

# **Evidence on inflation expectations from Canadian real return bonds**

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## Summary

Starting with the UK in 1981, many of the industrialized countries have issued long-term bonds whose principal value is indexed to the rate of inflation. One of the benefits that economists predicted from issuing such bonds is that the difference between the yield on indexed and nominal bonds would be an indicator of the market's expectations of inflation. This could be a useful guide for central banks in judging the success of their monetary policy in stabilizing the inflation rate.

This paper examines the data from Canada, which began issuing indexed ("real return") bonds in 1991. It is found that it is possible to explain the relationship between real and nominal bonds with very small residuals, using a moving average of historical inflation and the US bond yield as explanatory variables.

The implication is that expectations in the nominal bond market are adaptive rather than forward looking. Therefore, while we are able to infer the market's expectations of inflation with a high degree of precision, this is not actually very useful as a guide to monetary policy or predicting future inflation.

## Introduction

Many economists have advocated inflation indexed bonds as a financial instrument that would contribute to economic efficiency. Early proponents such as Bossons (1974) argued that indexed bonds would provide savers and borrowers with an instrument that eliminates most of the risk associated with uncertain inflation, and therefore eliminates the cost of the risk premium.

With indexed bonds, the coupon rate represents a real interest rate. The principal value of the bond grows in line with a price index. Therefore, the real value of the principal returned to the lender twenty or thirty years later is the same as it was when the money was first borrowed. The interest payment each year is made on this rising value of principal, so the borrower's real cost of borrowing is also the same year after year.<sup>1</sup>

The United Kingdom was the first OECD country with a regular program of issuing indexed bonds, beginning in 1981, followed by several other countries, including Canada in 1991.<sup>2</sup> In both the UK and Canada, indexed bonds fulfilled the promise of their advocates. They were first introduced in periods of relatively high inflation, followed by substantial disinflation. The borrowing rate on nominal interest bonds at the time was quite high. The use of indexed bonds allowed the governments of the UK and Canada to pursue anti-inflationary policies without being penalized with extraordinarily high ex-post real interest rates on their long-term borrowings.

### **Is the difference between nominal and indexed bonds a guide to expectations?**

One of the secondary benefits that had been anticipated by the advocates of indexed bonds, as noted by Hetzel (1992), was as a way to help the central bank gauge expectations of inflation. He argued that the difference between the yield on nominal interest and real interest bonds would be a good approximation of the expected inflation rate. This has been a view held by academic economists, but practitioners have always been more skeptical. Hetzel himself quotes one of these:

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<sup>1</sup>By contrast, with regular bonds there is a higher nominal bond yield which attempts to account for the depreciation of the real value of the principal due to inflation. The annual interest payments are the same each year, which means that the real value of the payments diminishes each year when there is inflation. Borrowing costs are front end loaded, which creates an especially high burden on capital intensive projects in periods when there is high inflation and high nominal bond yields.

<sup>2</sup>The Canadian Government refers to them as "real return bonds." There are four issues outstanding currently, with maturities in 2021, 2026, 2031 and 2036. They represent about 6 percent of the value of Government of Canada marketable bonds.

“In an article in the *Financial Times* (April 29, 1991), Anthony Harris stated that the ‘gap has tracked current inflation faithfully, but has no forecasting value at all ... The market forecasts the way a picnicker does – by looking out of the window.”

While Hetzel was quick to dismiss this argument, the analysis below will suggest that Harris’s view was not so far off the mark.

The value of indexed bonds as a guide to future inflation was analyzed in considerable detail in a paper by Dudley et al (1996, 29), economists at Goldman Sachs. They argued that the difference between the yields on nominal and indexed bonds would be distorted by random fluctuations in the demand for different kinds of bonds:

“Even in the long run, the signal generated by relative shifts in nominal versus inflation-indexed bonds will be distorted by shifts in the size of the risk premia embedded in inflation-indexed versus nominal bonds .... changes in the risk premia embedded in inflation-indexed bonds will cause changes in inflation-indexed bond yields that have nothing to do with changes in real interest rates.”

About five years after real return bonds arrived on the scene in Canada, this issue was examined by Côté et al (1996), and they voiced concerns similar to those expressed by Dudley. They found that the difference could provide some insight into changes in the trend of inflation expectations, but that the results had to be interpreted with caution, due to factors such as the illiquidity of real return bonds and the unknowable risk premium on nominal bonds. These authors did not attempt any econometric analysis, which is not surprising considering the short history available at that time.

However, now that we have nearly 12 years of data on yields from real return bonds, it might be fruitful to undertake some econometric analysis. The caveats noted by Côté et al still apply. If there are major fluctuations in risk or liquidity premia, these will show up as noise in the time series, reducing the significance of the fit. However, as it turns out, it is possible to find quite a good fit, which suggests that these factors are not empirically important.

### **The historical relation between yields and inflation**

Before turning to an examination of the recent history of the indexed bond yield, it is useful to look at the broader history of bond yields. A simple graphical examination of the data reveals a strikingly close relationship between bond yields and past inflation.

In earlier studies, I put forward a very simple model for predicting long-term bond yields, suggesting that they were very closely correlated with a moving average of the inflation rate over the past ten years. Spiro (1989, 106) and Spiro (1994, 17) presented long-term graphs showing this correlation for the United States and Canada, respectively.

This “model” has certainly proven itself in out-of sample forecasting now that we have another decade’s worth of data to add to it. In Figure 1, an “out-of-sample forecast” line is included, covering the years from 1993 to 2002. This is the forecast produced by a regression over the years from 1960 to 1992, with the ten year moving average of CPI inflation as the only explanatory variable.

This simple regression very closely predicts the trend of the Canadian government long-term bond yield. It is worth emphasizing that this is a true out-of-sample forecast, in the sense that the model was not designed after the data for 1993 to 2002 were already known.

As Spiro (1994) predicted, bond yields were very slow to adapt to Canada’s very low inflation rate. The CPI inflation rate averaged only 1.8 percent from 1993 to 2002, but the bond market, with its eye on the past, “expected” more than this through most of the 1990s. The result was very high ex-post real returns for lenders, and high real costs for borrowers.

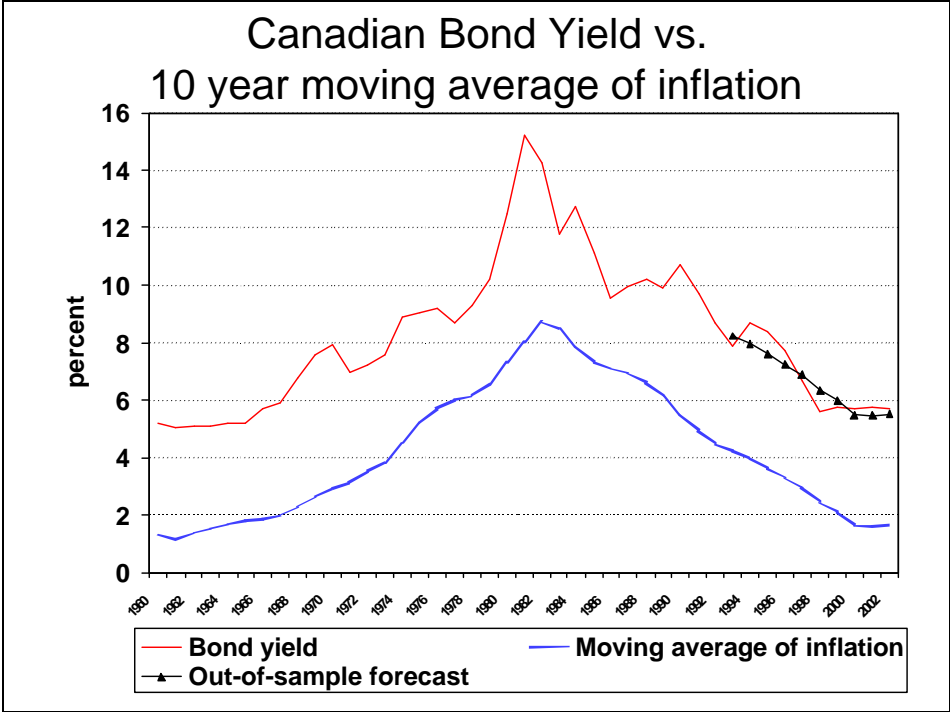


Figure 1

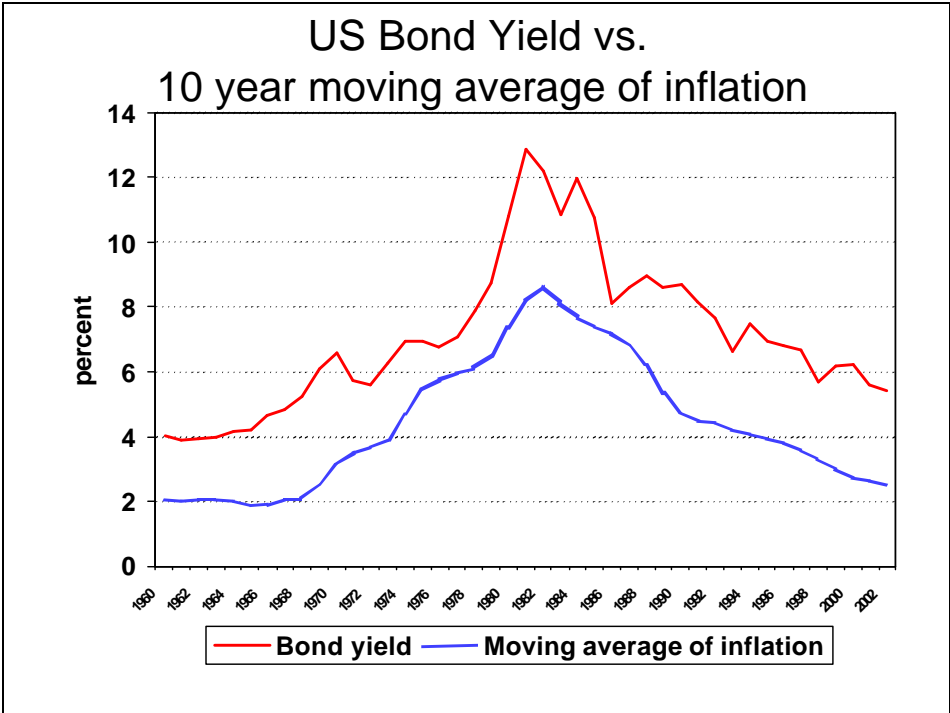


Figure 2

The pattern found in Figures 1 and 2 clearly supports an adaptive model of inflation expectations, as opposed to any plausible version of rational expectations. In adaptive expectations, the expected future value is based on an average of the current and past values of the variable, with no attempt to factor in new information such as changes in the policy regime. Huh and Lansing (2000), in constructing a model of disinflation for the United States, found that only the assumption of adaptive expectations could explain the history of the long-term nominal interest rate.

The majority view in the academic economics community probably still leans towards the view that expectations are rational, although there is an increasing number of doubters.<sup>3</sup> Based on the evidence here, it takes a considerable leap of faith to suppose that expectations of inflation in the long-term bond market in North America were rationally formed.

Over more than four decades, the bond market appears to have always based its expectations of future inflation on the average inflation of the past ten years, without regard to major and fairly obvious changes in monetary policy. Moreover, this expectation was usually seriously mistaken. Throughout the period when inflation was rising, real returns for bond investors were negative, while the reverse happened when inflation was falling, and borrowers ended up paying exorbitantly high real interest rates.<sup>4</sup>

This backward looking behaviour in the bond market began only in the 1960s. From the 1920s to the 1950s, the bond market ignored the inflation or deflation that had occurred over each of the past decades, perhaps because it was obvious that such volatility was not likely to become the start of a trend. In the second half of the 1950s, the bond market displayed a rare period of prescience, with bond yields rising from 3 percent in 1954 to 5 percent in 1959, even though the recent trend of inflation had been downward.<sup>5</sup> This correctly anticipated the much higher inflation of the 1960s.

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<sup>3</sup>Shiller (2003) goes so far as to describe the rational expectations view as “wishful thinking” on the part of its early proponents. Evans (1998) provides considerable quantitative evidence which call into question, but do not definitively rule out, the rationality of inflation expectations in the UK bond market.

<sup>4</sup>This unexpected surge in real borrowing costs is one of the main sources of the stranded debt carried by the electric utility sector.

<sup>5</sup>However, there were special factors at work in this period. From 1942 to 1951, the Federal Reserve regularly bought long-term Treasury bonds, with the goal of keeping the yield below 2.5 percent. (“Issues for Monetary Policy,” Speech by Federal Reserve Chairman Alan Greenspan to the Economic Club of New York, New York City, December 19, 2002.)



As noted, it is hard to claim that the bond yield behaviour observed historically is rational, unless one believes that the past history of inflation is the best possible predictor of future inflation. At the same time, this behaviour does not violate the principle of market efficiency. The change in the bond yield in period  $t$  does not give us any ability to predict its value in period  $t+1$ . The model discussed here implies that the only way to predict the bond yield in  $t+1$  is to predict the inflation rate at  $t+1$ .

## **Comparing Canada with the United Kingdom**

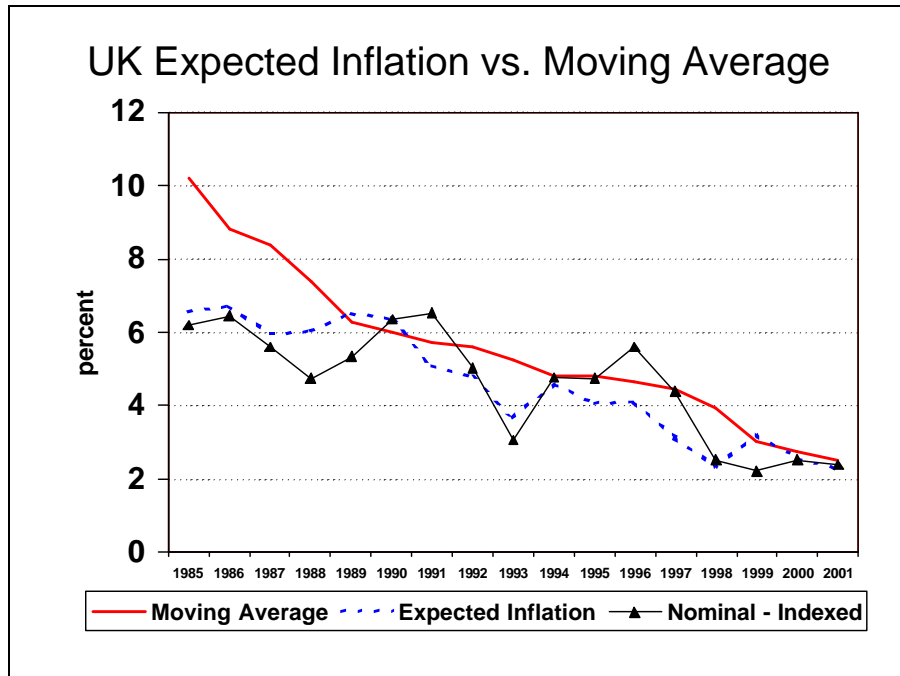
The United Kingdom has the longest experience with inflation-indexed bonds, starting in 1981. There, the expectations of inflation appear to be somewhat less anchored to past rates than in North America. The inflation expectation implied by the nominal-real difference was well below the ten year moving average of historical inflation throughout the 1980s, and mainly below it in the 1990s as well. However, part of the reason for this may be the extraordinarily high inflation there in the 1970s, reaching as high as 25 percent per year, considerably higher than what was experienced in North America. This very high inflation was included in the moving average as of the early 1980s, and it was perhaps easier for investors to dismiss it as an aberration. Another difference is that the inflation data plotted for the UK do not exclude energy prices.<sup>6</sup>

The Bank of England regularly publishes figures for the expected rate of inflation derived from the difference between regular and inflation indexed bonds, until recently using a methodology described by Deacon and Derry (1994). The values of this expectation series for the ten year horizon are plotted in Figure 3, along with the moving average of the previous ten years' rate of inflation. This expected inflation rate closely follows the trend, suggesting that it is adaptive, but it is usually slightly lower than the ten year moving average.

The difference between the nominal and indexed bond yield in the UK is also plotted in Figure 3 for comparison (data for December of each year). It too has followed the trend of the ten year moving average of the inflation rate.

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<sup>6</sup>The inflation rate is the "all items" retail price index CZBH from [www.statistics.gov.uk](http://www.statistics.gov.uk). An index excluding food and energy does not seem to be available for the UK. For Canada and the US, the inflation data plotted in Figures 1 and 2 exclude food and energy prices, which are more volatile. (For Canada, since 1984, the data also exclude indirect taxes.)



**Figure 3**

Looking at the UK experience, Breedon and Chadha (1997) found that the inflation expectation implied by the nominal and indexed bond difference usually over-predicted future inflation by a large margin. They suggest that it could either be due to a bias in the market's expectations or due to a risk premium in the nominal bond yield. They note, however, that "the size of overprediction seems very large for an inflation risk premium."

Further analysis by Breedon and Chadha (2003) suggests that the risk premium is unlikely to be significantly more than 50 basis points.<sup>7</sup> They note (77) that "the inflation term structure overpredicts the level of inflation by an average of around 200 bp." In this study, the authors also compare the forecast of inflation derived from the bond market with published forecasts of inflation by economists and other market participants. They find that the term structure was relatively good at predicting year to year changes in the inflation rate, and they remain agnostic about whether biased inflation expectations account for the excess returns in the nominal bond market relative to the indexed bond market.

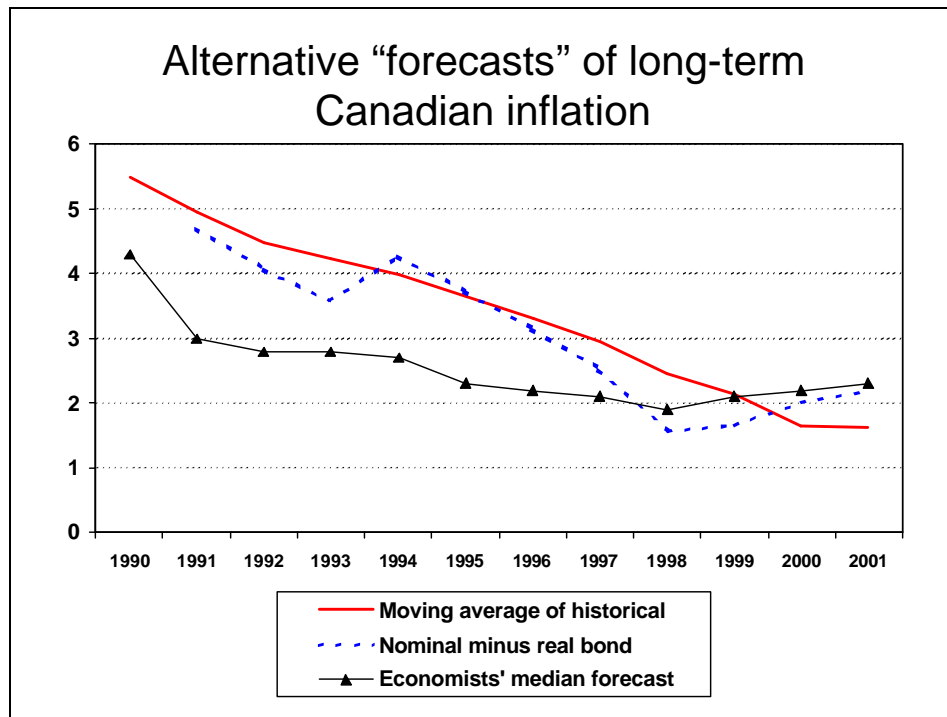
The published UK forecast data available to Breedon and Chadha had a maximum forecast horizon of only four years. Since these are long-term bonds, it is more

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<sup>7</sup>Evans (2003) takes a contrary view, arguing that the risk premium in the UK is large and variable, sometimes exceeding 100 basis points. Evans points out that the risk premium may fall as the expected inflation rate rises, so increases in the nominal-real spread can understate the expected rate of inflation.

interesting to compare them to forecasts by economists over a much longer time horizon. In Canada, an actuarial consulting firm conducts an annual survey of forecasters, asking them for their prediction of key economic and financial variables over a 15 year time horizon.<sup>8</sup> Figure 4 compares the results from this survey to the bond market's implicit forecast.

Until the late 1990s, the bond market's implicit forecast was persistently higher than the economists' forecasts. Since these are long-term forecasts, we cannot yet compare their accuracy against the actual outcome of inflation. However, if we now accept the Bank of Canada's target inflation rate of 2 percent as the best forecast of the long term, then clearly the economists' forecasts beginning in 1991 were considerably better than the bond market's. This evidence creates a strong presumption that expectations in the Canadian bond market during this period were backward looking.



**Figure 4**

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<sup>8</sup>This survey is now in its 22<sup>nd</sup> year. It was originally conducted by KPMG, but this firm has been taken over by Watson Wyatt. More information can be found at <http://www.watsonwyatt.com/canada-english/research/resrender.asp?id=CA-033&page=1>

## Explaining the relationship between nominal and indexed bond yields in Canada

The historical evidence in the previous section created a strong presumption that adaptive expectations, as represented by the moving average of past inflation, dominate the nominal bond yield. In this section, I will turn to examining what is revealed by the data on inflation-indexed (real return) bonds in Canada since 1991.

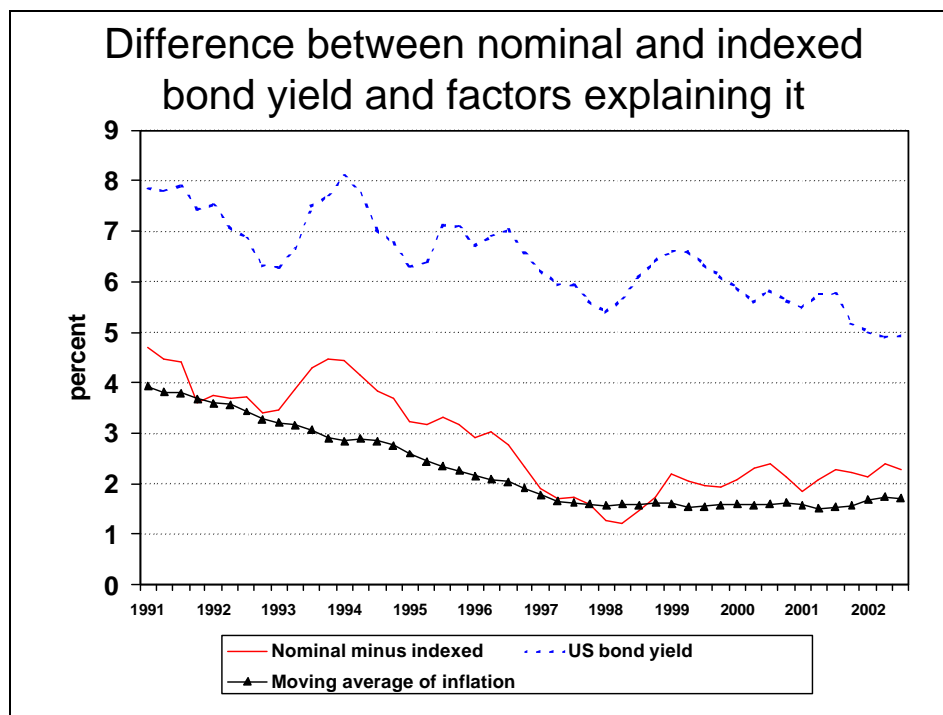


Figure 5

The yield on nominal bonds minus the yield on indexed bonds is depicted in Figure 5. When indexed bonds were first introduced in 1991, their yield was almost 5 percentage points lower than nominal bonds. This difference declined to bottom out at just over 1 percentage point in 1998. It bounced back to 2 percentage points in 1999, and has remained close to that level ever since.

In broad terms, the difference between the nominal and indexed bond followed the declining trend of the moving average of inflation, which is also plotted alongside it.<sup>9</sup> However, there have been some substantial deviations. It can be seen that these

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<sup>9</sup>In figure 5, the line depicts a seven year moving average of inflation, as opposed to the ten year moving average used in Figures 1 and 2. There is not a lot of difference between the seven year and ten year averages. However, in the regression analysis for the 1991-2003 period, it was found that using a seven year average gave the highest t-statistics.

deviations are closely correlated with fluctuations in the US government bond yield, which is also plotted in Figure 5.

Canadian nominal bonds closely follow major moves in the US bond market, whereas Canadian indexed bonds are less sensitive to the US market. This accounts for some of the larger changes in the nominal minus real difference, such as the big increase in 1994 and the big drop in 1998.

If anyone ever doubted it previously, the history of the 1980s and 1990s shows that Canada has an independent monetary policy which determines its own inflation rate. Therefore, when Canadian bonds follow a large swing in the US bond yield, it is not because of a sudden change in the expected inflation rate in Canada.

It is noteworthy that real return bonds do not follow these large swings. The people who invest in them presumably have a longer time horizon. These bonds are much less liquid, and therefore there are not very many speculators buying or selling real return bonds to try to anticipate short-term swings in value.

### **Econometric analysis**

The adaptive expectation appears to explain the difference in the trend between the nominal and indexed bond yield, but that does not tell us if these expectations are held by nominal bond investors, indexed bond investors, or both.

Two alternative hypotheses are possible about the relationship between the real bond yield, the nominal bond yield, and the expected inflation rate.

**Hypothesis I:** Nominal bond yield minus the adaptive expectation of inflation determines the yield on real return bonds.

Here,  $R_N = c + aE_R$  and  $R_R = R_N - bE_A$

where  $R_N$  is the nominal bond yield;  $E_R$  is the rational expectation value of inflation;  $R_R$  is the yield on real return bonds; and  $E_A$  is the adaptive expectation of inflation based on its historical moving average.

**Hypothesis II:** Nominal bond yield is determined by the real rate, the adaptive expectation of inflation, and speculative factors related to market volatility, denoted  $S$ .

Here,  $R_N = c + aR_R + bE_A + dS$ .

The relative independence of the real return bond's yield from US bond market speculative fluctuations is the key difference between it and the nominal bond yield. It is

the identifying element that can give us a reasonable degree of confidence that the adaptive expectations of inflation are at work in the nominal bond market. In the absence of this, one could suggest that expectations are rational in the nominal bond market, while it is investors in the real return bond market who have adaptive expectations.

In fact, the regressions strongly support Hypothesis II, that the nominal bond yield is the sum of the indexed bond yield plus the adaptive expectation of inflation. They tend not to support the opposite view, that the indexed bond yield is the nominal bond yield minus the adaptive expectation of inflation.

Table 1 presents regression results, with either the real return bond or the nominal bond yield as the dependent variable. The explanatory variables are:<sup>10</sup>

- The other bond yield – e.g., when the nominal bond yield is the dependent variable, the real return bond yield is one of the explanatory variables.
- The moving average of the CPI inflation rate.<sup>11</sup> Through experimentation, it was found that a seven year moving average maximized the t-statistic.
- The change in the US long-term bond yield.<sup>12</sup>

The bond yields and the inflation variable are all non-stationary, producing low Durbin-Watson statistics and raising the possibility of spurious correlation. Two different approaches were used to account for this. In two of the equations, an ARMA correction is used to eliminate autocorrelation.<sup>13</sup> (The regressions without these corrections are also included for comparison.)

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<sup>10</sup>Spiro (1990) notes that high government deficits could contribute to the expectation of inflation, due to the possibility of monetization. The value of government debt issued (as a percentage of GDP) was tried as an explanatory variable, but its t-statistic was only 0.2.

<sup>11</sup>The data used are for the CPI excluding food, energy, and indirect tax changes.

<sup>12</sup>The US has had a downward trend of inflation similar to Canada's. Including the level of the US bond yield as an explanatory factor for the Canadian bond yield would create an element of spurious correlation, given that we believe that Canadian monetary policy independently determines the Canadian inflation rate.

<sup>13</sup>Once this correction is made, the residuals become non-stationary, passing the ADF test at the 1% critical level, suggesting that the variables are cointegrated. The Johansen test also supports cointegration, with a trace statistic of 95.6, well above the 1% critical value of 47.2.

Taking first differences renders all the variables stationary,<sup>14</sup> and two of the regressions are estimated in this form. Essentially the same conclusions arise in this specification.

**Table 1. Regression results, relationship between nominal and real return bond yields**

Dependent variable	Constant	Moving average of inflation	Change in US bond yield	Nominal yield	Real yield	AR1	MA1	DW	Adjusted R <sup>2</sup>
Nominal yield	0.63 (1.8)	1.18 (4.6)	0.28 (3.9)		0.90 (5.0)	0.79 (6.7)	0.25 (1.4)	1.92	0.98
Nominal yield	0.41 (0.7)	1.15 (12.1)	0.30 (3.9)		0.96 (5.9)			0.30	0.93
Nominal yield*	0.03 (0.8)	1.03 (2.6)	0.60 (6.6)		0.71 (4.5)			1.66	0.75
Real yield	1.50 (3.0)	-0.22 (-1.0)	-0.01 (-0.2)	0.44 (5.1)		0.78 (6.1)	0.30 (1.6)	1.93	0.92
Real yield	1.56 (5.2)	-0.31 (-2.4)	-0.05 (-0.9)	0.47 (5.9)				0.30	0.71
Real yield*	-0.03 (-1.1)	-0.68 (-2.1)	-0.07 (-0.7)	0.46 (4.5)				1.67	0.48

All regressions based on quarterly data, 1991:4 to 2003:2. *t*-statistics in parentheses.

\*Denotes a regression where all variables were first-differenced. In the other regressions, the change in the US bond yield was from four quarters earlier.

It can be seen that the moving average history of inflation is significant, with a coefficient close to 1 in the regressions in which the nominal bond yield is the dependent variable, while it is well below 1 in the ones in which the real bond yield is the dependent variable. Similarly, the US bond yield is significant in the equations for the nominal bond, but not the real return bond.

Based on these regressions, it is reasonable to conclude that the yield on the real return bond is a good proxy for the underlying real yield expectation in the nominal bond market. The fluctuations in the risk premium appear to have been mainly in the nominal bond market. Moreover, these fluctuations appear to have been largely independent of Canadian factors, as they are highly correlated with changes in the US bond yield.

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<sup>14</sup>After differencing, the ADF test rejects a unit root at the 1% level of the Mackinnon critical value for all three bond yields, and at the 5% level for the moving average of inflation.

Results from a vector autoregression model are shown in Table 2. This estimation also confirms the significant influence of the moving average of inflation on the nominal bond yield, and its lack of influence on the real return bond's yield. Here, the lagged dependent variables are included, which makes the coefficients on the exogenous variables smaller.

**Table 2. Vector Autoregression Estimates**

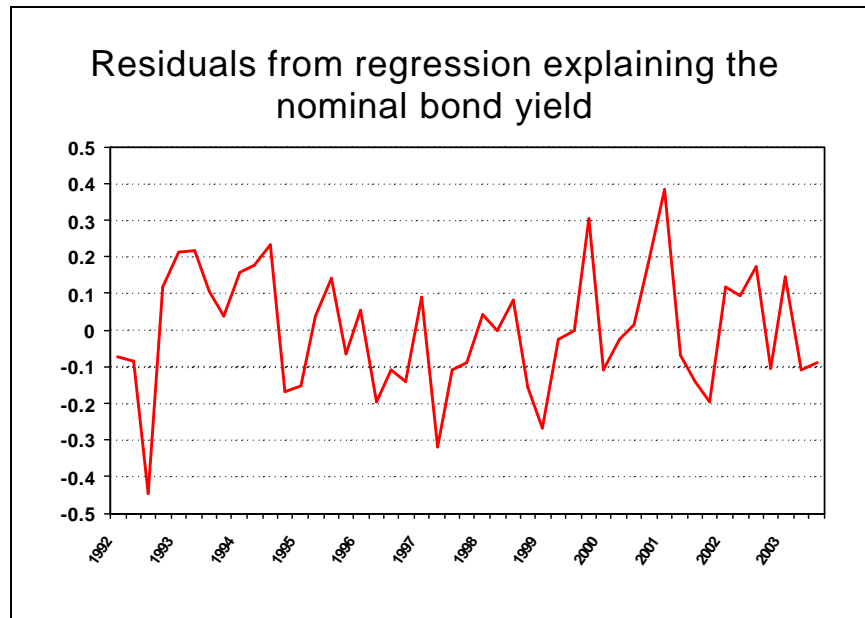
Sample(adjusted): 1992:2 2003:2		
t-statistics in [ ]		
	Nominal	Real
Nominal(-1)	0.87 [ 3.84 ]	0.00 [ 0.01 ]
Nominal(-2)	-0.07 [-0.33 ]	0.04 [ 0.27 ]
Real(-1)	-0.37 [-1.08 ]	0.89 [ 3.99 ]
Real(-2)	0.17 [ 0.45 ]	-0.14 [-0.57 ]
C	1.31 [ 2.51 ]	0.57 [ 1.65 ]
Moving average of inflation	0.41 [ 2.82 ]	0.06 [ 0.61 ]
US rate - US rate(-4)	0.23 [ 3.38 ]	0.07 [ 1.45 ]
Adj. R-squared	0.95	0.84
Sum sq. resids	3.25	1.42
S.E. equation	0.29	0.19

It cannot be denied that the inferences made here are from a relatively short history of the real return bond in Canada. In other periods, behaviour could become quite different.

Based on the data observed here, it appears that the risk/illiquidity premium on real return bonds has changed very little over this period. On theoretical grounds, the warning by Dudley et al (1996) that this premium can change substantially is certainly a valid one, but in practice it appears not to have been a problem.



If there had been large, persistent variations in the risk premium on real return bonds, intrinsic to that market, it would have left a large unexplained residual in the regression for the nominal bond yield. In that case, we would have been left with the possibility that there are substantial fluctuations in the expected inflation rate underlying the nominal bond yield, which are not explained by the past history of inflation. In fact, the residuals (plotted in Figure 6) are quite small, rarely exceeding 25 basis points in absolute value.<sup>15</sup>



**Figure 6**

In a different bond market or policy environment, there might have been major significant deviations in the expectation of inflation, which could not be approximated by the adaptive expectation based on the moving average of past inflation. If that had been the case, it is quite possible that there would have been no way for us to know that these were not due to fluctuations in risk premia, as Dudley warned. However, in Canada in the 1990s, inflation expectations appear not to have had much variation around their trend value.

## Conclusions

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<sup>15</sup>The residuals in Figure 6 are from regression using first differences in Table 1. The standard deviation of the residuals is 0.17 (17 basis points on the value of the bond yield). Even without ARMA correction, the standard deviation is only 0.36.

There have been two main schools of thought about the usefulness of indexed bonds as a guide to monetary policy. The optimistic school, typified by Hetzel (1992) argued that the difference between nominal and indexed bond yields was a good guide to expectations of future inflation.

The other school, typified by Dudley et al (1996), argued that the difference between these two types of bonds would be dominated by changing views about liquidity and risk premia, and therefore would not be a reliable guide to the expected future inflation rate.

The analysis in this paper, based on twelve years of experience with indexed bonds in Canada, has found that neither of these views quite hits the mark.

Contrary to Dudley's concern, it has been possible to find an econometric relationship between the yield on nominal and indexed bonds, with unexplained residuals that are very small. Large fluctuations for reasons intrinsic to the indexed bond market have not occurred.

However, while Hetzel appears to have been right that the difference between these two bonds would show the market's expectation of inflation, the nature of that expectation proved to be considerably less helpful than he had hoped.

The reason for this is that the Canadian nominal bond market appears to be persistently backward looking. The difference between nominal bonds and indexed bonds is best approximated by the average inflation over the past seven to ten years.

The finding that expectations of inflation are adaptive and backward looking suggests that this difference is not useful as a guide for monetary policy. If the Bank of Canada, at some time in the future, makes a major mistakes that causes long-term inflation to deviate significantly from the target rate of 2 percent, the bond market would be the last to know about it. Based on past performance, the likelihood is that the bond yield would remain anchored to the past history of inflation, and would respond to the change in inflation only with a very long lag.

While this finding is backed up by over forty years of history, there remains a possibility that behaviour will change in the future. As noted before, prior to the 1960s, the history of inflation was trendless, and expectations of inflation embedded in the bond yield were not backward looking. If inflation stays low and stable, we will once again have a history of trendless inflation, and the bond market may come to focus more on the analysis of current monetary policy to predict future inflation.

## Data Sources

Canadian data are all from Statistics Canada's CANSIM database, with the following series identifiers:

v122553	Real return bond yield
v122544	Government of Canada benchmark bond yields: long term
v36397	Consumer price index excluding food and energy

The US bond is the yield on 20 year constant maturity Treasury bonds, from the Federal Reserve Board database at <http://www.federalreserve.gov/releases/h15/data.htm>

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