that, for all three types of bonds, the largest monthly change, relative to the December change, occurs in March. This is important because it is changes in yields that correspond most closely with changes in holding period returns. The basic pattern of the US bond yield data illustrated in Table 4 has been observed previously. Using data from 1988 to 1998, Fridson (2000) shows that US 10-year Treasury bond yields tend to rise during the December to May interval, and fall from June to November, a seasonal pattern that is consistent with the findings reported here. Similarly, for the years 1947 to 2000, Ogden (2003, Table 3, 39) observes an average negative excess return on long-term US Treasury bonds in February, March and April (and also finds the highest positive excess return in October).[14]

While it is beyond the scope of this paper to rigorously identify the factors that may be the cause of the seasonal pattern in US 10-year Treasury bond yields, there are at least two potential explanations for this seasonality. First, the movement in yields is consistent with the high degree of seasonality in international bond issuance. Amato and Sobrun (2005) find that issuance tends to be highest in the first quarter and then falls as the year progresses, a pattern that is consistent with rising yields in the first quarter as shown in Table 4. They suggest that seasonality in issuance may arise out of a need to smooth cash flow due to systematic revenue-expenditure imbalances over the calendar year.

Second, seasonality in bond returns may be related to seasonality in equity returns, since equity returns have been observed to be lower in the May to October period (Bouman & Jacobsen, 2002; Ogden, 2003). A movement by investors out of equities in May to October, and into bonds, would tend to push up bond prices and returns, while a movement from bonds into equities from November to April would have the opposite effect. This would be generally consistent with the pattern found here of lower bond returns in January through April and higher returns in August through October.

## Concluding Comments

Using monthly data on individual bonds, this paper documents systematic seasonal variation in Canadian provincial government bond excess holding period returns and identifies factors that may be the cause of this seasonality. The Canadian provincial bond market is a sizable market, and the seasonality of returns in this market has not been examined previously. By investigating this market, this study contributes to the literature on seasonality in the market for government bonds, a market in which seasonality is less well understood than the markets for equities and corporate bonds. Further, with the provincial government bond data set employed in this study, it is possible to calculate the holding period return for each bond, so it is not necessary to make assumptions with respect to coupon payments and time to maturity, as must be done in many studies of bond seasonality. Finally, in contrast to most analyses of seasonality, this study illustrates the importance of considering international factors in explaining the seasonality of returns. Studies that consider only domestic causes of seasonality may give an imperfect indication of the factors that determine the seasonality of returns.

Excess returns are shown to be significantly negative in the month of March, when yields on provincial government bonds tend to rise. These results are robust across nonparametric and parametric tests, different empirical specifications and various sub-samples of the data. A trading strategy that took advantage of this seasonal pattern by selling at the end of February and buying at the end of March would have raised the average annual return on a portfolio of provincial government bonds by approximately 100 basis points, while also reducing the standard deviation of returns by over 5 percent.

A similar seasonal pattern is found for bonds issued by all ten provincial governments, so the source of the seasonal variation is not likely to be province-specific. Factors originating in the Canadian market, such as the level of federal government saving and changes in the outstanding quantity of Canada Savings Bonds, are shown to not be significant determinants of the observed seasonal variation in returns. In contrast to these domestic factors, changes in the US 10-year constant maturity Treasury bond yield are found to have a significant impact on the seasonal movements of provincial bond excess returns. These findings provide evidence that seasonality in the US bond market has a spillover effect on the seasonal variation in Canadian asset returns. It may, therefore, be important to incorporate international factors in models of return seasonality for other markets and countries.

The results presented above suggest several areas for future research. First, as the seasonal pattern in Canadian provincial bond returns are correlated with movements in US Treasury bond yields, a more complete understanding of seasonal movements in Canadian yields requires a better understanding of the causes of seasonal movements in US yields.

In contrast to the results of Athanassakos and Tian (1998) for Government of Canada bonds, the change in the quantity of CSBs is not found to significantly explain the seasonal pattern of provincial bond holding period returns. However, the results in Table 1 show a large rise in returns in October, the month in which investors are likely to purchase CSBs given the November 1 program deadline. Further, evidence in Table 4 shows a large fall in the two Canadian yields in October (although this change is not significant for the Government of Canada bonds), but no corresponding fall in US yields. This suggests a purely Canadian institutional factor may explain the October movement in Canadian yields and implies that the relationship between bond yields and the CSB program deserves further study.

Finally, given substitutability across assets, it seems unlikely that bond returns and stock returns follow unrelated seasonal patterns. For example, a movement out of stocks and into bonds may explain an increase in bond holding period returns and fall in equity returns in the latter part of the year. Further investigation of the possible relationship between bond market seasonality and stock market seasonality is warranted.

## Notes

1 See, for example, the recent contributions of Dimson and Marsh (2001), Bouman and Jacobsen (2002), and Ogden (2003).

2 See, for example, Gultekin and Gultekin (1983); Berges, McConnell, and Schlarbaum (1984); Tinic, Barone-Adesi, and West (1987); Jordan and Jordan (1991); Fama and French (1993); Clare, Psaradakis, and Thomas (1995); Longin and Solnik (1995); Maxwell (1998); Barnhill, Joutz ,and Maxwell (2000); Athanassakos (2002); Ogden (2003); and L'Her, Masmoudi ,and Suret (2004).

3 Kahn and Gulrajani (1993) and Deaves (1997), among others, examine factors that affect Canadian government bond returns, but do not consider seasonality.

4 See, for example, Schneeweis and Woolridge (1979); Smirlock (1985); Wilson and Jones (1990); Jordan and Jordan (1991); Fama and French (1993); Chan and Wu (1993, 1995); Maxwell (1998); Lavin (2000); Smith (2002); and Ogden (2003). Jordan and Jordan (1991, 271-3) provide an informative description of the construction of the index they employ and the assumptions underlying it. Studies of bond return seasonality that employ individual bond data include Chang and Pinegar (1986) and Athanassakos and Tian (1998).

5 Use of the excess holding period return rather than the holding period return, and the calculation of this excess return using the Treasury bill yield, is common and makes the analysis comparable to many other studies (see Fama & French, 1993). If holding period returns rather than excess holding period returns are used in the empirical analysis below, the results and conclusions are unaffected.

6 Since each bond is issued by a specific province, the set of bond dummies is perfectly collinear with the set of province dummies. An alternative, but equivalent, version of equation (2) is to drop the province dummies and include B-1 bond dummies (as is done in the last two columns of Table 1 below).

7 Estimates of the other parameters that appear in equation (2) are not presented to conserve space and because they are not essential to the discussion. As $\epsilon_{bt}$ may be heteroscedastic, the standard errors and all tests are corrected for heteroscedasticity.

8 The magnitude of the March effect found here is similar to the magnitude of the fourth quarter effect found by Athanassakos and Tian (1998) for Government of Canada bonds.

9 The term premium is the difference between the Govern-

ment of Canada long-term bond yield and the one month Treasury bill rate at the end of the previous period. The default premium is the difference between the corporate long-term bond yield and the Government of Canada long-term bond yield. See the appendix for details. The potential outlier years include the 1987 stock market crash, the 1997 Asian crisis, as well as the events of September 11, 2001 and the subsequent significant loosening of US monetary policy. See Maxwell (1998) for a similar approach to outliers.

10 The magnitude of this effect is similar to the 137 basis point advantage found by Clayton, Delozier,and Ehrhardt (1989) for divesting US Treasury bond holdings during January over the 1965-85 period. The average of the yearly returns is compared so that a possible beneficial return early in the sample, in conjunction with compounding, does not give one trading strategy an advantage simply on the basis of the timing of returns. A comparison of the compound returns yields the same conclusions as the average annual return comparison.

11 This data is for a sample of 53 bonds that includes the bonds of eight provinces and represents all the provincial government bonds with more that 6 months to maturity for which bid-ask spreads were published in the *Globe and Mail*, 8 July 2006, page B24.

12 Even with the somewhat higher estimates (21 to 27 basis points) for the trading costs associated with risky corporate bonds found by Chakravarty and Sarkar (2003) and Schultz (2001), transaction costs would not be so large as to eliminate the benefit, on average, of the activist trading strategy.

13 Since 1995, one of the goals of the Canadian Retail Debt Agency (the official issuing agency for CSBs) has been to move to year-round sales of CSBs (Orange, 1996). For this reason, a weaker seasonal effect would be expected in the sample employed here, which uses data for a more recent period than that employed by Athanassakos and Tian (1998).

14 In Canada, tax shielded contributions to Registered Retirement Savings Plan (RRSP) accounts in the first two months of the year can be applied to either the current or previous tax year. This Canada-specific institution, which tends to encourage an inflow of funds prior to the March 1 deadline, could potentially lead to seasonality in asset returns. If this were the case, one would expect to see yields fall in January and, particularly, February, and then rise in March. However, as can be seen from Table 4, yields rise in both January and February relative to December. Further, the similar pattern of Canadian and US yields over the first half of the year suggests that seasonal movements in returns are caused by factors that are not specific to Canada. This evidence would appear to indicate that RRSP contributions cannot explain the seasonality in bond yields.

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## Appendix

*Variable Descriptions and Sources*

**Excess holding period return:** The monthly holding period return for each provincial government bond, at an annual rate, minus the one month Government of Canada Treasury bill rate from the end of the previous month, also at an annual rate. The Treasury bill rate is from Statistics Canada's Cansim database (identifier: V122529). The excess holding period return on provincial bond b at time t, $R_t^b$, is calculated as follows:

$$R_t^b = \left(\left(\frac{P_t^b - P_{t-1}^b}{P_{t-1}^b}\right) \times \left(\frac{365}{N_t}\right) + \frac{\text{coupon}^b}{P_{t-1}^b}\right) \times 100 - RTB_t \,, \tag{1}$$

where:

$P_t^b$ = the end-of-month bid price for bond b with a face value of \$100 (clean price);
$\text{coupon}^b$ = the annual coupon payment for a \$100 bond paid on bond b;
N = the actual number of days between price data points;
$RTB_t$ = the one month Government of Canada Treasury bill rate at the end of the previous month, also at an annual rate.

Note that $\frac{P_t^b - P_{t-1}^b}{P_{t-1}^b}$ is the monthly capital gain. Multiplying this term by (365/N) converts this monthly gain to an annual rate using the exact number of days. (Note that the results are almost identical if a conversion factor of 12 is used rather than [365/N].)

The bond price and coupon data, as well as data required to derive N, are from:

*FT Bonds – Canadian Prices*, Toronto, Financial Post, annual 1998-03, and *Canadian Bond Prices*, Toronto: Financial Post, annual, 1983-97. Prices are the clean closing bid prices for the last business day of the month.

Sample period January 1983 – December 2003. Bonds were excluded from the sample if:

1. There was no information on the bond's characteristics in *FP Bonds Government* or the *Government Bond Record.*
2. The outstanding quantity did not equal the issued quantity.
3. The data indicated the bond was callable, redeemable, extendable, retractable, defeased or partially defeased, had a sinking fund that did not commence for several years after the issue date, or had other characteristics (warrants, options, etc.) that could affect the price.
4. There was no information on interest frequency, issue date or issue amount.
5. The bond was not issued in Canadian dollars.
6. The bond did not have a semi-annual coupon with principal paid at maturity.
7. The bond was issued in exchange for another bond.
8. The bond had a variable coupon or variable maturity date.
9. The price data listed two bonds with the same coupon and maturity, and so it was not possible to distinguish the bonds.

**Issue amount** = Dollar amount issued of the bond. This is the most recent information on the amount of the bond outstanding. *Source:* 1998-2003, *FP Bonds – Government*, annual, Toronto: Financial Post. 1985-1998, *Government Bond Record*, Toronto: Financial Post, annual.

**Maturity** = Months to maturity of the bond. Since bonds can mature on any day of the month, maturity is calculated so that, if a bond matures after the 15$^{th}$ of the month, the month is included as a month to maturity. However, if a bond matures on the 15$^{th}$ or earlier, the month is not counted as a month to maturity. *Source*: Same as for the bond price.

**Year dummies** = a set of twenty (0,1) dummy variables that equal one in a particular year, and zero otherwise. The base year is 2003.

**Month dummies** = a set of eleven (0,1) dummy variables that equal 1 in a particular month and 0 otherwise. The base month is December.

**Bond dummies** = a set of (0,1) dummy variables, one for each of the 313 bonds, less one for the constant.

**Province dummies** = a set of nine (0,1) dummy variables, one for each province. Ontario is the base province.

**ΔUSYL** = First difference of the end-of-month (last business day) US 10-year constant maturity Treasury bond yield. Source: The US Federal Reserve variable TCM10Y, not seasonally adjusted. Daily data downloaded 29 June 2004 from the US Federal Reserve website: www.federalreserve.gov/releases/h15/data.htm.

**ΔUSYS** = First difference of the end-of-month (last business day) US 3-month Treasury Bill yield in the secondary market. Source: The US Federal Reserve variable TBSM3M, not seasonally adjusted. Same website as ΔUSYL.

**REQ** = Monthly rate of change of the Standard and Poor's (500) US stock market index (Statistics Canada, Cansim database, series V37425), measured at an annual rate, minus TBSM3M (see above).

**GOVSAV** = real monthly Canada federal government savings. Federal savings are deflated by the all-items CPI (Statistics Canada, Cansim database, series V735319). Federal savings are from the Statistics Canada Cansim database (1/83-3/85: V6612; 4/85-3/96: V6665; 4/96-3/97: V6518; 4/97-3/98:V6557; 4/98-3/99: V6598; 4/99-3/00: V6437; 4/00-3/01: V843672; 4/01-12/03: V3723446).

**ΔCSB** = monthly percentage change in the real quantity of Canada Savings Bonds (CSBs) outstanding. The stock of CSBs is from the Statistics Canada Cansim database, series V37296. This is deflated by the all-items CPI (Cansim series V735319).

Other variables:
**Term Premium** = the end of the previous month difference between the Government of Canada Benchmark long-term bond yield (Cansim series V122544) and the one month Treasury bill rate (Cansim series V122529).
**Default Premium** = the end of the previous month difference between the Canada Scotia Capital all corporates long-term bond yield (Cansim series V122518) and the Government of Canada Benchmark long-term bond yield (Cansim series V122544).