
Taxation and Bond Market Investment Strategies: Evidence from the Market for Government of Canada Bonds

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PRÉCIS

Le présent article montre que, contrairement à ce que proposent certains conseillers en placements, pour un investisseur canadien assujéti à l'impôt sur le revenu des particuliers, le rendement après impôt d'une obligation à escompte est *toujours* supérieur (ou au pire, égal) au rendement d'une obligation au-dessus du pair. Cette situation provient du fait que le taux d'imposition des gains en capital est inférieur au taux d'imposition des revenus convertis en taux d'intérêt au Canada. On montre également qu'une réduction du taux d'imposition des gains en capital au Canada *augmente* le rendement après impôt des obligations à escompte mais *réduit* le rendement après impôt des obligations au-dessus du pair, et peut même faire en sorte que le rendement sur les obligations au-dessus du pair soit *négatif*. En outre, une réduction du taux d'imposition des revenus en intérêts augmente le rendement après impôt de toutes les obligations, mais augmente aussi le rendement des obligations au-dessus du pair par rapport aux obligations à escompte. Bien que l'on soit en droit de s'attendre à ce que le rendement après impôt plus faible des obligations à coupon élevé entraîne une augmentation du rendement après impôt de ces obligations, on n'a trouvé aucun élément de preuve dans le vaste ensemble de données sur les deux parties correspondantes des obligations du gouvernement du Canada émises entre 1986 et 2006. La quasi-égalité des rendements après impôt qui a été observée depuis 1995 pour les obligations ayant des coupons différents implique que les particuliers au Canada obtiennent un rendement après impôt sur les obligations au-dessus du pair significativement inférieur à celui des obligations à escompte.

ABSTRACT

This article shows that, contrary to the suggestion of some investment advisers, for an individual Canadian investor subject to personal income taxation, the after-tax yield on a discount bond is *always* higher than (or, at worst, equal to) the yield on a premium bond.

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This follows because the tax rate on capital gains is lower than the tax rate on coupon income in Canada. It is also shown that a decline in the capital gains tax rate *raises* the after-tax yield on discount bonds but *reduces* the after-tax yield on premium bonds, and may even cause the yield on premium bonds to become *negative*. Further, a cut in the tax rate on *interest* income raises the after-tax yield on all bonds, but raises the yield on premium bonds relative to discount bonds. While the lower after-tax yields on higher-coupon bonds might be expected to cause the pre-tax yields on these bonds to rise, no evidence of such tax capitalization is found using a large data set of matched pairs of government of Canada bonds for the period 1986-2006. The observed near-equality of pre-tax yields since 1995 for bonds with different coupons implies that individuals in Canada earn a significantly smaller after-tax yield from holding premium bonds than discount bonds.

KEYWORDS: TAXATION ■ INVESTMENT INCOME ■ BONDS ■ CAPITAL GAINS ■ PERSONAL INCOME TAXES ■ DISCOUNT

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INTRODUCTION

Tax tip: When choosing between similar bonds with the same yield to maturity, the best choice would be the one with the highest premium, because it will provide a higher capital loss when the bond matures.

Investing Tax Issues, Canadian Tax and Financial Information
(online: <http://www.taxtips.ca/personaltax/investing/taxtreatment.htm>)

Many people would shy away from buying Bond Two because it's trading at a premium. A smarter investor would say that Jack should be indifferent between Bond One and Bond Two, because the yield to maturity on these bonds is almost identical. Now, what would a genius investor tell Jack? . . . A genius investor would tell Jack to purchase Bond Two—the one trading at a premium. Why? Both Bond One and Bond Two offer virtually the same yield to maturity—before taxes. On an after-tax basis, however, Bond Two provides a greater yield to maturity . . . (assuming he's an Ontario resident in the highest tax bracket).

Tim Cestnick, "Buy High, Sell Low? Good Idea for Bonds That Come with a Capital Loss," *Globe and Mail*, October 14, 2006, B11

In the column published the week following the *Globe and Mail* article cited above, Tim Cestnick provided a qualification: “The problem with these figures is that they ignored the taxes owing on the bond coupon interest during the term of the bond. . . . Bond One is a better choice than Bond Two on an after-tax basis.”¹ These statements suggest that, for individual taxpayers, there may be confusion about whether there is a tax advantage to investing in bonds that sell at a premium or a discount, where a bond sells for a *premium* when its market price is greater than its face value (the amount that the issuer pays the bearer at maturity) and sells at a *discount* if its price is less than its face value.²

The logic of the argument implied by the tax tips quoted above is that a bond purchased at a premium, and held to maturity, will realize a capital loss that can be used as a tax writeoff against capital gains earned on other investments. In contrast, a bond purchased at a discount will earn a capital gain that generates a tax liability. Despite this capital gains tax liability, it is shown below that, for an individual Canadian investor subject to personal income taxation, the *after-tax* yield on a discount bond is *always* higher than (or, at worst, equal to) the yield on a premium bond.

The analysis in this article provides a systematic examination of the implications of personal income taxation in Canada for pre-tax and after-tax bond yields from the perspective of an individual. In so doing, it explains why the advice given in the epigraphs would lead to lower, not higher, after-tax yields. Further, it shows that the magnitude of the difference in the after-tax yields of bonds with different coupon rates can be a large fraction of the after-tax yield.

An individual investor will be indifferent between a bond trading at a premium and a bond trading at a discount if pre-tax yields adjust and thereby create an “implicit tax” that equalizes the after-tax yields of bonds with different coupons. As noted by Scholes and Wolfson, “the result of taxing assets differentially is the creation of a system of implicit taxes, where the prices of tax-favored assets are bid up such that their before-tax rates of return fall below those of equally risky but less tax-favored assets.”³ A key component of this study is to assess whether such capitalization occurs using a large sample of government of Canada bond yields (the benchmark for bonds issued in Canada). The capitalization of taxes in bond yields is important to both

1 Tim Cestnick, “Here’s Some General Rules for Tax-Smart Fixed-Income Investing,” *Globe and Mail*, October 21, 2006, B15. Surprisingly, a week after the clarification was printed, on November 2, 2006, the *Globe and Mail* posted the original column at its website, <http://www.theglobeandmail.com/servlet/story/RTGAM.20061102.wcestnick101406/BNStory/TaxCentre/home>, and it was still there in September 2008.

2 A bond’s coupon payment (usually expressed as a percentage of the face value) is the amount to be paid by the issuer of the bond to the bondholder at regular intervals (semi-annually in Canada). A bond sells at a premium if the coupon rate is greater than the current market yield; it sells at a discount if the coupon rate is less than the market yield; and it sells at par if the coupon rate equals the market yield.

3 Myron S. Scholes and Mark A. Wolfson, *Taxes and Business Strategy: A Planning Approach* (Englewood Cliffs, NJ: Prentice Hall, 1992), 116.

purchasers and issuers of bonds because it could affect both after-tax and pre-tax yields. The impact of taxes on pre-tax yields also has implications for the distribution of the burden of tax changes across individual investors, and between individual investors and corporate, institutional, and non-resident investors.

The empirical results presented in this article are obtained using a large and previously unused data set of government of Canada bond prices and yields. This data set consists of matched monthly observations for bond pairs, where the bonds in each pair have different coupon rates but are identical in terms of issuer (the government of Canada) and date of maturity. The use of bond pairs greatly simplifies the analysis, since it is then not necessary to control for important differences across bonds, such as risk and time to maturity. Previous studies have found it problematic to test for tax effects on bond yields because of the difficulty associated with separating tax effects from the impact of differences in other bond characteristics, and this data set provides a significant advantage in this regard.

The analysis yields several important findings. First, after-tax yield differences across bonds with equal *pre-tax* yields but different coupons can be large. Over the sample of 2,190 monthly observations on 49 bond pairs for the 1986-2006 period, the average *after-tax* yield of the low-coupon bond is 3.74 percent compared with just 3.27 percent for the high-coupon bond, a difference of 47 basis points (hundredths of a percent). In the more recent 1995-2006 period, the *after-tax* yield of the low-coupon bond (2.32 percent) exceeds that of the high-coupon bond (1.67 percent) in each pair by an average of 65 basis points, a difference equivalent to 33 percent of the average after-tax yield in the sample (1.99 percent).⁴ These results are intuitive because the yield on a bond consists of two components—a coupon payment and a capital gain or loss—and, for a given pre-tax yield, a bond with a lower coupon earns a higher proportion of its yield in terms of a capital gain.⁵ Thus, for an individual investor paying a higher rate of tax on interest income than on capital gains (the typical individual investor in Canada), there are clear tax benefits to investing in bonds with *lower* coupons.⁶

Further, the analysis shows that a cut in the capital gains tax (with no change to the tax on interest income) will increase the after-tax yields on bonds that trade at a

4 These calculations employ the highest tax rate in each year for an individual living in Ontario.

5 Since capital losses can only be written off against capital gains, the after-tax yield on a premium bond—which is characterized by a capital loss if held to maturity—will be even lower if the investor does not have a capital gain against which to write off the capital loss. If, as in Canada, capital losses can be carried forward to future years, the after-tax yield on the bond will depend on how long the taxpayer must wait to use the capital loss to write off a capital gain. On the other hand, the option to carry back a capital loss against a capital gain from a previous year would provide an immediate tax benefit once the capital loss is realized at redemption.

6 This conclusion does not apply to tax-shielded investments (such as those held in registered retirement savings plans [RRSPs]) or to zero-coupon bonds. In Canada, the yield from holding a zero-coupon bond or a strip bond (calculated as the discount rate that equates the face value at maturity to the price at the time of purchase) is considered to be interest income and is taxed as ordinary income rather than as a capital gain.

discount, but will *decrease* the after-tax yields on bonds that sell at a premium. Thus, the proposal by the Conservative Party during the 2006 election campaign to defer recognition of capital gains on individuals' sales of assets when the proceeds are re-invested within six months would benefit individual taxpayers holding discount bonds relative to those holding premium bonds, and could even cause the after-tax yield on higher-coupon premium bonds to be negative.

Notwithstanding the large differences in the personal income tax liabilities that arise from differences in bond coupons, the empirical results indicate that Canadian bond prices do not capitalize these tax liabilities.⁷ Since 1995, the pre-tax yields on

7 Other studies have found evidence of this type of adjustment for tax-advantaged assets, such as US municipal bonds, although adjustment is typically not complete. Mary E. Lovely and Michael J. Wasylenko, "State Taxation of Interest Income and Municipal Borrowing Costs" (1992) vol. 45, no. 1 *National Tax Journal* 37-52, find that a 1 percentage point fall in the state income tax rate causes a 2.9 basis point fall in the yield to maturity on new issues of state bonds, while Gerald D. Gay and Seokchin Kim, "The Coupon-Induced Tax Clientele Effect in Bond Prices" (1991) vol. 12, no. 5 *Managerial and Decision Economics* 367-76, provide some evidence of coupon-induced clientele effects in the US Treasury market during the 1977-1986 period. Multicountry studies by Robert H. Litzenberger and Jacques Rolfo, "An International Study of Tax Effects on Government Bonds" (1984) vol. 39, no. 1 *Journal of Finance* 1-22, find that taxes affect the prices of bonds in Germany, Japan, the United Kingdom, and the United States, while Sylvester C.W. Eijffinger, Harry P. Huizinga, and Jan J.G. Lemmen, "Short-Term and Long-Term Government Debt and Nonresident Interest Withholding Taxes" (1998) vol. 68, no. 3 *Journal of Public Economics* 309-34, find that withholding taxes affect government bond yields in industrialized countries. In contrast, other studies have found that taxes do not substantially affect bond prices: see Richard C. Green and Bernt A. Ødegaard, "Are There Tax Effects in the Relative Pricing of U.S. Government Bonds?" (1997) vol. 52, no. 2 *Journal of Finance* 609-33; Eugene F. Fama and Kenneth R. French, "Taxes, Financing Decisions, and Firm Value" (1998) vol. 53, no. 3 *Journal of Finance* 819-43; Edwin J. Elton and T. Clifton Green, "Tax and Liquidity Effects in Pricing Government Bonds" (1998) vol. 53, no. 5 *Journal of Finance* 1533-62; and David A. Guenther, "The Relation Between Tax Rates and Pre-Tax Returns: Direct Evidence from the 1981 and 1986 Tax Rate Reductions" (1994) vol. 18, no. 3 *Journal of Accounting and Economics* 379-93. For example, Guenther, *supra*, finds that US Treasury bill yields respond to tax changes, but the magnitude of the response is small relative to that which would be expected if the marginal investor were an individual rather than, say, a tax-exempt organization. Using data for Canada, Michael J. Brennan and Eduardo S. Schwartz, "A Continuous Time Approach to the Pricing of Bonds" (1979) vol. 3, no. 2 *Journal of Banking and Finance* 133-55, find only a small effect of income taxes on Canadian government bond yields, but John S. McCallum, "The Impact of the Capital Gains Tax on Bond Yields" (1973) vol. 26, no. 4 *National Tax Journal* 575-83, finds that the announcement of the introduction of a capital gains tax in Canada in 1969 had an impact on bond yields. Alexandra E. Mackay, Eliezer Z. Prisman, and Yisong S. Tian, "Non-Segmented Equilibria Under Differential Taxation: Evidence from the Canadian Government Bond Market" (2000) vol. 4, no. 3 *European Finance Review* 253-78, also find some evidence of a tax effect in the Canadian government bond market during the 1964-1986 period. There is also a large related literature on the link between capital gains tax changes, stock returns, and dividend yields. Examples using Canadian data include Ben Amoako-Adu, M. Rashid, and M. Stebbins, "Capital Gains Tax and Equity Values: Empirical Test of Stock Price Reaction to the Introduction and Reduction of Capital Gains Tax Exemption" (1992) vol. 16, no. 2 *Journal of Banking and Finance* 275-87; Kenneth J. McKenzie and Aileen J. Thompson, "The Impact of the Capital Gains Exemption on Capital Markets" (1995) vol. 21,

government of Canada bonds have differed by only a few basis points despite large differences in coupon rates. Further, empirical evidence indicates that even these very small differences in pre-tax yields do not change systematically in response to changes in the relative tax treatment of interest income and capital gains. This implies that, since 1995, bond prices have not changed in order to equate, or even partly equate, after-tax yields for individual investors. This is not surprising since individuals hold a relatively small proportion of government of Canada marketable bonds (see table 1).⁸

In contrast to the 1995-2006 period, from 1986 through 1991, pre-tax bond yields are found to be generally higher for bonds with higher coupons.⁹ While this is consistent with the view that pre-tax yields adjust to compensate investors for the greater tax liabilities associated with higher coupons, the pre-tax yield differences are, on average, only about one-third of the level necessary to equate after-tax yields. More importantly, pre-tax yield differences show little or no correlation with actual tax changes over this period. Once again, this is not surprising, given the evidence in table 1 of the small proportion of government of Canada bonds held by individuals. While the pre-tax yields on higher-coupon bonds tend to be larger during the 1986-1991 period, this difference presumably arises from factors other than those related to the interaction of taxes and coupon differentials—factors such as market illiquidity, lack of transparency, and ad hoc bond pricing practices.¹⁰ These practices became less prevalent after the introduction of reforms to the operation of the market for government of Canada bonds by the financial sector and the Bank of Canada in the early 1990s, and this may explain the much smaller pre-tax yield differential after this time.

The results imply that the marginal investor in the market for government of Canada bonds is an investor who pays no tax, such as a pension fund, since that type of investor will earn the same after-tax return on high- and low-coupon bonds. As noted by Scholes and Wolfson, the marginal taxpayer “is indifferent between purchasing two equally risky assets, the returns to which are taxed differently.”¹¹

supplement 1 *Canadian Public Policy* 100-15; and Tao Zeng, “Corporate Dividend Yields and the Lifetime Capital Gains Tax Exemption” (2002) vol. 50, no. 4 *Canadian Tax Journal* 1307-19.

- 8 The holdings of individuals in table 1 include bonds held in tax-deferred (RRSP) accounts. The greater the extent to which individuals have the option to hold bonds in RRSPs, the less likely it is that taxes on individual bondholders will be capitalized in bond yields.
- 9 Paul Halpern and John Rumsey, “Strip Bonds and Arbitrage Bounds” (2000) vol. 17, no. 2 *Canadian Journal of Administrative Sciences* 143-52, also observe that lower-coupon government of Canada bonds had lower yields (were “overpriced”) in the period from March 1992 to May 1993, a finding that, they note, is consistent with a tax explanation. However, their focus is on institutional changes that increased the liquidity of strip bonds, and they do not investigate the interaction of tax rate changes, relative coupon levels, and pre- and after-tax yields.
- 10 Grahame Johnson, “Government of Canada Yield-Curve Dynamics, 1986-2003” (Winter 2004-5) *Bank of Canada Review* 17-28; and Miles Whittingham, “The Canadian Market for Zero-Coupon Bonds” (Winter 1996-97) *Bank of Canada Review* 47-62.
- 11 Scholes and Wolfson, *supra* note 3, at 96.

TABLE 1 Shares of Holdings of Outstanding Government of Canada Marketable Bonds by Investor Type

End of period	Persons and unincorporated business ^a	Non-financial corporations including government business enterprises ^b	Bank of Canada ^c	Government and financial government business enterprises ^d	Trusteed pension plans and social security funds ^e	Chartered banks and near-banks ^f	Life insurance and other financial institutions ^g	Non-residents ^h	Total Holdings ⁱ	<i>Can \$ millions</i>
1986	11	1	10	8	22	5	15	27	102,338	
1987	12	1	9	7	22	6	15	27	113,102	
1988	11	1	9	7	22	6	14	31	123,024	
1989	9	1	8	6	23	4	13	36	131,257	
1990	8	1	7	6	23	5	12	38	146,115	
1991	6	1	6	6	22	8	12	38	164,295	
1992	5	1	4	7	21	11	13	38	178,476	
1993	5	0	3	6	19	16	13	37	203,930	
1994	6	1	2	7	20	18	14	31	237,567	
1995	5	1	2	7	19	18	15	32	264,802	
1996	6	1	3	8	19	19	14	32	295,969	
1997	9	1	4	8	20	16	13	29	317,101	
1998	10	1	5	8	21	16	14	26	331,943	
1999	8	1	6	8	22	14	14	27	332,419	
2000	8	1	7	8	22	16	12	24	329,670	
2001	9	1	8	10	20	17	13	23	315,443	
2002	7	1	9	9	20	14	15	26	308,770	
2003	8	1	10	12	21	13	16	20	294,009	
2004	7	1	11	13	22	11	17	20	275,961	
2005	8	1	11	13	22	13	16	17	267,818	
2006	6	1	11	14	21	12	17	17	263,176	

(Table 1 is concluded on the next page.)

TABLE 1 Concluded

- ^a Includes mutual funds. Cansim series V33483 + V34179 – V33484 all divided by Total Holdings.
- ^b Cansim series V33236 divided by Total Holdings.
- ^c Cansim series V33689 divided by Total Holdings.
- ^d Excludes social security funds. Cansim series V32597 + V34323 – V34589 all divided by Total Holdings.
- ^e Cansim series V34085 + V34589 all divided by Total Holdings.
- ^f Cansim series V33736 divided by Total Holdings.
- ^g Includes life insurance business; segregated funds of life insurance companies; and total other financial institutions. Excludes mutual funds. Cansim series V34023 + V34056 + V34114 – V34179 all divided by Total Holdings.
- ^h Cansim series V34623 divided by Total Holdings.
- ⁱ Total Holdings = Cansim series V34786 – V33484.

Source: Statistics Canada, *National Balance Sheet Accounts, by Sectors*, CANSIM II Table 3780004.

Infra-marginal investors are subject to tax rates different from those of the marginal investor, and are not indifferent to the choice of differentially taxed assets. Thus, given the differential taxation of coupon and interest income in Canada for individuals, individuals represent the “natural clientele” for low-coupon bonds. As Scholes and Wolfson point out, “Unless investors correctly identify their natural tax clienteles, they will not maximize their after-tax rates of return.”¹²

The central prescription of the analysis from a tax-planning perspective is that an investor who is subject to a lower rate of tax on capital gains than on other income should choose bonds with lower coupons. The lower tax rate on capital gains than on interest income implies that, the smaller the coupon on a bond (whether the bond sells for a premium or a discount), the smaller is the tax liability associated with the bond. If pre-tax yields were to adjust to compensate for differences in the tax liabilities of bonds with different coupons, lower-coupon bonds would not have a tax advantage, but the evidence presented below indicates that this type of tax capitalization does not occur. Rather, in the most recent period, pre-tax yields for bonds with different coupons have been almost identical. Finally, the advantage of lower-coupon bonds arising from the differential taxation of capital gains and coupon income works in the same direction, but is much larger than the standard tax deferral argument made in favour of low-coupon bonds (which holds even in the absence of differential taxation).

The next section describes the tax treatment of the bond-related income of individuals. Examples are provided to illustrate the qualitative and quantitative impact of changes in the tax treatment of coupon income and capital gains on after-tax bond yields. Then, using data on matched pairs of government of Canada bonds, empirical evidence is presented to show how pre-tax and after-tax bond yields have adjusted in response to tax rate changes. The results and policy implications are discussed in the concluding section.

¹² Ibid., at 97.

THE TAX TREATMENT OF BONDS IN CANADA AND IMPLICATIONS FOR AFTER-TAX YIELDS

Bond Coupons and the Tax Treatment of Bonds

With a coupon payment of C each period, a face value of \$100, and a market price of P , the pre-tax yield to maturity (Y) of a bond with M future coupon payments¹³ is given by

$$P = \sum_{m=1}^M \frac{C}{(1+Y)^m} + \frac{100}{(1+Y)^M}. \quad (1)$$

The after-tax yield to maturity, Y^{AT} , takes into account that individual investors pay tax on coupon and capital gains income and, given the market price P , is determined by the expression¹⁴

$$P = \sum_{m=1}^M \frac{C(1-\tau)}{(1+Y^{AT})^m} + \frac{100}{(1+Y^{AT})^M} - \frac{(100-P)\gamma\tau}{(1+Y^{AT})^M}, \quad (2)$$

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- 13 The yield to maturity is the yield that equates the present discounted value of a bond's income stream to the market price of the bond. Even in the absence of taxes, the yield to maturity will not be the same for two bonds with different coupon rates unless the term structure is flat. If the term structure is rising, the yield to maturity is higher for bonds with lower coupons because lower-coupon bonds earn more of their income as capital gains that arrive farther in the future. Since these future payments are discounted using larger discount factors, the market price of these bonds is lower and the yield to maturity is higher. (See Richard Brealey, Stewart Myers, Gordon Sick, and Ronald Giammarino, *Principles of Corporate Finance*, 2d ed. (Toronto: McGraw-Hill Ryerson, 1992), 596-600.) However, this effect is generally small, particularly when compared with the magnitude of the tax effects illustrated below. For example, using the average coupons for the high- and low-coupon bonds of each pair in the sample employed in this study (12 and 8 percent, respectively), the average maturity of the bonds in the sample (4 years), and the average zero-coupon yield curve from the Bank of Canada (over all days for which there are data during the sample period, 1986-2006), the coupon effect would cause the yield to maturity of the low-coupon bond to exceed that of the high-coupon bond by just 1.3 basis points (0.013 percentage points). Even for relatively extreme cases in the sample, the magnitude of the coupon effect remains quite small. When maturity is extended to the longest maturity bond in the sample, 132 months (11 years), the difference in yields is only 2.9 basis points. When the discount rates for the steepest 4-year zero-coupon yield curve in the sample are employed (a term premium of 3.1492 percent on September 26, 1994), the difference is 6.26 basis points. Using the discount rates associated with the greatest yield curve inversion for a maturity of 4 years (-3.181 percent on August 3, 1989), the coupon effect is only -2.3 basis points.
- 14 The formula in equation 2 implies that the tax system treats capital gains and losses symmetrically, that tax rates are known and believed to be constant through time, and that taxes are imposed when bond income is paid to bondholders. A similar formula is used in many other studies. See Alexander A. Robichek and W. David Niebuhr, "Tax-Induced Bias in Reported Treasury Yields" (1970) vol. 25, no. 5 *Journal of Finance* 1081-90; and Green and Ødegaard, *supra* note 7.

where, as in Canada, the tax system applies the standard income tax rate, τ , to coupon income, but only applies a fraction, γ , of this tax rate to capital gains income. Since $0 \leq \gamma \leq 1$, the capital gains tax rate, $\gamma\tau$, is less than or equal to the tax rate on coupon income.

If the *pre-tax* yields on two bonds with different coupons are equal, and the tax rate on capital gains differs from the tax rate on coupon income, so that $0 \leq \gamma < 1$ as in Canada (where γ currently equals 0.5), then the *after-tax* yields on the bonds must differ. Since tax is assessed at a lower rate on capital gains than on coupon income, from equation 2, the bond with the higher coupon must have the smaller after-tax yield. The greater the difference in the coupon rates, and the greater the difference in the two tax rates, the larger is the difference in the after-tax yields. The tax rate differential makes it advantageous for individual investors to hold bonds with the lowest non-zero coupons, and thus the lowest market price, so that the smallest proportion of the bond's yield is in the form of coupon payments and the largest proportion in the form of capital gains.

A simple example provides an indication of the magnitude of the impact of taxes on the after-tax yields of individuals for bonds with different coupon rates. Consider two bonds that mature in one year, are identical in terms of risk characteristics, have a face value of \$100, and earn the same pre-tax yield (Y) of 5 percent. The coupon (C) on one of the bonds is assumed to be 3 percent while the coupon on the other bond is 7 percent, and, for simplicity, coupon payments are made only once a year. From equation 1, the price of each bond is determined by the formula

$$P = \frac{100 + C}{1 + Y}. \quad (3)$$

The price of the bond with a 3 percent coupon will be \$98.095, while the price of the bond with the 7 percent coupon will be \$101.905. Given the price of the bond from equation 3, equation 2 implies that the after-tax yield is

$$Y^{AT} = \frac{100 + C(1 - \tau) - (100 - P)\gamma\tau}{P} - 1. \quad (4)$$

For the relatively realistic case in which the tax rate on income (τ) is 40 percent, while only 50 percent of capital gains are taxable, the after-tax yield on the bond with the 3 percent coupon is 3.39 percent, while the bond with the 7 percent coupon has an after-tax yield of only 2.63 percent. Thus, the low-coupon (discount) bond earns a yield that is 29 percent higher than the bond with the higher coupon ($3.39/2.63 = 1.29$). Further, these calculations presume that an investor has capital gains on other investments against which the capital losses associated with the premium bond can be applied. If this is not the case, the after-tax yield on the bond with the 7 percent coupon will fall from 2.63 percent to just 2.25 percent, so that the after-tax yield will be 50 percent higher on the low-coupon bond relative to the yield on the high-coupon bond ($3.39/2.25 = 1.51$).

The source of the difference in after-tax yields is the divergence of the tax rate on capital gains from the tax rate on other income. If 100 percent of capital gains are taxed, so that the two tax rates both equal 40 percent, the after-tax yield would be 3 percent on both bonds, irrespective of their coupon levels. It is the interaction of the unequal tax rates with the different coupon levels that creates the disparity in after-tax yields.

An Example Using Actual Government of Canada Bonds

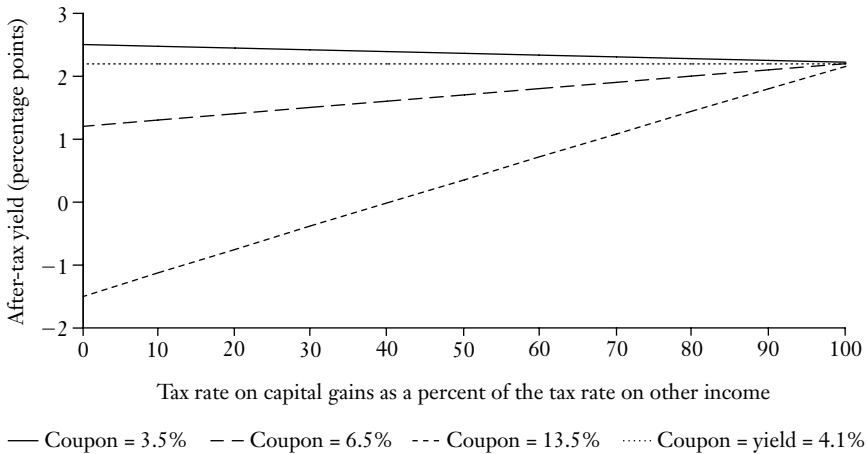
The example given above employs two hypothetical one-period bonds. For a better understanding of the relationship between tax rates and coupon levels, and to gain some sense of the realistic magnitude of these tax effects, consider three actual government of Canada bonds. These bonds had coupon rates of 3.5, 6.5, and 13.5 percent, respectively, and matured on June 1, 2004. Two years prior to maturity, on May 31, 2002, the bid prices for these three bonds (per \$100 face value) were \$98.78, \$104.49, and \$117.80, respectively, implying almost identical pre-tax yields of 4.142, 4.129, and 4.102 percent.¹⁵ Using these prices and yields, and equation 2 above, it is possible to solve for the after-tax yield (Y^{AT}) of each bond as of May 31, 2002 and, in addition, to use simulations to illustrate the relationship between the after-tax yield for each of the three bonds and the tax rates on ordinary income and capital gains.

Figure 1 graphs the after-tax yields for the 3.5, 6.5, and 13.5 percent bonds, as well as for a hypothetical bond with a coupon equal to the market yield of 4.1 percent (so that it trades at neither a premium nor a discount), against the tax rate on capital gains (measured as a percentage of the tax rate on other income). The tax rate on other income, τ , is assumed to be 46.4096 percent (the maximum tax rate for a resident of Ontario on May 31, 2002).¹⁶ An examination of figure 1 indicates that

15 Financial Post Corporation, *FP Bonds—Canadian Prices 2002* (Toronto: Financial Post, 2003), 4.

16 The tax rate for Ontario was chosen because this is the province with the largest population. In May 2002, the maximum federal income tax rate was 29 percent, the rate for the highest tax bracket in Ontario was 11.16 percent, and the maximum Ontario surtax was 56 percent, resulting in an overall rate of 46.41 percent. Since the federal tax accounts for a large share of the overall tax rate, the difference in rates across provinces is relatively small. In 2005, rates were somewhat higher in provinces to the east of Ontario, with a top rate of 48.64 percent in Newfoundland, and lower in provinces west of Ontario, with the lowest rates being 39.00 percent in Alberta and 43.7 percent in British Columbia (Karin Treff and David B. Perry, *Finances of the Nation 2005* (Toronto: Canadian Tax Foundation, 2006), table 3.9). Thus, the choice of province is unlikely to greatly alter the results, although the tax advantage associated with discount bonds is likely to be somewhat smaller in Alberta than in Ontario. Since high income earners are more likely to have savings to invest, the highest individual income tax rate is employed. This choice may not be critical to the analysis because marginal income tax rates rise quickly with income in Canada. The rate in Ontario is over 30 percent when personal income for a single taxpayer is just \$40,000, while the tax rates at this income level in all the other provinces represent a larger proportion of the maximum marginal tax rate than is the case for Ontario (Treff and Perry, supra).

FIGURE 1 After-Tax Yields on Bonds with Different Coupon Rates and the Same Pre-Tax Yield (Tax Rate on Other Income = 0.464096, Pre-Tax Yield = 4.1 Percent)

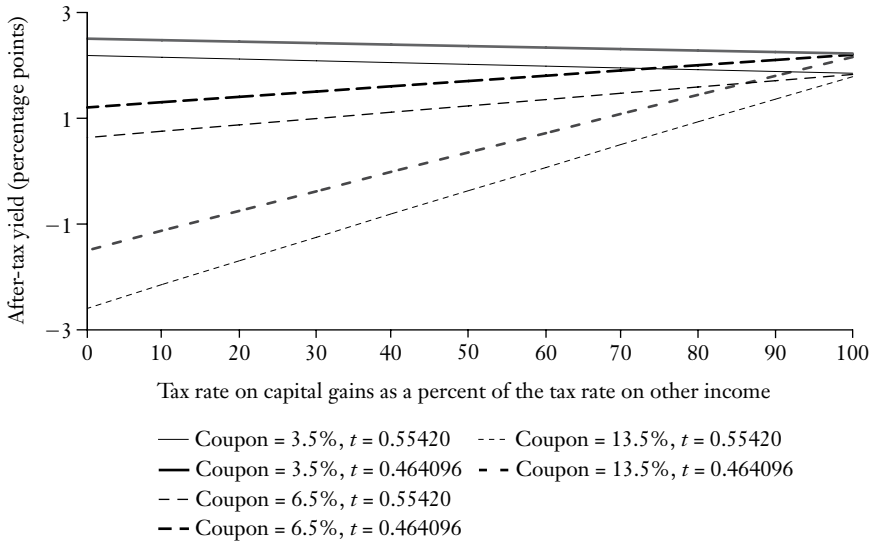


the after-tax yields differ markedly across the four bonds, and that the magnitude of this difference depends on the capital gains tax rate. For example, when the capital gains tax rate is 50 percent of the ordinary income tax rate ($\gamma = 0.5$), the rate in effect in 2002, the after-tax yields vary from 2.4 percent for the lowest-coupon bond to 0.4 percent for the highest-coupon bond. Even the difference between the after-tax yields of the bonds with the 6.5 and 3.5 percent coupons (a comparison that is similar to the hypothetical example in the previous section) is quite large—equal to 40 percent of the after-tax yield ($2.4/1.7 = 1.4$).

Figure 1 also reveals that a cut in the capital gains tax rate, holding the tax on other income constant, would cause the after-tax yields of the three bonds to differ by an even larger amount. For example, if the tax rate on capital gains fell to zero, a change similar to that proposed by the current federal government,¹⁷ the after-tax yield on the bond trading at a discount would rise (since it would realize a capital gain and now would not have a tax liability associated with that gain). In contrast, the after-tax yields of the other two bonds, both of which trade at a premium, would actually *fall*. This follows because a bond that sells at a premium suffers a capital loss on redemption, and this capital loss is valuable only to the extent that it can be used to counter the tax liability associated with the capital gain earned on another asset. When the capital gains tax rate declines, this benefit also falls, and it disappears completely if the tax rate on capital gains is zero. For the bond with the 13.5 percent

17 The Conservative Party of Canada, “Stand Up for Canada: Federal Election Platform 2006,” proposed to “[e]liminate the capital gains tax for individuals on the sale of assets when the proceeds are reinvested within six months” (online: <http://www.conservative.ca/media/20060113-Platform.pdf>), 16.

FIGURE 2 After-Tax Yields on Bonds with Different Coupon Rates and Tax Rates (Tax Rate on Other Income (t) = 0.55420 or 0.464096)



coupon, the after-tax yield becomes negative when the capital gains tax rate falls below 40 percent of the tax rate on other income, and is negative 1.5 percent if the capital gains tax rate is zero. Of course, if the capital gains tax rate and the tax rate on other income are equal ($\gamma = 1$), as shown in figure 1, the after-tax yields of all four bonds are almost identical.¹⁸

The impact on the after-tax yields of bonds with different coupon levels from a change in the tax rate on ordinary income is illustrated in figure 2. This figure shows the after-tax yields of the three government of Canada bonds used in figure 1 when the tax rate on other income is 46.4096 percent (the rate in 2002), as well as

18 The yields will not be identical because of a tax-deferral effect: the lower the coupon of a bond, the greater the proportion of the yield that comes as a capital gain, which is taxed in the future. Thus, with a flat yield curve, the lower the bond coupon, the higher the after-tax yield to maturity of the bond (Miles Livingston, "Taxation and Bond Market Equilibrium in a World of Uncertain Future Interest Rates" (1979) vol. 14, no. 1 *Journal of Financial and Quantitative Analysis* 11-27). (With an upward-sloping yield curve, this effect is opposite in sign to the coupon effect on the yield to maturity discussed above in note 13.) This means that there is a tax advantage to *all* taxpaying investors from holding lower-coupon bonds, even those investors who pay the same rate of tax on capital gains and interest income. However, this tax timing or deferral effect is likely to be small relative to the effect of the differential taxation of capital gains and interest income. For example, given a bond pair with the average characteristics of the bonds in the sample employed below (12 and 8 percent coupons on the high- and low-coupon bonds in the pair, respectively; four years to maturity; and a pre-tax yield to maturity of 7.5 percent), the after-tax yields differ by only 9 basis points (0.09 percentage points) when capital gains and interest income are taxed at the same rate (0.464096).

for a tax rate of 55.42 percent (the maximum tax rate in effect in Ontario in 1986, and one of the highest rates in the recent past).¹⁹ As expected, a decrease in the tax rate on other income from 55.42 to 46.4096 percent causes the after-tax yields on all three bonds to rise. For example, if the capital gains tax rate is the same as the tax rate on other income ($\gamma = 1$), the yields on all three bonds rise by about 0.4 percentage points (from 1.8 percent to 2.2 percent). If the tax rate on capital gains is 50 percent of the tax rate on interest income, the approximately 9 percentage point cut in the income tax rate has a greater relative impact on higher-coupon bonds, since the after-tax yields on the 13.5, 6.5, and 3.5 percent bonds rise by 0.72, 0.47, and 0.35 percentage points, respectively. Further, if the capital gains tax rate is zero, the tax cut causes the after-tax yield on the 13.5 percent coupon bond to rise by over a full percentage point, from -2.6 to -1.5 percent. Even for the bond with the 6.5 percent coupon, the after-tax yield rises by 0.6 percentage points. In contrast, for the bond with the smallest coupon (3.5 percent), the after-tax yield rises by only 0.3 percentage points. Thus, the greatest benefit of an ordinary income tax cut is to holders of bonds with the largest coupons. This follows because the higher a bond's coupon, the larger is the proportion of the yield in the form of coupon payments that are subject to the ordinary income tax rate. This effect is magnified when the capital gains tax rate is smaller because the coupon payment tax liability becomes a larger part of the total tax liability.

EMPIRICAL ANALYSIS OF THE IMPACT OF TAXES ON PRE-TAX AND AFTER-TAX BOND YIELDS

Since a bond with a lower coupon earns a greater proportion of its yield as a capital gain, and the tax rate on capital gains is lower than the tax rate on coupon income, one might expect that investors paying personal income tax would prefer to hold low-coupon bonds. This type of preference would put downward pressure on the pre-tax yields of low-coupon bonds relative to the yields of high-coupon bonds (creating an "implicit tax," as noted by Scholes and Wolfson).²⁰ If pre-tax yields *fully* adjusted to compensate for tax differences, after-tax yields would be equal for bonds with identical characteristics but different coupons. Using government of Canada bond data, the analysis that follows examines how the pre-tax and after-tax yields on high- and low-coupon bonds differ, and whether there is a systematic relationship between these differences and tax rates.

Data

In order to more easily isolate the impact of coupon differences on bond yields, this study employs observations on bond pairs, where each pair consists of two bonds

19 In 1986, the maximum federal tax rate was 34 percent and the maximum federal surtax was 11.5 percent. The Ontario tax rate was equal to 50 percent of the federal basic tax and the Ontario maximum surtax was 3 percent.

20 *Supra* note 3.

that have different coupon rates but are identical in terms of the issuer (the government of Canada) and the date of maturity.²¹ The use of bond pairs to analyze the impact of taxes on yields means that it is not necessary to control for potentially important differences across bonds, such as issuer risk and time to maturity.²²

The bond data are taken from *Canadian Bond Prices* and *FP Bonds—Canadian Prices*,²³ both published by the Financial Post Corporation. The sample consists of 2,190 end-of-month observations on the prices of 94 bonds that can be combined to form 49 bond pairs.²⁴ The span of the data is from 1986 through 2006, but some of the bonds matured during this period while others were newly issued. As a consequence, the time period covered by the data for each bond pair is not the same for all pairs. The average number of observations per bond pair is 44.7, although the number of observations per pair ranges from 2 to 112 months. The number of observations per year varies from 45 to 203 and averages 104.3. As noted in part A of table 2, the average coupons of the high- and low-coupon bonds are just under 12 and 8 percent, respectively, so that the average difference between the coupons of the bonds in each pair is approximately 4 percentage points. For a summary of descriptive statistics, see the data appendix at the end of this article.²⁵

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- 21 All the bonds in the sample are non-callable and pay interest on a semi-annual basis, but the bonds in each pair may differ in terms of amount issued and issue year. Only data on bonds denominated in Canadian dollars are employed, and (as is typical in the literature) the sample is restricted to bonds with at least 13 months to maturity.
- 22 Similar types of samples have been employed previously in studies of the US bond market by Litzenberger and Rolfo, *supra* note 7; Bradford D. Jordan and Susan D. Jordan, “Tax Options and the Pricing of Treasury Bond Triplets” (1991) vol. 30, no. 1 *Journal of Financial Economics* 135-64; Ehud I. Ronn and Yongjai Shin, “Tax Effects in U.S. Government Bond Markets,” in Frank J. Fabozzi, ed., *Advances in Fixed Income Valuation Modeling and Risk Management* (New Hope, PA: F.J. Fabozzi Associates, 1997), chapter 13; and Elton and Green, *supra* note 7. An advantage of the data set employed here is the relatively large number of observations (2,190). Earlier studies use quite small samples of just 30-40 observations, although these refer to bond “triplets” rather than pairs. Elton and Green employ a similar number of observations as we use here, but their data are daily rather than monthly, and thus cover a shorter time span.
- 23 Financial Post Corporation, *Canadian Bond Prices* (Toronto: Financial Post, annual, 1986-1997); and Financial Post Corporation, *FP Bonds—Canadian Prices* (Toronto: Financial Post, annual, 1998-2006).
- 24 Ninety-four bonds can be used to construct 49, rather than 47, bond pairs because there are four cases where three bonds share the same maturity date and thus can be used to form two bond pairs. In these cases, each pair consists of the lowest- or highest-coupon bond in the triplet combined with the third bond.
- 25 While the Financial Post Corporation data set includes end-of-month closing bid yields as well as prices, the yields utilized in our empirical analysis were calculated by using the bond price data and the standard bond pricing formula (equation 1). Since the empirical analysis requires the calculation of after-tax yields, the calculation of both pre-tax and after-tax yields means that it is possible to ensure that a similar methodology is used to calculate both types of yields (since there are slight differences in the algorithms used to solve for the yield in the non-linear bond pricing formula). The pre-tax yields reported by the Financial Post Corporation were found to be effectively indistinguishable from those used here.

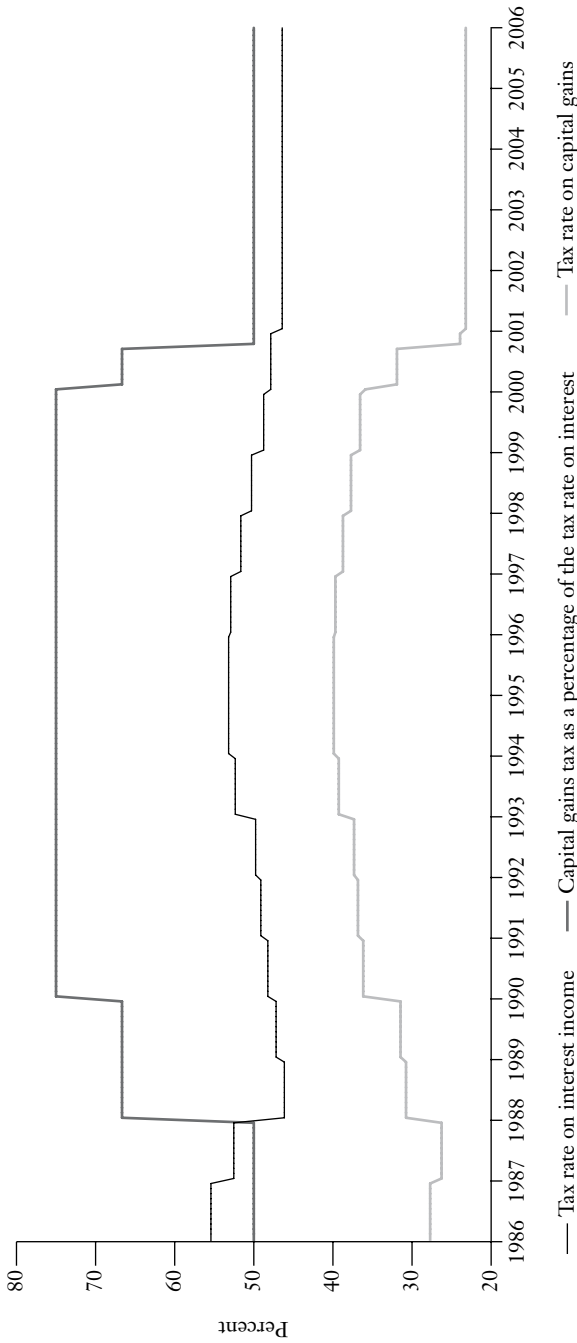
TABLE 2 Average Pre-Tax and After-Tax Yields and Coupon Rates for Bond Pairs (Percent)

A. Average coupon rates for bonds in the sample					
	Average coupon rate of high-coupon bond in pair	Average coupon rate of low-coupon bond in pair	Average difference in coupon rates for bonds in each pair (high coupon – low coupon)		
1986-2006	11.824	7.875	3.949		
1986-1991	12.662	9.095	3.567		
1995-2006	10.618	6.116	4.502		
B. Average pre-tax yields for bonds in the sample					
	Average pre-tax yield to maturity of high-coupon bond in pair	Average pre-tax yield to maturity of low-coupon bond in pair	Average difference in pre-tax yields for the bonds in a pair (high coupon – low coupon)		
1986-2006	7.670	7.514	0.156		
1986-1991	10.074	9.798	0.276		
1995-2006	4.935	4.916	0.019		
C. Average after-tax yields for bonds in the sample ^a					
	Average after-tax yield to maturity of high-coupon bond in pair	Average after-tax yield to maturity of low-coupon bond in pair	Average difference in after-tax yields of bonds in a pair (high coupon – low coupon)	Average tax rate on interest income, τ	Average tax rate on capital gains, $\gamma\tau$
1986-2006	3.269	3.740	-0.471	49.34	31.69
1986-1991	4.693	5.055	-0.362	49.58	31.41
1995-2006	1.670	2.317	-0.647	48.47	30.03

^a After-tax yields are calculated using observed bond prices and the highest tax rates applicable on capital gains and coupon income for a personal income taxpayer in Ontario at the time of the observation. The tax rate averages given in the last two columns are the averages of the end-of-month highest individual tax rate in Ontario for the period indicated.

Figure 3 illustrates the maximum tax rates on interest (coupon) income (τ) and capital gains ($\gamma\tau$), as well as the capital gains tax as a proportion of the tax rate on interest income (γ), for individuals living in Ontario, from 1986 through 2006. The tax rate on coupon income changed 14 times during this period. It was highest in 1986, at 55.42 percent, but reached a second peak of 53.19 percent in 1994, before falling to 46.41 percent by 2001 (a decline of just under 13 percent). While a large number of the 16 changes in the capital gains tax rate, $\gamma\tau$, were due to movements in the tax rate on other income, τ , the value of γ also changed four times during the sample period, so that the simple correlation between the two tax rate series is only 0.599. The capital gains tax rate generally rose during the first half of the sample period, reaching a high of 39.89 percent in 1994 (75 percent of the tax rate on interest

FIGURE 3 Tax Rates on Interest Income and Capital Gains, 1986-2006 (Ontario Resident, Maximum Rate)



income) before falling to 23.2 percent in 2001 (a reduction of almost 42 percent). Throughout the sample period, the capital gains tax rate was lower than the tax rate on interest income, implying a tax advantage to the holding of low-coupon bonds.²⁶

Matched Bond Pair Pre-Tax Yield Differentials: Overview of the Data

The average pre-tax yield differential for the whole sample, as well as for 1986 to 1991 and 1995 to 2006, is given in part B of table 2, while annual averages are given in table 3 and illustrated in figure 4. Figure 4 also plots two dotted lines representing, respectively, one standard deviation above and one standard deviation below the average for each year. From 1995 onward, the average pre-tax yield differential was under 10 basis points, and the distribution of yield differentials was quite compact. However, during that period, there were large differences between the coupons for the high- and low-coupon bonds, with these differentials averaging 4.5 percentage points (table 2, part A) and varying from 1.5 to 8.75 percentage points. Hence, the similarity of pre-tax yields is not the result of small coupon differences.

In contrast to the post-1994 period, prior to 1995, pre-tax bond yield differentials were much larger and there was considerably more dispersion in these differentials—a standard deviation of up to 25 basis points, compared with approximately 3 basis points in the later period. For 1986 through 1991, the pre-tax yield on the high-coupon bond in each pair exceeded the yield on the low-coupon bond by an average of almost 28 basis points. While this average pre-tax yield difference is much larger than the average for 1995 to 2006, the average coupon difference between the high- and low-coupon bonds of 3.57 percentage points for 1986 to 1991 was, perhaps surprisingly, smaller than the 4.5 percentage point difference in the post-1994 period. This suggests that the larger pre-tax yield differentials in the earlier period are not due to larger coupon differentials.

To gain a preliminary indication of whether, during the 1986-1991 period, the pre-tax yields on high-coupon bonds exceeded the yields on low-coupon bonds in order to offset differences in tax liabilities, the pre-tax yield differential that would have been needed to equalize after-tax yields for each pair of bonds is calculated and compared with the actual pre-tax yield differential.²⁷ For the period 1986-1991, the average pre-tax yield differential is 27.6 basis points, while the average pre-tax differential required to equalize after-tax yields is 79 basis points. Hence, the observed pre-tax yield differential is only about one-third of the size needed, on average, to

26 A lifetime capital gains deduction was introduced in 1985, capped at \$100,000 in 1988, and eliminated in 1994. For those individual investors who could make use of the deduction, the proportion of capital gains that were subject to tax (γ) was reduced to zero; therefore, the relative benefit of bonds with lower coupons was larger than it would have been in the absence of the deduction.

27 This is done by using equation 2 to calculate the price of the high-coupon bond that would make the after-tax yield on that bond the same as the after-tax yield on the low-coupon bond. Given this price, equation 1 is then used to calculate the required pre-tax yield.

TABLE 3 Pre-Tax Yield on High-Coupon Bond Minus Pre-Tax Yield on Low-Coupon Bond (Annual Average)

Year	Yield difference (basis points)	Number of observations
1986	27.5	150
1987	31.6	190
1988	28.3	203
1989	25.5	179
1990	23.4	181
1991	29.1	146
1992	17.2	122
1993	9.4	86
1994	12.2	52
1995	5.6	56
1996	2.4	72
1997	1.8	62
1998	4.9	87
1999	6.8	86
2000	5.1	73
2001	0.8	45
2002	-1.0	94
2003	-0.9	73
2004	-1.8	70
2005	-0.9	83
2006	0.1	80
Average 1986-2006	15.6	2,190
Average 1986-1991	27.6	1,049
Average 1992-1994	13.6	260
Average 1995-2006	1.9	881

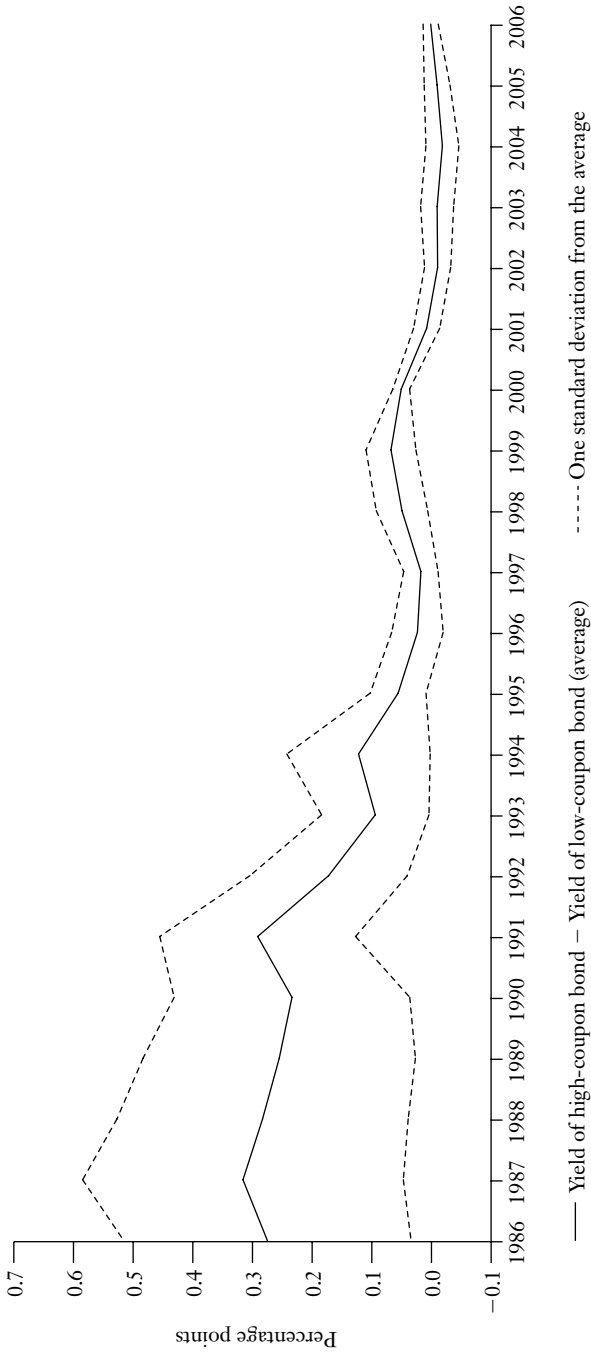
equalize after-tax yields.²⁸ As a consequence, after-tax yields differed by an average of 36.2 basis points between 1986 and 1991 (table 2, part C).

The pre-tax yield differential between high- and low-coupon bonds fell dramatically during the period from 1991 through 1994, and subsequently almost disappeared (see figure 4 and table 3). Some evidence suggests that this change was caused by institutional reforms to the operation of the market for government of Canada bonds introduced by the financial industry and the Bank of Canada in the early 1990s in order to improve the efficiency and liquidity of the bond market.²⁹ Given

28 In comparison, for the period 1995-2006, the average pre-tax yield differential is just 2 basis points, while the differential required to equate after-tax yields is 97 basis points.

29 See Andrew Branion, "The Government of Canada Bond Market Since 1980" (Autumn 1995) *Bank of Canada Review* 3-21; Paul Halpern and John Rumsey, "A Note on Market Efficiency, Institutional Practice, and Economic Constraints in the Experience of the Canadian Bond Market" (1997) vol. 21, no. 1 *Journal of Banking and Finance* 113-23; Halpern and Rumsey, supra note 9; Nancy Harvey, "Recent Initiatives in the Canadian Market for Government of Canada Securities" (Summer 1999) *Bank of Canada Review* 27-35; Toni Gravelle, "Markets for

FIGURE 4 Average Difference Between High- and Low-Coupon Pre-Tax Bond Yields



the likelihood of institutional change, the pre-1992 and post-1994 periods are examined separately, while the 1992-1994 period is excluded from further analysis.³⁰

The Impact of Tax Changes on Pre-Tax Yields

The analysis in this section uses regression techniques to determine whether there is a systematic relationship between tax rates on personal income and the *pre-tax* yield differential between high- and low-coupon bonds. If tax rates are capitalized into bond prices, there should be a systematic relationship between movements in tax rates and the *pre-tax* yield differential.

The estimating equation is derived by first specifying the pre-tax yield of an individual bond to be a function of the exogenous variables in equations 1 and 2—the bond's coupon rate, months to maturity, the personal income tax rate on interest income, and the personal income tax rate on capital gains—as well as the general level of interest rates in the economy (to control for changes in the general level of yields).³¹ As is evident from equations 1 and 2, the process that determines yields is highly non-linear; accordingly, the pre-tax yield equation is assumed to take the translog form, a commonly used flexible functional form.³² Taking the difference of the translog expressions for the pre-tax yields of the high- and low-coupon bonds in each bond pair eliminates common factors, both those that are observable and those that are not. This produces an estimating equation with the yield difference as the dependent variable and, as explanatory variables, the differences in the levels and squared values of the log coupons, as well as the product of the log coupon difference with each of the other explanatory variables. As noted above, owing to institutional changes, the impact of tax rates on the pre-tax yield differential is estimated separately for 1986 through 1991 and 1995 through 2006.³³

Government of Canada Securities in the 1990s: Liquidity and Cross-Country Comparisons" (Autumn 1999) *Bank of Canada Review* 9-18; and Éric Chouinard and Zahir Lalani, "The Canadian Fixed-Income Market: Recent Developments and Outlook" (Winter 2001-2) *Bank of Canada Review* 15-25.

- 30 Johnson notes in his study of the yield curve for government of Canada bonds, *supra* note 10, at 19, that "the period between the late 1980s and the early 1990s had very different characteristics from the late 1990s and early 2000s."
- 31 As above, the tax rates used are the highest tax rates in Ontario for the month in question. The general interest rate employed is the one-year government of Canada Treasury bill rate. The conclusions are unchanged if either the amount issued of each bond or monthly dummy variables are included as additional explanatory variables.
- 32 Specifically, each yield is assumed to be a quadratic function of the logs of the right-hand side variables. This means that the yield equation incorporates, as arguments, the levels of the log of each variable, the square of the log of each variable, and the cross-products of the logs of all the variables.
- 33 The estimating equation does not incorporate two tax changes: first, the elimination of the \$1,000 interest deduction in 1988 and, second, the temporary introduction of the lifetime capital gains deduction described above in note 26.

TABLE 4 Estimates of the Marginal Impact of a Change in Tax Rates on the Pre-Tax Yield Differential (Percentage Points)

One percentage point change in	1986-1991	1995-2006
Tax rate on capital gains ^a	-0.0023	0.0021*
Tax rate on other income ^b	0.0014	-0.0063*

Notes: The dependent variable in the regression equation from which the marginal effects are derived is the pre-tax yield on the high-coupon bond minus the pre-tax yield on the low-coupon bond. The explanatory variables are the difference in the log of the two bonds' coupon rates, the difference in the square of the log of the coupon rates, the difference in the log of the coupon rates interacted, respectively, with the log of the number of months to maturity, the log of the individual tax rate on interest income, the log of the individual tax rate on capital gains, and the log of the one-year Treasury bill rate. There are 1,049 observations for the 1986-1991 sample and 881 observations for 1995-2006. The R^2 values for the 1986-1991 and 1995-2006 estimates are 0.667 and 0.615, respectively.

Since the estimating equation is non-linear in the tax variables, the marginal effects are functions of some of the explanatory variables and are evaluated at the mean values of the explanatory variables for the relevant sample period.

^a The effect of a one percentage point change in the percentage of capital gains that are subject to income tax (that is, a one percentage point change in γ).

^b The effect of a one percentage point change in the income tax rate (τ). It takes into account that a change in τ also alters the tax rate on capital gains ($\gamma\tau$).

* The estimated coefficient estimate is significant at 95 percent using heteroscedasticity corrected standard errors, which allow the errors for the observations associated with each bond pair to be correlated.

Table 4 presents the marginal impact of a 1 percentage point increase in the ordinary income tax rate (τ), as well as a 1 percentage point increase in the share of capital gains that is subject to tax (γ), on the pre-tax yield *differential* (in percentage points). The capital gains tax effect of -0.0023 implies that, during the 1986-1991 period, a rise of 25 percentage points in the share of capital gains that is subject to tax (the maximum change in this tax rate over the last 25 years) would cause the pre-tax yield on the high-coupon bond to fall relative to the yield on the low-coupon bond, by less than 6 basis points ($25 \times 0.23 = 5.75$). The negative coefficient is consistent with the expected direction of this effect, since a rise in the capital gains tax rate reduces the after-tax yield of the lower-coupon bond by more; therefore, the pre-tax yield of the low-coupon bond would be expected to rise relative to the yield on the high-coupon bond. However, the estimated effect is statistically insignificant and quite small. For the 1995-2006 period, the estimated effect of the capital gains tax on the pre-tax yield difference is equally small and has a sign that is opposite to the direction expected if taxes are capitalized in bond yields.

The impact of changes in the ordinary income tax rate on the pre-tax yield differential is also not large. For the 1986-1991 period, the estimated effect is positive, as expected, since an increase in this tax reduces the after-tax yield on the high-coupon bond relative to that on the low-coupon bond. However, the marginal effect is statistically insignificant and quite small: the maximum change in the ordinary income

tax rate over the 1986-2006 period of 9.01 percentage points would alter the yield differential by only 1.3 basis points ($0.14 \times 9.01 = 1.26$). For the 1995-2006 period, the estimated coefficient, once again, does not have the expected sign and, although statistically significant, implies a change in the pre-tax yield differential of less than 6 basis points in response to a 9 percentage point change in the tax rate.

The results in table 4 appear to suggest that pre-tax yields do not adjust to lessen the impact of tax changes on after-tax yields. Even during the 1986-1991 period, although the pre-tax yields of high-coupon bonds exceeded the yields of low-coupon bonds, pre-tax yield differences did not adjust sufficiently to compensate for tax rate changes. Thus, changes in tax rates do not provide an explanation for the gap between high- and low-coupon pre-tax yields during the 1986-1991 period, nor do they explain the virtual disappearance of this gap after 1995.

The Impact of Tax Changes on After-Tax Yields

The analysis in the previous section shows that the pre-tax yield differential between high- and low-coupon bonds adjusts only marginally in response to tax changes. This suggests that, for investors who pay personal income tax, the after-tax yield differential between bonds with different coupons should be systematically affected by movements in tax rates. To determine the magnitude of this effect, estimates are obtained for the marginal impact of the capital gains tax rate and the ordinary income tax rate on the after-tax yield differential. The regression equation employed takes the same form as that used to analyze pre-tax yields, and estimates of the marginal effects are presented in table 5.

During the 1986-1991 period, the estimates imply that a 25 percentage point rise in the proportion of capital gains that is subject to tax would increase the average after-tax yield on the high-coupon bond relative to the yield on the low-coupon bond in each pair by almost 28 basis points ($27.5 = 1.10 \times 25$). For the period 1995-2006, the estimated effect is almost 44 basis points ($43.5 = 1.74 \times 25$). As expected, the effect is positive, since low-coupon bonds earn more of their yield in terms of capital gains and, thus, a rise in the capital gains tax rate reduces the after-tax yield on low-coupon bonds relative to the yield on high-coupon bonds.³⁴ In both periods, the impact of the tax is statistically significant and of a large enough magnitude to be significant to investors. For example, the 44 basis point change in the after-tax yield differential that follows from the estimates for 1995-2006 represents a rise in the after-tax yield on the high-coupon bond relative to that on the low-coupon bond

34 The impact of a rise in the capital gains tax rate on after-tax yields will vary with the characteristics of the bonds considered. One point of comparison is the average bond pair in the sample. This bond pair has a maturity of four years, a pre-tax yield of 7.5 percent, and rates for the high- and low-coupon bonds of 12 and 8 percent, respectively. For this bond pair, an increase in the capital gains tax rate from 50 to 75 percent of the rate on other income causes the after-tax yield difference (the high-bond yield minus the low-bond yield) to change by 33 basis points. (The after-tax yields on the high- and low-coupon bonds rise from 3.17 to 3.54 percent and from 3.92 to 3.96 percent, respectively.)

TABLE 5 Estimates of the Marginal Impact of a Change in Tax Rates on the After-Tax Yield Differential (Percentage Points)

One percentage point change in	1986-1991	1995-2006
Tax rate on capital gains	0.0110*	0.0174*
Tax rate on other income	-0.0056*	-0.0128*

Notes: See the notes to table 4. The dependent variable in this case is the after-tax yield on the high-coupon bond minus the after-tax yield on the low-coupon bond. The R^2 values for the 1986-1991 and 1995-2006 estimates are 0.856 and 0.975, respectively.

* The estimated coefficient estimate is significant at 95 percent using heteroscedasticity corrected standard errors, which allow the errors for the observations associated with each bond pair to be correlated.

equivalent to 22 percent of the average after-tax yield on the bonds in the sample ($0.435/1.99 = 0.219$).

As explained earlier, since more of the yield on a high-coupon bond is in terms of interest, an increase in the tax rate on interest income will reduce the after-tax yield on a high-coupon bond relative to the yield on a low-coupon bond (if pre-tax yields do not capitalize the tax change). According to table 5, for both sample periods, an increase in the tax rate on interest income has a statistically significant and negative impact on the after-tax yield differential between high- and low-coupon bonds. However, this effect is relatively small. The estimates imply that, if the tax rate on interest income rises by 9.01 percentage points, the after-tax yield on the high-coupon bond will fall relative to the after-tax yield on the low-coupon bond by 5 basis points ($5.04 = 9.01 \times 0.56$) for the 1986-1991 period, and by just under 12 basis points ($11.5 = 9.01 \times 1.28$) for the 1995-2006 period.³⁵

One reason why the after-tax yield differential changes by only a small amount in response to a change in the tax rate on interest income is that an increase in the income tax rate raises both the tax rate on coupon income and the tax rate on capital gains, since the capital gains tax rate is a percentage of the ordinary income tax rate. Because these two taxes have opposite effects on the after-tax yield differential, the net effect can be small, particularly when the capital gains tax rate is a large percentage of the tax rate on interest income.³⁶

35 The smaller effect of the change in the tax rate on other income in the earlier period may be partly due to the lower average coupon difference during this period (3.567 percentage points compared with 4.502 in the later period). The small coefficient estimate, even in the later period, may be partly due to the relatively high rate of tax on capital gains over much of the period. From 1987 to 2000, as a percentage of the tax rate on interest income, the capital gains tax rate was either 67 or 75 percent.

36 If the impact on the after-tax yield differential is calculated for a 9.01 percentage point rise in the tax on coupon income *while holding the capital gains tax fixed*, the after-tax yield on high-coupon bonds relative to the yield on low-coupon bonds would fall by almost 18 basis points using the estimates for 1986-1991 and by 31 basis points using the estimates for 1995-2006.

DISCUSSION AND POLICY IMPLICATIONS

The findings presented in this article contradict the investment advice quoted in the introduction suggesting that there is a tax advantage to holding premium bonds. This follows because, in Canada, individuals pay a lower rate of tax on capital gains than on interest income. As a consequence, the smaller the coupon on a bond (whether the bond sells for a premium or a discount), the smaller is the tax liability associated with the bond. Using data for government of Canada bonds over the 1986-2006 period, we have found the average magnitude of the difference in after-tax yield between high- and low-coupon bonds to be quite large—almost 50 basis points. In the more recent 1995-2006 period, this difference was 65 basis points, an amount equal to almost one-third of the average after-tax yield (table 2, part C). Therefore, from a tax perspective, individual investors should always choose bonds with lower coupons.³⁷ This is an important issue since individuals and unincorporated businesses currently hold approximately \$60 billion of bonds (not including holdings through mutual funds or Canada savings bonds).³⁸

Examples presented in this article indicate that a cut in the capital gains tax rate would increase the after-tax yield on bonds that sell at a discount but reduce the after-tax yield on bonds that sell at a premium. With a sufficiently low tax rate on capital gains relative to the tax rate on interest income, the after-tax yield on a premium bond with a large coupon can actually be *negative*. This surprising result follows because a bond trading at a premium not only has a higher coupon-based tax liability but also realizes a capital loss, and the capital loss is useful only to the extent that it offsets the taxes associated with capital gains on other assets. This usefulness declines with the level of the capital gains tax rate, so that a cut in the capital gains tax rate will make it more likely that a bond selling at a premium will earn a negative after-tax yield. As shown in our examples, a capital gains tax rate of 40 percent or less of the tax rate on other income is sufficient to cause the after-tax yield on a bond with a 13.5 percent coupon to be negative when the pre-tax yield is 4.1 percent and the tax rate on other income is 46.4 percent.

Our results also show that a reduction in the tax rate on interest income raises the after-tax yield on all bonds but has a proportionally greater impact on higher-coupon bonds, since these bonds earn a greater share of their yield in the form of interest income. Further, the lower the capital gains tax rate, the greater is the *relative* increase in the after-tax yield on higher-coupon bonds from a cut in the ordinary income tax rate. If the capital gains tax is 50 percent of the tax on interest income and the pre-tax yield is 4.1 percent, a 9 percentage point decline in the personal income tax rate causes the after-tax yield on a 13.5 percent coupon bond to rise by

37 This investment strategy also applies to non-financial corporations, which face different tax rates on coupon and capital gains income. However, as is evident from table 1, non-financial corporations are very small holders of government of Canada bonds.

38 Calculated from data in Statistics Canada, *National Balance Sheet Accounts, Quarterly Estimates, Fourth Quarter 2007*, catalogue no. 13-214-XIE (Ottawa: Statistics Canada, 2008).

0.72 percentage points, while the after-tax yield on a 3.5 percent coupon bond rises by only half as much (0.35 percentage points).

Given that the impact of taxes on after-tax bond yields depends on bond coupon levels, changes in tax rates are likely to have distributional repercussions for holders of premium and discount bonds. In 2000, the proportion of capital gains subject to tax fell from 75 percent to 66 percent and then to 50 percent, yielding a relative tax advantage to holders of lower-coupon bonds. Further, a cut to the capital gains tax rate, as proposed by the Conservative Party during the 2006 election campaign (for reinvested assets), would benefit individual holders of lower-coupon government of Canada bonds relative to those holding higher-coupon bonds.

The greater tax liability associated with high-coupon bonds might be expected to diminish the demand for these bonds and, thereby, raise their relative pre-tax yields. However, since 1995, the pre-tax yields on high- and low-coupon government of Canada bonds with the same maturity date have been almost identical. Further, regression analysis indicates that tax rate movements cause the pre-tax yield differential between high- and low-coupon bonds to change by an economically small amount and in a direction opposite to that which would be expected if taxes were capitalized in pre-tax yields.

In contrast to the post-1994 period, a comparison of pairs of government of Canada bonds during the period 1986-1991 shows that the bond with the higher coupon earned a pre-tax yield that was, on average, 27.6 basis points greater. However, regression analysis shows that, for this earlier period, the change in the pre-tax yield differential between high- and low-coupon bonds in response to tax rate movements is not statistically or economically significant. For example, the estimates indicate that a fairly large fall in the tax rate on capital gains, from 75 to 50 percent of the tax rate on other income, would lead to an average 5.8 basis point rise in the *pre-tax* differential between high- and low-coupon bonds (using the estimates from table 4). This is small relative to the 28 basis point estimate of the average change in the *after-tax* yield differential that would result from the same change in the capital gains tax rate (table 5). More significantly, it is less than one-tenth the size of the 79 basis point average pre-tax yield differential required to equalize after-tax yields on high- and low-coupon bonds over this period. Hence, although the pre-tax yields on higher-coupon bonds were greater on average during the 1986-1991 period, this difference does not appear to have been the result of tax capitalization. Other possible explanations that have been suggested are that many bonds were not liquid and that traders used “rules of thumb”³⁹ and “idiosyncratic” bond-pricing formulas. These factors generally became less prevalent after the introduction of reforms to increase efficiency in the operation of the market for government of Canada bonds,

39 Whittingham, *supra* note 10, at 54, notes, “These rules of thumb often underestimated the present value of the nearest coupon payments, especially in an upward-sloping yield curve environment: the greater the value of the coupon on the bond, the greater the possible underpricing.”

in the early 1990s.⁴⁰ Further, liquidity in the bond market improved during the early 1990s and became similar to that of other major bond markets.⁴¹

One implication of the finding that the pre-tax yield differential between high- and low-coupon bonds is largely insensitive to movements in personal income tax rates is that yield curve estimates do not depend on the interaction of coupon rates and tax rates. Accurate models of the term structure are an important element of models that have been developed in recent years to explain credit spreads and to price credit risk derivatives and other contingent claims. If the pre-tax yields on bonds with different coupons reacted differently to tax changes, yield curve estimates would be sensitive to individual tax rates as well as to the particular sample of bonds employed. Tax-related coupon effects are considered to be of sufficient importance that Bank of Canada estimates of the government of Canada yield curve exclude observations for bonds that trade at large deviations from par.⁴² However, the results presented above imply that the interaction of taxes and coupon differentials should not affect yield curve estimates. Further, these findings mean that the interaction of taxes and coupon differentials is not likely to be important to bond issuers.

The evidence presented above indicates that individual taxpayers earn different after-tax yields on high- and low-coupon bonds. This implies that individual investors are not the “marginal investor” in this market, if we define the marginal investor as “the investor for whom the after-tax returns are the same for two differentially taxed alternative investments of equal risk.”⁴³ If individual investors did play the role of the marginal investor, they would sell bonds with low after-tax yields and buy bonds with high after-tax yields, and this would cause the pre-tax yields of the bonds to change until the after-tax yields were equated. Individual investors would not be expected to be the marginal investor if, as suggested by Green and Ødegaard,⁴⁴ they have higher transaction costs than institutional investors.⁴⁵

40 See Whittingham, *supra* note 10; and Johnson’s observation, *supra* note 30.

41 Branion, *supra* note 29; Gravelle, *supra* note 29; and Stacey Anderson and Stéphane Lavoie, “The Evolution of Liquidity in the Market for Government of Canada Bonds” (Summer 2004) *Bank of Canada Review* 19-31.

42 Bank for International Settlements, *Zero-Coupon Yield Curves: Technical Documentation*, BIS Papers no. 25 (Basel, Switzerland: Bank for International Settlements, 2005).

43 Guenther, *supra* note 7, at 383 in footnote 6.

44 *Supra* note 7.

45 Merle Erickson, Austan Goolsbee, and Edward Maydew, “How Prevalent Is Tax Arbitrage? Evidence from the Market for Municipal Bonds” (2003) vol. 56, no. 1, part 2 *National Tax Journal* 259-70, show that the costs of arbitrage may be part of an explanation for the US municipal bond “puzzle.” The puzzle arises from the very small spread between the yields on bonds that earn taxable interest and the yields on similar US municipal bonds, which are tax-exempt for some groups, including individual investors (John M.R. Chalmers, “Default Risk Cannot Explain the Muni Puzzle: Evidence from Municipal Bonds That Are Secured by U.S. Treasury Obligations” (1998) vol. 11, no. 2 *Review of Financial Studies* 281-308).

The near-equality of pre-tax yields for bonds with different coupons since 1995, and the insensitivity of the pre-tax yield differential to tax rate changes, suggests that the marginal investor in the bond market is an investor who pays no tax, such as a pension fund.⁴⁶ The finding that individual investors are not the marginal investor in the bond market is consistent with the rather small share of government of Canada marketable bonds held by individual investors—only 6 percent of the total in 2006 (see table 1). Larger shares are held by pension funds (21 percent), private-sector financial institutions (29 percent), and non-residents (17 percent).⁴⁷ On the other hand, if most bonds sell at a premium, the small share of holdings by individuals may be a result of the treatment by the tax system of premium bonds, which effectively discourages individuals from holding these bonds.

The empirical analysis described above employs data on government of Canada bonds. However, the key implication of the analysis for individual taxpayers, that discount bonds should be preferred to premium bonds when pre-tax yields do not capitalize differences in tax liabilities, applies to all types of bonds. A topic for future research is to examine whether the pre-tax yields on other types of bonds capitalize individual tax liabilities. Since the pre-tax yields of government of Canada bonds do not capitalize taxes, tax capitalization would not be expected with other types of bonds if there is arbitrage between these bonds and government of Canada bonds.⁴⁸ The extension to other types of bonds is important because individual holdings of

46 There will be no marginal investor in the bond market if no single type of bondholder is indifferent between every bond. If a marginal investor does not exist, so that all types of bondholders choose to hold only a subset of bonds (those with the highest after-tax yields for each particular bondholder type), the market is characterized by tax clienteles (a segmented equilibrium). A “clientele effect exists if a security is rationally held by investors in only particular tax brackets” (Stephen M. Schaefer, “Tax-Induced Clientele Effects in the Market for British Government Securities” (1982) vol. 10, no. 2 *Journal of Financial Economics* 121-59, at 121). One would expect that, in the presence of tax clienteles, tax changes, by altering the relative yield of different bonds to different groups of investors, would alter the relative demand for bonds of different types and, as a result, alter the relative pre-tax yields of bonds. The evidence of little impact of tax movements on pre-tax yield differences appears to cast doubt on the existence of tax clienteles.

47 Note that the values for individual bondholdings given in table 1 include tax-exempt investments as well as holdings by mutual funds.

48 In 2006, individual holdings of provincial government and other Canadian bonds, as a share of the total outstanding, were only slightly higher than the share of government of Canada bonds held by individuals shown in table 1, and are small relative to the holdings of other major types of bondholders (see Statistics Canada, *supra* note 38). Thus, on the basis of bondholdings, it does not seem likely that individual investors represent the marginal investor in these markets. On the other hand, in 2006, individuals (excluding individual holdings through mutual funds) held over 35 percent of municipal government bonds; therefore, there is a greater possibility that, in this market, bond yields have capitalized differences in individual tax liabilities. However, municipal bonds represent only about 3 percent of Canadian bonds outstanding (Statistics Canada, *supra*).

provincial government, municipal government, and other Canadian bonds are approximately seven times individual holdings of government of Canada bonds.

The analysis above provides evidence that, for an individual taxpayer, there is a tax advantage to holding discount bonds over premium bonds. However, during some periods, discount bonds have been difficult to acquire. The general decline in interest rates in the late 1990s caused the prices of bonds to rise, with the result that more bonds were priced at a premium to their face value.⁴⁹ Data from TD Waterhouse, a Canadian financial institution that provides online trading in government of Canada bonds for individuals, shows that, for a randomly chosen date—December 5, 2007—there were 17 government of Canada bonds available for purchase by retail investors, and all were priced at a premium. For federal government agency bonds, 18 of 20 were selling at a premium and, for maturities of over three years, all the agency bonds were selling at a premium. Thus, even if an investor is aware of the tax implications associated with different bond coupon levels, there may simply be no discount bonds available. The financial industry could respond to this shortage by “repackaging” premium bonds to be resold at prices closer to par,⁵⁰ but may not do so because of the costs associated with repackaging, small consumer demand (perhaps attributable to ignorance of the tax implications associated with different coupon levels),⁵¹ and the small size of the individual investor bond market.

49 Another possible reason for the limited supply of discount bonds could be a preference by institutional investors for discount bonds. Even though this type of investor does not face a tax disadvantage by holding premium bonds, managers may prefer not to have to record a “capital loss” on a bond that is purchased at a premium. This point has been made by Halpern and Rumsey, *supra* note 29, at 114) who quote the Canadian Securities Institute’s *Bond Trading Techniques*: “The treatment of unrealized book losses, or more specifically, a reluctance to sell bonds below recorded book cost, is perhaps the single greatest obstacle to successful maximization of return within a bond portfolio.” Whittingham, *supra* note 10, at 54, suggests that this may be an explanation for the existence of the larger pre-tax yield differences in the earlier period (1986-1991), and it could be a non-tax reason for the insensitivity of these differences to tax changes. However, presumably this effect has not been large in the period since 1995, given that there were only small differences in pre-tax yields during this period.

50 Current Canadian tax legislation prevents financial institutions from issuing financial instruments to purposely avoid tax. While this would prevent financial institutions from repackaging bonds selling at a premium into bonds that sell at a discount, it should not prevent firms from repackaging premium bonds into bonds that sell at par, since this would be equivalent to retiring existing debt and issuing new debt at par.

51 As has been shown in other contexts, individual investors do not always choose investments with a view to maximizing after-tax returns (Brad M. Barber and Terrance Odean, “Are Individual Investors Tax Savvy? Evidence from Retail and Discount Brokerage Accounts” (2003) vol. 88, no. 1-2 *Journal of Public Economics* 419-42).

APPENDIX**Data Table Descriptive Statistics**

Number of bonds	94	
Number of bond pairs	49	
Number of bond pair observations	2,190	
Sample period	1986-2006	
	Average	Range
Coupon rate of high-coupon bond in pair	11.824	4.25-15.00
Coupon rate of low-coupon bond in pair	7.875	3.0-13.0
Amount issued of each bond type (Cdn\$ millions)	2,752.8	22.5-15,000.0
Yield to maturity of high-coupon bond in pair	7.670	2.279-13.549
Yield to maturity of low-coupon bond in pair	7.514	2.268-13.223
After-tax yield to maturity of high-coupon bond in pair	3.269	-0.539-6.998
After-tax yield to maturity of low-coupon bond in pair	3.740	0.728-7.478
Maturity (months)	51.1	13-132
Tax rates (%)		
Other income	44.2	40.16-51.0
Other income including surtaxes	49.3	46.1-55.4
Capital gains	28.3	20.1-34.4
Capital gains including surtaxes	31.7	23.2-39.9
Capital gains as a share of tax on other income	64.2	50-75

Note: After-tax yield calculations employ the highest individual tax rate in Ontario.