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A Comparative Analysis of the returns on Provincial and Federal Canadian Bonds

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Abstract

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Abstract

Our empirical analysis unveils a striking uniformity between the returns of Canadian federal and provincial bonds. Furthermore, the return spreads between these debt instruments are shown to be white noise. Relying on tests for mean-variance spanning, we also show that market participants are unlikely to benefit from expanding portfolios of federal bonds with debt securities issued by the Canadian provinces.

Keywords: Diversification Benefits; Bonds; Spanning; Canada.

JEL classification: G11, G18.

This paper addresses questions like: How beneficial is exposure to the market for province-issued bonds, from the perspective of investors already holding a portfolio of federal debt instruments? In particular, does investing in Canadian provincial bonds improve the return to risk-bearing? What if short sales are not feasible?

Traditionally, the literature on Canadian government bonds has focused on bonds issued by the federal government. In contrast, by including debt instruments issued by the provinces, this study essentially considers the entire Canadian market for government bonds.

Our analysis starts with a qualitative comparison of the federal and provincial bond markets in order to focus on the evaluation of gains arising from portfolio diversification. In recent years, the evaluation of the diversification benefits associated with broadening the investment opportunities set has been the subject of a sizeable literature. Studies in this field have quantified the advantages of expanding the set of tradable assets from the domestic to the international equity market (among others, Bekaert and Urias, 1996; Errunza et al., 1999; De Roon et al., 2001; Li et al., 2003; Chiang et al., 2007). Other works have investigated the gains from portfolio diversification across different classes or sets of assets (e.g., Eun et al., forthcoming).

Few studies have analyzed the merits of portfolio diversification across bond markets. Hunter and Simon (2004) have examined the investment possibilities set offered by bonds issued by the national governments of Japan, U.K. and Germany from the perspective of investors whose current holdings

are in bonds issued by the United States (U.S.) Along the same lines, Chiang at al. (2007) have analyzed bonds from emerging economies.

Cappiello et al. (2006) have studied the tendency of international bond markets to co-move as a result of synchronic economic cycles with mixed results.[1] While their results do not directly gauge gains from portfolio diversification, evidence of bond market co-movements suggests that diversifying across bond markets might fail to entail any significant benefit.

This research article contributes to the literature on the gains from portfolio diversification by analyzing the Canadian market for government bonds, inclusive of debt securities issued by Canadian provinces.

Canadian provinces enjoy significant fiscal independence and can tailor bond issues to their needs. In view of the fact that expenditure and revenue levels vary across regional governments, it might be hypothesized that differences across local economies should be mirrored by the returns of the debt securities issued by these jurisdictions. If this were the case, market participants could effectively diversify their portfolio by holding bonds issued by a relatively large number of subnational governments.

In a preliminary study on the merits of diversification in the market for bonds issued by Canadian provinces (Galvani and Behnamian, 2008) we found evidence against this view. In fact, our analysis documents the absence of diversification benefits across provincial bond markets for most Canadian

[1] Solnik et al. (1996) and Hunter and Simon (2005) documented strong co-movements for economic downturns.

provinces, with the empirical evidence being particularly compelling when short-selling restrictions are taken into account. Continuing the same line of research, this paper investigates the benefits from exposure to the market for provincial bonds from the perspective of investors holding a portfolio of Canadian federal bonds. We have found that these diversification gains tend to be insignificant, with especially compelling evidence against diversification gains when short selling restrictions are considered.

The relative thinness of the derivative market for federal debt instruments and the inexistence of such a market for provincial bonds suggests, supported by anecdotal evidence, that selling these fixed income securities short might be an unattainable trading practice. Therefore, the evaluation of the merits of portfolio diversification within the market for Canadian government bonds should take into account short-selling restrictions. In this paper we rely on the test of diversification benefits with short-sale restrictions that have been proposed in De Roon et al. (2001).

It is a well-known fact that bonds issued by municipalities of the United States (U.S.) tend to yields higher returns than U.S. federal debt instruments, and therefore the associated return spreads are consistently positive and significant *(*Green and Ødegaard, 1997*)*. The natural explanation for these spreads' persistency, besides different tax regimes between different level of government, is that they account for different risk levels, where risk includes default and liquidity concerns (e.g., Wang et al., 2008).

In contrast to what is observed in the U.S. bond market, our empirical

analysis suggests that the return spreads between national and subnational Canadian debt instruments are persistently insignificant. In fact our analysis documents that the spreads between federal and provincial bond of similar maturities are plain white noise. A possible explanation for this discrepancy between the U.S. and Canadian bond markets is that agents hold different expectations about a federal bailout of subnational jurisdictions across the border. For Canada, the observed homogeneity of the federal and provincial returns suggests that the market's expectations lay on an implicit bailout provision for provincial debt instruments in distress.

The remainder of the paper is structured as follows. The next section provides an analytical framework and describes the econometric approach that we adopted. The data library utilized for our empirical analysis is described in Section 2. This is followed by a descriptive comparison of the federal and provincial market for government bonds, which is divided in two parts, Market Description and Average Performance. Next, Section 5 discusses the results of the tests for diversification benefits that we employed. A short statement of conclusions follows in Section 6. Finally, two short appendices provide some robustness checks of our empirical analysis.

1 Background

From a methodological perspective, the assessment of the effects of changes in agents' investment opportunities sets requires that traders should be able to

compare strategies across scenarios. Mean-Variance (MV) analysis (Markowitz, 1952) offers a suitable framework for this comparison because it identifies the collection of optimal portfolios associated with a given set of investment assets.

Diversification benefits can be gauged by the relative distance between the MV frontiers generated by the investments that are already represented in agents' portfolios and those associated with a broadened opportunities set. Whenever these efficient frontiers are not significantly different we say that there is spanning or, alternatively, that the benchmark investments are said to span the additional trading opportunities (henceforth called test assets). These concepts are discussed by Huberman and Kandel (1987), who developed a regression-based test for spanning.[2] They showed that tests for spanning can be performed by evaluating linear restrictions in a regression of the excess returns of the test assets over the collection of the benchmark excess returns, plus a constant.

Denote by r_{Nt} and r_{Kt} the time-t excess returns of N test and K benchmark assets, respectively. Tests for spanning can be performed by evaluating some linear restrictions in the multivariate regression of r_{Nt} over r_{Kt} (plus a constant)

$$r_{Nt} = \alpha + \beta r_{Kt} + \varepsilon_t, \text{ for } t = 1, 2, \ldots, T \tag{1}$$

where $E[\varepsilon_t] = 0_N$, β is an $(N \times K)$ matrix, and 0_N and α are vectors of the

[2] De Roon and Nijam (2001) is an excellent survey of MV spanning tests.

N-dimensional space. There is spanning whenever the linear restrictions

$$\alpha = 0_N,\ \beta 1_K = 1_N \tag{2}$$

cannot be rejected. Intuitively, the test assets fail to offer significant diversification benefits whenever they can be replicated, up to a zero-mean error term, by a portfolio of the benchmark securities.[3]

In the MV framework, the risk reward of a portfolio is gauged by its Sharpe ratio (i.e., the ratio between its excess return and standard deviation). Jobson and Korkie (1982, 1984, 1989) measured gains from the exposure to new markets in terms of changes in the optimal Sharpe ratio. They showed that the augmented and benchmark frontiers entail statistically indistinguishable Sharpe ratios whenever the linear restrictions

$$H_{02} : \alpha = 0_N \tag{3}$$

fail to be rejected. In this sense, the regression coefficients α constitute a performance measure that quantifies, in terms of return to risk-bearing, the gains associated with broadening the investment opportunities set.

Because return to investment lies at the core of investors' objectives, tests for spanning can be fruitfully complemented with the evaluation of the risk-bearing compensation that is entailed by the expansion of the collection of

[3] Because of the similarity between the standard formulation of the Capital Asset Pricing Model and equation (1), the constant coefficients are traditionally given the name of generalized Jensen's alphas.

tradable assets.

Kan and Zhou (2001) showed that whenever $\beta 1_K = 0_N$ the benchmark and the augmented frontiers have the same global minimum variance (GMV) portfolio. The GMV portfolio of a collection of risky assets is defined as the trading position entailing the lowest level of variance. Van Zijl (1987) calls the risk associated with this portfolio the *unavoidable level of risk* because no other trading strategy of the risky securities yields a return with a smaller variance. If these linear restrictions on the slopes β in (1) hold true, then the test assets fail to decrease the level of unavoidable risk offered by the benchmark market.

The previous discussion illustrates that the null hypotheses of spanning H_{01} can be decomposed into assessments of the changes in the level of unavoidable risk and of the risk-bearing compensation. In a nutshell, there is spanning whenever the test assets fail to improve both the return to risk and the level of unavoidable risk offered by the benchmark market.

The measures of diversification gains reviewed in this section make the assumption that agents can short sell both the test and benchmark assets, which is not always the case in practice. Recently however, De Roon et al. (2001) have shown that the tests for spanning can be modified to account for short-selling restrictions as well. The linear restrictions displayed in (2) are substituted by a collection of inequalities of the form $\nu\alpha^{(\nu)} - \beta^{(\nu)}1_K \leq 1_N$ for each zero-beta return ν, where $\alpha^{(\nu)}$ and $\beta^{(\nu)}$ are obtained from a modified version of the baseline model. This modified model consists of a linear

regression equivalent to the regression in (1), in which the benchmark assets are restricted to those constituting the efficient portfolio whose zero-beta rate is ν, under the no-short-sales assumption. Identifying these assets is a matter of solving a quadratic optimization problem with inequality constraints. The Elton, Gruber, and Padberg algorithm for the identification of the tangency portfolio under a no-short-sales restriction (e.g., Elton et al., Ch. 9, 2003) indicates that the relevant range of the zero-beta return ν can be partitioned into intervals in which $\alpha^{(\nu)}$ and $\beta^{(\nu)}$ remain unchanged. Finally, testing for spanning is equivalent to jointly evaluating the inequalities $\nu\alpha^{(\nu)} - \beta^{(\nu)}1_K \leq 1_N$ at the extremes of these intervals of ν.[4]

2 Data

This study relies on a dataset containing the end-of-the-month prices and coupons of federal and provincial bonds.[5] The provincial bonds are issued in Canadian currency by the ten provinces of Canada: Nova Scotia (NS), Prince Edward Island (PE), Alberta (AB), Manitoba (MN), Newfoundland (NF), Saskatchewan (SK), Ontario (ON), New Brunswick (NB), British Columbia (BC), and the province of Quebec (PQ). In the preceding list, the provinces

[4]For further details, the interested reader is referred to De Roon et al. (2001) and Kodde and Palm (1986). We base our inference for the spanning tests with short selling restrictions on the empirical distribution of the calculated test statistics, as estimated by a semi-parametric bootstrap (Davidson and MacKinnon, Section 4.6, 2004).

[5]This unique data library has been used by Landon and Smith (2000, 2007) to examine creditworthiness spillovers across Canadian provinces, as well as to analyze bond-return seasonal variations (Landon and Smith, 2006).

are ordered according to the number of bonds issued, from the smallest to the largest.

Our sample of monthly price observations for federal bonds range from January 1983 to December 2006 while our sample of price data for provincial bonds covers the period from January 1983 to December 2003, or approximately two decades. In order to create equivalency between both theses sets of data, we have confined our analysis to the shorter sample when comparing the investment opportunities offered by the federal and provincial bonds.

In our sample there are 375 federal bonds and 313 provincial bonds. Bonds for which only one return can be calculated, and bonds that are not completely identified by their maturity date, volume of issue, and coupon were discarded from the sample, leaving us with 303 and 310 federal and provincial bonds respectively. The average maturity for the federal bonds is 8.67 years, and the average coupon is 8.12%. The corresponding values for the provincial bonds are 9 years and 8.9% respectively.

The time-t monthly holding period *net* return, expressed by annual rate and in percentage terms, is defined by the following formula

$$r_t = \left[\left(\frac{p_t - p_{t-1}}{p_{t-1}} \right) \times \frac{365}{N_t} + \frac{C}{p_{t-1}} \right] \times 100, \tag{4}$$

where p_t is the price of a bond with \$100 face value at the end of month t, N_t is the number of trading days between two price data points, and C is the annual coupon. The overall average return on a federal bond in our

	Average	Skewness	Kurtosis
NS	8.70	-0.11	3.64
PE	12.03	-0.37	3.90
AB	6.97	-0.05	4.59
MN	8.21	-0.07	3.60
NF	10.80	-0.26	3.70
SK	9.41	–0.33	4.13
ON	8.87	-0.01	3.86
NB	8.98	-0.19	4.16
BC	11.48	-0.19	3.71
PQ	10.14	-0.10	4.13
Federal	7.28	-0.03	4.08

Table 1: Summary Statistics of Annualized Net Returns

sample is 7.28% while on provincial bonds it is 9.56%. To adjust for inflation we have subtracted from each calculated return the corresponding return of the Canadian one-month T-Bill. All results presented in this paper remain unchanged when nominal returns are considered and are available from the authors upon request.

Table 1 provides some summary statistics, including the average, robust t-statistic, skewness, and kurtosis of the bond annualized net returns, sorted by issuer.

Robust t-statistics (unreported) indicate that all these average returns are significantly different from zero.[6] Sample skewness and kurtosis indicate that the return distribution is fairly symmetrical and displays rather thin tails. Standard normality tests reject normality for the majority of the bonds in the sample.

[6]Throughout this article, the significance level is set to 5%.

	Average	S.D.	Number	Volume %
Short Term	7.07	9.78	92	30
Medium Term	8.96	13.54	61	13
Long Term	9.54	20.47	150	58

Table 2: Federal Bonds

	Average	S.D.	Number	Volume %
Short Term	8.61	10.92	5	1
Medium Term	8.97	12.62	63	16
Long Term	10.65	20.99	242	83

Table 3: Provincial Bonds

3 Market Description

This section briefly outlines general characteristics of the Canadian market for governmental bonds which we categorize into maturity bands of 1-3 years, 4-5 years, and above 5 years.[7] Table 2 reports the sample average return on federal bonds within each maturity band, the associated average standard deviation (SD) and the number of bonds in each band. The last column breaks down federal government's debt into its short-, medium- and long-term components. Table 3 lists analogous statistics for provincial bonds.

Robust t-statistics (unreported) indicate that the average return on provincial and federal bonds is significantly different from zero for each maturity group. A comparison of the volume per maturity band for provincial and federal governments indicates that the provinces tend to borrow for the long run more than the federal government does.

Next, we evaluate the federal and provincial debt volume in four dis-

[7] Alternative maturity bands have been considered in Appendix A.

	1983-88	1989-94	1995-99	2000-06
Short Term %	17	25	30	48
Medium Term %	20	17	12	0
Long Term %	63	58	58	52
Total	116,025	198,750	224,309	178,801

Table 4: Federal Bonds, Volume

joint subsamples of five years: 1983-1988, 1989-94, 1995-1999, and 2000-2006 (2000-2003 for provincial bonds). A bond is counted in a given sub-sample only when its issuing date falls within the time interval considered. Table 4 breaks down the federal debt volume by maturity bands over these subsamples, in percentage terms. The last row lists the total federal debt volume that is accounted for by the bonds in our sample in millions of Canadian dollars.

Table 4 suggests that the federal government privileges either short- or long-term debt instruments. This remains true when the maturity bands are 1-3, 4-10 and 11 and above years.

A count of the number of bonds issued in each sub-sample (unreported) indicates that over time, the federal government has deepened its bond issues while reducing their variety in terms of coupons and maturities. For example, in the first sub-sample there are 120 bonds (38 short-, 28 medium-, and 54 long-term) that can be distinguished either by coupon or maturity while in the last subperiod (from 2000-2006) the corresponding figure is a mere 27 (15 short, zero medium, and 12 long term bonds). This reduction in combinations of maturities and coupons comes in contrast with an increase

	1983-88	1989-94	1995-00	2001-03
Short %	1	1	0	0
Medium %	21	15	4	3
Long %	78	85	96	97
Volume	11,609	43,912	70,171	13,146

Table 5: Provincial Bonds, Volume

in the outstanding federal debt of about 54%.

Table 5 breaks down the volume of pooled provincial debt over the sub-samples considered. Debt volume is sorted by maturity bands and reported in percentage terms. The last row lists the stock of provincial debt that is accounted for by the bonds in our sample expressed in millions of Canadian dollars.

Table 5 clearly indicates that there is one order of magnitude between federal and provincial debt volume. Also, provinces seem to consistently privilege the issue of long-term debt securities over short- and medium-term contracts. This remains true when the maturity bands are 1-3, 4-10 and 11 and above years.

Table 6 offers a summary of provincial debt, broken down by province, over the same time intervals. For each sub-sample, the first column reports the volume of outstanding debt associated with the bonds in our sample expressed in millions of Canadian dollars. The second column breaks down the stock of pooled provincial debt by province in percentage terms.

Table 6 suggests that the market for provincial bonds is dominated by a few large players in each sub-sample. Remarkably, several provinces alternate

	1983-88		1989-94		1995-00		2000-03	
	M Can $	%	M Can $	%	M Can $	%	M Can $	%
NS	250	2.2	200	0.5	3450	1	1300	9.9
PE	74	0.6	330	0.8	155	0	200	1.5
AB	1000	8.6	4965	11.3	3587	1.1	—	—
MN	575	5	2100	4.8	3225	1	825	6.3
NF	200	1.7	125	0.3	1950	0.6	450	3.4
SK	1660	14.3	3405	7.8	2535	0.8	1500	11.4
ON	500	4.3	12000	27.3	288832	87.5	4000	30.4
NB	485	4.2	2575	5.9	3900	1.2	1500	11.4
BC	2125	18.3	5890	13.4	6330	1.9	1250	9.5
PQ	4740	40.8	12323	28.1	16208	4.9	2122	16.1

Table 6: Volume by Province

to form the group of large issuers, with some persistence of PQ (top two for three of the four selected subsamples) and a stunning predominance of ON over the 1995-2005 interval.[8] Setting a cutoff at 10% of the pooled provincial debt, most of the bonds in our sample were issued by SK, PQ and BC in the 1983-1988 sample; by AB, BC and PQ from 1989 to 1994; by ON from 1995 to 2000; and by SK, ON, NB and PQ from 2000 to 2003.

4 Average Performance

We have aggregated bonds from each province into a provincial equally weighted (EW) portfolio with monthly rebalancing. The reason for looking at such portfolios is that their performance measures the return from investing in the average portfolio constituent. By extension, the return from the

[8] Observations for AB are missing for the last subsample because the Alberta government stopped issuing bonds in 1997.

EW indexes	EW Corr.	Av. Ret.	Cross-Corr.
NS	0.93	9.94	0.94
PE	0.93	10.86	0.92
AB	0.94	8.59	0.89
MN	0.90	9.21	0.90
NF	0.92	11.01	0.92
SK	0.91	9.37	0.94
ON	0.93	8.72	0.84
NB	0.94	9.63	0.90
BC	0.93	9.68	0.93
PQ	0.92	9.83	0.92
Federal	0.88	9.04	0.93

Table 7: Correlation Between EW Indexes and Constituents, Average Annualized Net Return of EW Indexes and Average Correlation Across Provincial EW Indexes

average portfolio constituent can gauge the average return of the aggregate market.

The average correlation between the EW indexes and their constituents is reported in the first column of Table 7 and the EW indexes' average returns are listed in the second.

For each province, the correlation between the EW portfolio and its constituents indicate that these indexes summarize extremely well the investment possibilities offered by each province' bonds, ranging from 0.9 (Manitoba) to 0.94 (Alberta and New Brunswick). To put these numbers in context, the average return correlation of individual futures with popular commodity futures indexes, such as, for example, the Goldman Sachs Commodity Index, is a mere 0.2 (Erb and Harvey, 2006). The corresponding value for

the S&P/TSX 60 index is 0.3.[9]

The last column of Table 7 reports the average correlation between each provincial EW index and the remaining nine provincial EW indexes. The last row of this column reports the average correlation of the EW index of federal bonds with these of the provinces. The majority of these values score very highly, above 0.9, which indicates that the markets for provincial bonds are highly correlated amongst one another. Textbook knowledge of portfolio management indicates that the average correlation across assets is a rough measure of diversification benefits: the higher the correlation, the lower the gains (e.g., Elton et al., Ch. 4, 2003). Hence, these values suggest that investing in multiple provincial bond markets can hardly be considered an effective diversification strategy.[10]

The correlation between the EW index of federal bonds and an EW of the pooled provincial bonds is particularly suggestive, being at 0.93. This extremely high value denounces strong and persistent co-movements of the federal and provincial bond markets. This result is also robust to disaggregation into maturity bands: the corresponding values of the correlation coefficient are 0.84, 0.94 and 0.95 for short-, medium-, and long-term contracts respectively.[11] Plots of the returns of these indexes graphically document that the

[9] Robust t-statistics indicate that the average return of the EW index for each province is significantly different than zero. Skewness and kurtosis suggest that these indexes are distributed rather symmetrically around the mean, with relatively thin tails.

[10] A detailed analysis of the merits of diversification across provinces can be found in Galvani and Behnamian (2008).

[11] Due to the parsity of short term provincial bonds, the comparison between the average return of federal and provincial bonds is limited in its significance.

average performance of EW portfolios of federal and provincial bonds with similar maturities are extremely alike. For instance, Figure 1 plots the EW indexes for long maturities. The similarity between the indexes is obvious. Once more, a high correlation suggests that federal and provincial bonds are unlikely to offer diversification benefits with respect to each other.

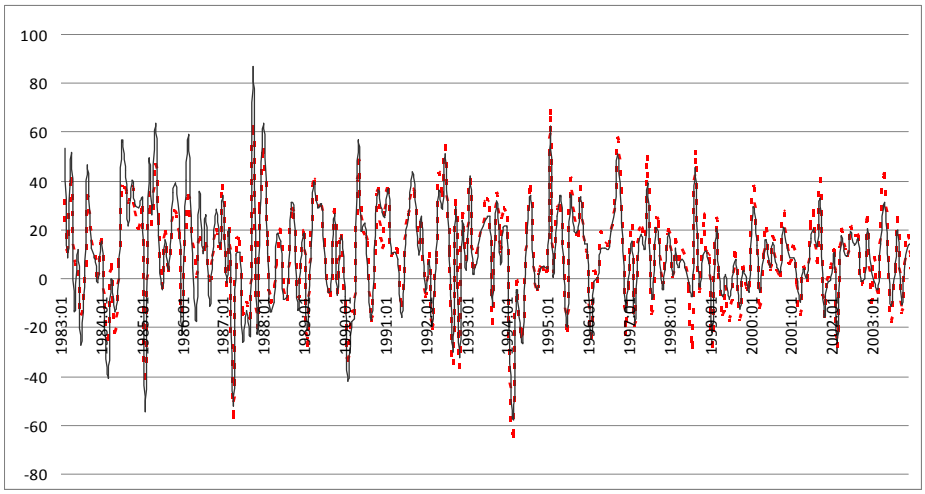

Figure 1: EW long term provincial (dashed line) and federal

The spread between the federal and provincial EW indexes measures the relative average performance of these bonds. Significant differences between the returns entailed by federal and subnational bonds of similar maturities should mirror, besides different tax regimes, the relative riskiness of these two classes of debt securities where risk includes insolvency and liquidity concerns (e.g., Wang et al., 2008).

If the analysis of the spreads between municipal and federal bonds in the United States teaches us something, it is that bonds issued by sub-central governments tends to yields higher returns, especially for long-term maturities. This is called the Muni puzzle. Accordingly, in the absence of explicit federal bailout provisions for subnational governments in financial distress, provincial bonds might be expected to yield higher average returns, especially for the high end of the yield curve. This should be reflected by a significant and systematic spread between the average performance of provincial and federal bonds, with larger gaps for long term contracts.

This study documents that, surprisingly, this is not the case. For all maturities, the spreads of the EW indexes turn out to be being normally distributed. Also, the auto-correlation and partial auto-correlation functions reveal that these spreads do not follow any ordinary and/or seasonally adjusted moving average or auto-regression processes. The use of ordinary and seasonal moving average lags and auto-regressive components fail to improve the goodness-of-fit of the model compared to not using any lag of the spreads. In simpler terms, these spreads are white noise, a finding which does not support the conjecture that there might exist a systematic return gap between federal and provincial bonds. Even more surprisingly, the average return spread is not significantly different from zero for long-term maturities, both in the case of 10- and 5-year maturity cutoffs. For medium-term bonds the spread is a meagre 0.03% on the annualized return. This comes in sharp contrast to spreads associated with the U.S. market for bonds issued by the

federal and municipal (including state) authorities.

5 Spanning

Samples of returns for finitely lived securities (e.g., options, futures contracts, and bonds) are naturally unbalanced because the observations of the sample after the expiration date, and before the date of issue, are missing. However, one way of handling strings of missing values is by constructing indexes like those introduced in the previous section. An alternative practice is to break up the period covered by the data into short time intervals, as is typically done in the rolling-window framework, an approach that delivers a sequence of overlapping subsamples for which backfilling biases are minimized.

From a modelling perspective, considering individual assets rather than broad indexes offers the advantage of not limiting traders' investment activities to predetermined strategies that are implicitly dictated by the definition of the indexes. This might be a significant feature when evaluating gains from diversification which might require, to be earned, the design of portfolios that are not represented by these indexes. For this reason, we anchor the diversification benefits offered by provincial bonds to the performance of portfolios offered by *individual* bonds issued by the federal government. In contrast, the provincial bonds are considered both individually *and* by aggregating them with an equally weighted (EW) index representing each province. We decided to utilize indexes of provincial bonds in addition to

individual contracts because of our econometric approach. Simulations show that the reliability of tests of diversification benefits improves whenever the number of additional assets is decidedly smaller with respect to the size of the of benchmark market (e.g., Kan and Zhou, Table 1, 2001). Hence, by aggregating the provincial markets into only a few indexes, we improve the robustness of our analysis. An additional reason for utilizing the EW indexes is that they summarize the investment possibilities offered by provincial bonds exceptionally well, as Table 7 indicates.[12] In the ensuing discussion, we rely upon the EW indexes of provincial bonds. The results of the test for diversification benefits for individual provincial bonds are presented in Appendix B.

In order to mitigate backfilling biases, in each window we discard bonds for which return data points are available for less than 50% of the months. This delivers a rather large sample of federal bonds for most of the windows, as well as a large sample of provincial bonds where these are considered individually (see Appendix B). Kan and Zhou (2001) have shown that the reliability of the tests for spanning greatly improves if the size of the augmented possibilities set is decidedly larger than the number of available observations. For this reason, we further reduced the number of bonds in our samples by discarding all issues with less-than-average volume, where

[12] In a previous study (Galvani and Behnamian, 2008) we aggregated bonds issued by each Canadian province by EW indexes and moving-source time series, as in Bessembinder (1992) and De Roon et al. (2000). We demonstrated that the EW indexes display a markedly higher correlation with their constituents than the one observed for the moving-source time series.

the average is taken over the bonds that passed the 50% criteria.[13] In support of this additional selection procedure, we argue that small bond issues are unlikely to offer relevant investment opportunities to the marginal market participant. This is because low-volume issued are typically purchased before they hit the open market, by institutional investors.

In addition to the combination of six-year window width and 50% cutoff, we have tried the 4-, 8-, and 10-year windows with, 25%, 75%, and 100% thresholds. Of course, higher cutoff points may bias the sample against short-term bonds, thus possibly understating their importance on the market.[14] On the other hand, lower thresholds might raise concerns of backfilling biases. The six-year length represents a compromise between reasonably sized subsamples and retaining a significant number of bonds for each province in most windows.

The rolling-window analysis delivers approximately 181 overlapping subsamples per province. In each of these subsamples, we evaluate the restrictions displayed in (2). The first column of results in Table 8 reports the fraction of six-year windows for which the data fail to reject the null of spanning (Hypothesis H_{01}), sorted by province. The next column lists the analogous frequencies for the Sharpe ratio test (Hypothesis H_{02}).

[13] For some provinces and some windows (e.g., the first 40 windows for Alberta) either this selection process or simply the unavailability of provincial bonds delivers an empty investment opportunities set of provincial bonds. These windows were not considered for the calculation of the frequencies reported in Tables 8 and 12.

[14] This might be especially relevant for the federal bond market where approximately 30% of the bonds are short-term.

	H_{01}	H_{02}.	Short Selling
NS	0.82	0.82	0.94
PE	0.71	0.75	0.65
AB	0.61	0.95	0.71
MN	0.69	0.72	0.70
NF	0.58	0.62	0.70
SK	0.71	0.78	0.76
ON	0.75	0.91	0.92
NB	0.65	0.86	0.89
BC	0.71	0.83	0.74
PQ	0.66	0.73	0.85

Table 8: Spanning Tests per Province, EW Indexes

For each window, the linear restrictions associated with the null hypotheses of spanning and equality of the Sharpe ratios have been evaluated by asymptotic and finite sample tests (Jobson and Korkie, 1989). In addition, all statistics have also been compared with their bootstrap 0.05 critical values.[15] While all of these testing techniques lead us to the very same conclusions, we decided to rely on the empirical distribution of the Wald tests in determining our results, in order to maintain consistency with an analysis of the cases in which there are short-selling restrictions.

The frequencies reported in the first and second results columns of Table 8 suggest that provincial bonds fail to offer significant diversification benefits with respect to federal bonds for most of the issuing provinces, and in most of

[15]The Wald statistics utilized for our analysis have been evaluated correcting for heteroskedasticity and autocorrelation of the error terms, as in Newey and West (1987). We obtained these statistics' empirical distributions by semi-parametric bootstrapping, as described in Davidson and MacKinnon (2004, Section 4.6).

the considered windows.[16] For some provinces, the rejection of the hypothesis of spanning occurs decidedly more frequently than that of the equality of the Sharpe ratios. Given the linear restrictions displayed in 2 and 3, these rejections of H_{01} seem to be driven by that of the linear restriction $\beta 1_K = 1_N$. Separate tests (available upon request from the authors) confirm this intuition.

As mentioned in Section 1, when $\beta 1_K = 1_N$, the test assets fail to decrease the level of unavoidable risk associated with the benchmark collection of investment opportunities. Hence, our empirical analysis indicates that the bonds issued by some provinces might be valuable to market participants with an interest in hedging against risk, rather than to those agents whose target is the maximization of the return to risk-bearing. However, even from the perspective of risk-minimizing investors, the benefits from exposure to provincial debt instruments are limited.

Futures contracts on bonds are thought to facilitate taking short positions when market makers fail to support short sales. The absence of financial derivatives on provincial bonds, together with the relative thinness of the market for futures contracts on bonds issued by the federal government, suggest that trading strategies involving short selling these debt instruments might be difficult if not impossible to implement.

A constrained trading environment might affect the gains from portfolio

[16] No discernible trend can be identified for these frequencies, as they appear to be time-independent.

diversification in both ways. In fact, trade restrictions might render unattainable some portfolios that would otherwise reap the advantages of an expanded set of investments. On the other hand, the very same trade limitations might render unattainable some efficient portfolios of the benchmark assets. In this case, exposure to an augmented set of investment opportunities might deliver superior portfolio performance.

The final column of Table 8 reports the fraction of windows in which data fail to reject spanning, sorted by province, under the assumption that short sales are not allowed, as in De Roon et al. (2001).[17] Our findings document the absence of significant diversification benefits in most of the windows and for all provinces. For most provinces, short-sales restrictions seem to weaken the gains from diversification benefits with respect to efficient portfolios of federal bonds. This suggests that the gains from portfolio diversification entailed by provincial bonds seem to be driven by short-selling, a trade which is likely to be difficult or simply impossible to implement in the Canadian market for provincial bonds.

A comment is in order. This paper relies on an historical sample. Hence, any benefits we find (or fail to find) may have little bearing on future performance. That said, our results indicate that over a period of about two decades, the benefits entailed by provincial bonds seem to be weak and mainly concentrated on the possibility of achieving a lower level of unavoidable risk

[17] An analysis of the power of these tests similar to the one reported in De Roon et al. (2001), but performed with our database, is available upon request from the authors.

(as measured by the GMV portfolio), rather than on an increase in the reward to risk-bearing. In addition, these gains seem to be sensitive to the trading environment, becoming weaker when short-selling restrictions are imposed for several provinces.

6 Conclusions

This study has shown that bonds issued by Canadian provinces do not entail a return premium or a risk-exposure reduction with respect to federal debt instruments. In fact, our analysis suggests that investors holding a portfolio of federal bonds do not enjoy significant gains when they expand trading to provincial bonds. This seems to hold true from the perspective of both return-to-risk-focused investors as well as for agents who additionally worry about risk reduction.

The relative performance of federal and provincial bonds should mirror the relative riskiness of these two classes of debt securities, where risk includes insolvency and liquidity concerns (e.g., Wang et al., 2008). Credit ratings assigned by well-known rating agencies do not seem to support the conjecture that federal and provincial bonds bear the same level of risk. In fact, in the vast majority of the months in our sample, the ranks of the ten provinces were spread over seven out of the eight Moody's credit-rating categories, while the federal government was virtually default free (e.g., Landon and Smith, 2000).

This homogeneity of federal and provincial bond returns, in the face of

significant variability of credit ratings, suggests that market participants systematically underplay agencies' risk assessments and/or the risk factors that drive these agencies' assessments. A plausible explanation for this behavior might be ascribed to the market's expectations of an implicit federal guarantee for provincial debt. In fact, granted that market agents perceive the federal government as last-resort guarantor for provinces in financial distress, default risk becomes negligible for provincial bonds. Consequently, return spreads between federal and provincial bonds should be small, as it is in fact documented by our empirical analysis.

The market's expectation that a national government would guarantee debt issued by the subnational authorities has important implications for the creditworthiness of the entire federation. In fact, if on the one hand the implicit bailout provision lowers the price of borrowing for subnational jurisdictions, on the other it creates a governance problem. This is because whenever the federal government is the guarantor for each subnational government, then the level of debt securities issued by one subnational government influences the creditworthiness of the entire federation (Landon and Smith, 2000, 2007). Of course, in good times only the positive effect of this credit spillover might be appreciable, such as the low cost of financing provincial debt, which in turn implies negligible spreads between federal and provincial bonds.

Because no Canadian province defaulted on its debt during the years covered by the available database, an event-study approach (e.g., Burnie, 1994),

aimed at quantifying market expectations for a federal intervention by means of an analysis of federal and provincial bond spreads before and after a significant credit event, is clearly not applicable. However, a possible avenue for the measurement of these expectations might be offered by the returns of Canadian government bonds over 2008 and 2009. The creditworthiness spillover documented by Landon and Smith (2000, 2007) suggests that a worsening financial standing for one or a handful of provinces, coupled with a contraction of federal revenues, might affect the creditworthiness of all provinces. In this case, we should observe a sharp rise in the federal/provincial bonds' return spreads *for all provinces*, regardless of their level of financial distress, as investors revise their expectations of the eventuality and extent of federal bailout provisions.

7 Appendix A

This appendix replicates some of the statistics reported in Sections (3) and (4) using a different definition of maturity bands. Presently, short-term bond have maturities between one and four years while medium-term bonds have maturities that fall between five and ten years. Long-term bonds are defined as maturities of 11 years or longer. Tables 9 and 10 replicate Table 2 and 3 respectively. Table 11 reports the correlation within maturity bands between EW indexes of federal and pooled provincial bonds

	Average	S.D.	Number	Volume %
Short Term	7.07	9.78	92	30
Medium Term	8.46	14.54	139	44
Long Term	10.02	23.67	72	26

Table 9: Federal Bonds

	Average	S.D.	Number	Volume %
Short Term	8.61	10.92	5	$\leq 1\%$
Medium Term	9.73	16.97	176	61
Long Term	11.22	23.17	129	39

Table 10: Provincial Bonds

8 Appendix B

This appendix reports the results of the tests for spanning when provincial bonds are represented by individual bonds rather than EW portfolios as in Section 5.

For all provinces, the rate at which the hypothesis of spanning H_{01} fails to be rejected is much lower than that reported in Table 8. In contrast, the frequencies with which data do not reject the hypothesis of Sharpe ratio equality are comparable to those reported in the same table, as are those associated with the tests for spanning with short-selling restrictions.

While we expect that the use of disaggregated data would provide some evidence of the merits of portfolio diversification, it is remarkable that, for

Short Term	0.89
Medium Term	0.97
Long Term	0.95

Table 11: Correlation EW Federal and Provincial, Average

	H_{01}	H_{02}	Short Selling
NS	0.78	0.92	0.99
PE	0.50	0.53	0.82
AB	0.51	0.89	0.74
MN	0.54	0.78	0.81
NF	0.52	0.81	0.84
SK	0.79	0.87	0.82
ON	0.46	0.90	0.95
NB	0.38	0.71	0.88
BC	0.45	0.72	0.91
PQ	0.54	0.82	0.94

Table 12: Spanning Tests Per Province, Individual Bonds

most provinces and windows, these benefits turn out to be insignificant. After all, for a rejection of the hypotheses of spanning to occur, it suffices that only *one* provincial bond offer some diversification opportunities over the efficient portfolios of federal debt instruments.

The results of the tests for the equality of the Sharpe ratio inform us that diversification gains, when significant, are to be ascribed to a decrease in the level of unavoidable risk, rather than to improvements of the return in risk-bearing. This is consistent with what we find when relying on EW portfolios of provincial bonds as we did in Section 5. Lastly, the results reported in Table 12 indicate that taking into account short-selling restrictions strongly weakens the strength of these gains.

This appendix shows that the use of disaggregated data does not alter our conclusions. Provincial bonds fail to offer significant portfolio diversification gains from the perspective of investors holding a portfolio of federal debt

instruments. The empirical evidence is particularly compelling when short-selling restrictions are taken into consideration.

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