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THE OCTOBER 1979 CHANGE IN THE MONETARY REGIME: ITS IMPACT ON THE "FORECASTABILITY" OF INTEREST RATES

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ABSTRACT

Subsequent to the October 1979 shift in monetary policy in the United States, interest rates in North America not only reached unprecedented levels, but also exhibited unprecedented volatility. This paper shows that the anticipated quarterly changes in long-term rates associated with the rational expectations model have remained small during this post-shift period. Recorded forecasts of long-term interest rates in Canada continue to prove inferior to the no-change prediction of the martingale model. The "perverse" relationship between the slope of the yield curve and the subsequent movement in long-term rates exists in the Canadian data, but is of only modest value in a forecasting context. The excess return on long-term bonds implicit in the recorded forecasts of the level of interest rates varies sharply, yet there is no evidence that forecasters have identified a predictable component of a time-varying term premium.

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I. Introduction

In October 1979, the Federal Reserve implemented a new policy of targeting monetary aggregates rather than interest rates. Subsequent to this apparent change in the conduct of monetary policy, interest rates in the United States not only reached unprecedented levels, but also exhibited unprecedented volatility.[1] Reflecting the close linkages between the U.S. and the Canadian capital markets, interest rates in Canada exhibited similar behavior.[2]

One element of the October 1979 change in the monetary regime that is as yet unexplored is its impact on the "forecastability" of interest rates. Two theoretical points are now well known. First, Sargent (1976) and Pesando (1978) have shown that under the joint hypothesis of market efficiency and a time-invariant term premium, short-term movements in long-term interest rates will be inherently "non-forecastable," at least so long as the yield curve is reasonably flat. Under this rational expectations model of the term structure, agents without access to inside information will not be able to improve upon the no-change prediction of the martingale model. Secondly, as emphasized by Pesando (1979), there is nothing in the theory of efficient markets to suggest that agents cannot outperform the no-change prediction in their forecasts of short-term movements in short-term interest rates.

The unprecedented levels and volatility of interest rates make timely an investigation of two <u>empirical</u> questions. First, have the anticipated quarterly changes in long-term interest rates remained sufficiently "small" that the no-change prediction continues to characterize accurately the rational expectations model? Secondly, have forecasters been able to outperform the no-change prediction in this environment of volatile interest

rates? If time-varying term premiums have become more important, as alleged by many participants in the capital market, then short-term movements in long-term interest rates may have a significant "forecastable" component, even if the bond market is informationally efficient.

Further, there is an "awkward fact" regarding the slope of the term structure and the subsequent movement in long-term interest rates that merits attention in the forecasting context. When the term structure has a positive slope (that is, when the long-term rate exceeds the short-term rate), the prediction of the rational expectations model is that the long-term rate will subsequently rise. The anticipated capital loss is necessary to equalize the holding-period return on short- and long-term bonds, up to the time-invariant term premium. Yet, as Shiller (1979) has emphasized, on the basis of interest rate data drawn from both the United States and the United Kingdom, the empirical relationship appears to be the opposite. Under the null hypothesis of market efficiency, the implication is that a time-varying term premium does exist and is positively related to the slope of the yield curve. The quantitative importance of this relationship, and the question of whether it is reflected in recorded forecasts, merit attention.

Due to the availability of recorded forecasts of both short-term and long-term interest rates in Canada,[3] it is useful to address these empirical questions with Canadian data. This paper is thus organized as follows. First, the post October 1979 data on interest rates in Canada are examined to see if the anticipated quarterly changes in long-term interest rates under the rational expectations model continue to be "small." Secondly, three sets of recorded forecasts of short-term and long-term interest rates are evaluated, using the no-change prediction of the martingale model as a benchmark. To provide an additional perspective, the excess returns on long-term bonds that

are implied by the recorded forecasts are also calculated. Thirdly, the relationship between the future change in the long-term interest rate and the current slope of the yield curve is explored, both before and after the October 1979 shift in policy. The importance of any time-varying term premium so identified is quantified, and used to provide a further perspective on the evaluation of the recorded forecasts. A summary and statement of conclusions completes the paper.

II. Anticipated Changes in Long-term Interest Rates under the Rational Expectations Model

Let $E_t(H_t^{(n)})$ denote the expected return on an n-period bond held during period t, let r_t denote the one-period interest rate at the beginning of period t, and let $\phi^{(n)}$ denote the marginal term premium - assumed to be time-invariant - accorded an n-period bond if held for one period. Then, in its most useful formulation for the present purpose,[4] the rational expectations model requires:

$$E_t(H_t^{(n)}) = r_t + \phi^{(n)}. \qquad (1)$$

Implicit in (1) is the value of the long-term interest rate (now, an $(n-1)$-period rate) expected to prevail at $t+1$. This is the long-term rate which produces the capital gain or loss necessary to satisfy (1). The anticipated change in the long-term interest rate is the difference between this expected long-term rate and its current value.

To calculate the anticipated change in the long-term rate, it is useful to employ the linearized expression for the holding-period yield on long-term bonds $(\tilde{H}_t^{(n)})$ derived by Shiller (1979):[5]

$$\tilde{H}_t^{(n)} = \frac{R_t^{(n)} - \gamma_n R_{t+1}^{(n-1)}}{1 - \gamma_n} \tag{2}$$

where $\gamma_n = \gamma(1 - \gamma^{n-1})/(1 - \gamma^n)$ and $\gamma = 1/(1 + \bar{R})$, and where $\bar{R}$ equals the "normal" long-term interest rate around which the expression for the holding-period yield is linearized. Equations (1) and (2) can be rearranged to yield:

$$E_t(R_{t+1}^{(n-1)}) = (1/\gamma_n)[R_t^{(n)} - (1 - \gamma_n)(r_t + \phi^{(n)})]. \tag{3}$$

The anticipated change in the long-term interest rate under the rational expectations model is thus:

$$E_t(R_{t+1}^{(n-1)}) - R_t^{(n)} = [(1 - \gamma_n)/\gamma_n](R_t - (r_t + \phi^{(n)})). \tag{4}$$

If one has data on an index of long-term interest rates (ideally, a constant maturity index), one can comfortably ignore the change in the maturity of the bond and simply refer to the left-hand-side of (4) as the anticipated change in the long-term rate.

Have the anticipated changes in the long-term interest rate under the rational expectations model remained "small" subsequent to the October 1979 change in the policy regime? Since economists traditionally forecast macroeconomic variables on a quarterly basis, and since recorded data on quarterly interest rate forecasts are available, this is the unit of observation adopted in the remainder of this paper. Data on 90-day Treasury bills and long-term Government of Canada bonds, as well as data on 90-day finance company paper and long-term corporate bonds, permit us to calculate

the anticipated changes in the respective long-term rates. To implement equation (4), we need: (i) to specify the terms to maturity of the respective indexes of long-term interest rates; (ii) to estimate the marginal term premium, and (iii) to choose the "normal" long-term rate around which to linearize the expression for the holding-period yield.

For both the Canada and the corporate bonds, the term to maturity is 17 years or 68 quarters (n = 68).[6] As shown by McCulloch (1975), the marginal term premium approaches the average term premium quite rapidly. The latter - under the rational expectations model - is simply equal to the average spread between the long-term and the corresponding short-term interest rate. During the period 1979:4-1985:3, the spread between the long-term Canada rate and the 90-day bill rate averaged 46 basis points, and the spread between the corporate bond rate and the paper rate averaged 107 basis points. These figures are used to approximate the marginal term premium which appears in equation (4). For the period 1957:1 to 1979:3, these term premiums were set equal to the corresponding spreads of 131 and 133 basis points, respectively.

The average value of the long-term rates rose sharply in the later sample period, from 6.72% and 7.63% to 12.97% and 13.96% for the Canada and corporate bonds, respectively. In light of these sharp increases, it is inappropriate to linearize around the average value of the long-term rates over the combined sample periods. Instead, we linearized around the average values in each of the two subperiods. This raised the value of the term enclosed in square brackets on the r.h.s. of (4) by about 50% in the later sample period.[7] Other things equal, this raises the anticipated changes in long-term rates associated with the rational expectations model by about 50% in this post-shift sample period.[8]

The actual and anticipated changes for the long-term Canada and corporate rates are summarized in Table 1. To focus on the impact of the shift in the policy regime, the results for the period 1957:1-1979:3 are contrasted with those for the period 1979:4-1985:3.

The results indicate that anticipated changes in long-term rates are about three times larger after the shift in the policy regime, yet still relatively small. The mean absolute anticipated change in the long-term Canada rate equalled 6.39 basis points after the shift, compared to 2.10 basis points before the shift.[9] For corporate bonds, the corresponding figures are 7.08 basis points and 2.57 basis points.[10] The maximum anticipated change in the Canada bond rate rose from 6.60 basis points to 17.63 basis points; in the corporate bond rate, from 9.32 basis points to 20.17 basis points.[11]

In spite of the increased size and volatility of the anticipated changes in the long-term rate, these anticipated changes continue to be dominated by the actual changes. For the Canada bonds, the mean absolute value of the actual change in the long-term rate equalled 109 basis points, which is close to twenty times the mean absolute value of the anticipated change. Of particular significance is the size of the variance of the actual changes compared to that of the anticipated changes. The ratio of the latter to the former equalled 0.3% for the Canada bonds, and 0.4% for the corporate bonds. These fractions are lower than the corresponding ones for the earlier sample period. Under the rational expectations model, anticipated and unanticipated changes in the long-term rate must be uncorrelated. Under this model, 99.7% and 99.6% of the variances of the observed changes in the interest rate on Canada and corporate bonds in the post-shift sample period reflect the receipt of new information.

Table 1

Actual and Anticipated Changes in Long-Term Interest Rates in Canada: 1957:1 - 1985:3

Period 1957:1 - 1979:3

	Canada Bonds		Corporate Bonds	
	Anticipated	Actual	Anticipated	Actual
Mean Absolute Change	2.10	26.51	2.57	23.33
Maximum Absolute Change	6.60	127.00	9.32	119.00
Mean Change	0.04	7.04	0.03	6.45
Standard Deviation	2.72	34.84	3.23	30.82

Period 1979:4 - 1985:3

	Canada Bonds		Corporate Bonds	
	Anticipated	Actual	Anticipated	Actual
Mean Absolute Change	6.39	108.67	7.08	113.13
Maximum Absolute Change	17.63	263.00	20.17	316.00
Mean Change	-0.53	2.42	-0.59	2.38
Standard Deviation	7.83	139.39	8.84	145.83

Note: All numbers refer to basis points at annual rates.

III. An Analysis of Recorded Interest Rate Forecasts in Canada

Pesando (1981) examined the recorded forecasts of both short- and long-term interest rates in Canada made by Data Resources Incorporated (DRI) of Canada and the Conference Board in Canada, as well as the means of the quarterly surveys of interest rate forecasts compiled by McLeod, Young, Weir and Company Limited. He found that the no-change prediction of the martingale model outperformed the recorded forecasts of the long-term rates, but not of the short-term rates.

We have updated the recorded forecasts examined in this earlier study, in order to assess the impact - if any - of the October 1979 shift in the monetary regime on the accuracy of the recorded forecasts. Under the rational expectations model, anticipated changes in the long-term interest rate have increased in the post-shift period, suggesting cet. par. that the recorded forecasts of long-term rates are more likely to outperform the no-change prediction. Further, if time-varying term premiums have become more important, then the rational expectations model will be a less satisfactory approximation to reality. If so, the implication - again - is that the recorded forecasts of long-term rates are more likely to outperform the martingale model. As previously noted, there is nothing in the theory of efficient markets to suggest that agents cannot outperform the no-change prediction in their forecasts of movements in short-term rates. The success of the recorded forecasts of short-term rates documented in the earlier paper serves, in the main, to enhance the "credibility" of the recorded forecasts of long-term rates, in spite of the inability of the latter to outperform the no-change prediction.

The root-mean-square errors of the recorded forecasts, both one quarter and two quarters ahead and for the pre- and post-shift sample periods, are

shown in Table 2.[12] Shown also are the root-mean-square errors of the no-change prediction. The martingale forecasts were set equal to the interest rate at the end of the latest month which unambiguously preceded the month in which the recorded forecasts were made. This procedure confers an informational advantage to the recorded forecasts. This advantage typically consisted of about two weeks, but in some cases approached a full month.

On balance, the recorded forecasts fare quite poorly. There is no evidence that the recorded forecasts of the long-term rates are superior to the no-change prediction. Forecasts of the long-term rate (or rates) by DRI and the Conference Board were significantly inferior to the martingale model in the post-shift period, while the accuracy of the survey forecasts compiled by McLeod, Young, Weir is about the same as that of the no-change prediction. The most distinguishing feature of the post-regime results, however, is the deterioration in the accuracy of the recorded forecasts of the short-term rates. For both DRI and the Conference Board, the recorded forecasts of the short-term rate are <u>also</u> inferior to the martingale model.[13]

Financial practitioners often emphasize the ability of forecasters to predict turning points in interest rates as a major - if not the major - criterion in performance evaluation. For portfolio managers, whose relevant decision may be to increase or to reduce the fraction of their funds allocated to long-term bonds, the implicit loss function apparently assigns considerable weight to directional guidance.

The success of the recorded forecasts in identifying turning-points is summarized in Table 2A. The key measure is the fraction of the one-period $(E_t(R^{(n)}_{t+1}) - R^{(n)}_t)$ and two-period $(E_t(R^{(n)}_{t+2}) - R^{(n)}_t)$ forecasts of the change in the long-term rate that are correctly signed. For the combined sample period, the fraction of the one-period forecasts that are correctly signed

Table 2

Recorded Forecasts of Short- and Long-term Interest Rates Versus the Martingale Alternative[a]

Source	Sample	Series	Root Mean Square Forecasting Errors: One Period Recorded	One Period Martingale	Two Period Recorded	Two Period Martingale
Data Resources of Canada	Pre-Shift 1975:2-1979:3	90-day Treasury bills	89.3	82.9	159.5	140.4
		90-day Finance paper	74.9	80.9	142.6	141.5
		Long-term Canada bonds	42.6	37.3	87.0	81.0
		McLeod, Young, Weir 10 industrial bonds	45.7	36.7	90.4	77.2
		McLeod, Young, Weir 10 provincial bonds	38.6	37.0	81.7	79.2
	Post-Shift 1979:4-1985:2	90-day Treasury bills	189.3	179.0	323.5	304.5
		90-day Finance paper	192.9	188.9	333.6	309.1
		Long-term Canada bonds	124.4	110.3	186.0	150.7
		McLeod, Young, Weir 10 industrial bonds	146.8	117.9	202.7	166.7
		McLeod, Young, Weir 10 provincial bonds	146.5	117.8	198.9	160.9
The Conference Board in Canada	Pre-Shift[b] 1975:1-1979:3	90-day Finance paper	81.5	85.6	129.2	134.0
		McLeod, Young, Weir 10 industrial bonds	44.7	37.4	87.6	72.2
	Post-Shift[b] 1979:4-1984:4	90-day Finance paper	167.5	142.3	293.2	277.2
		McLeod, Young, Weir 10 industrial bonds	147.9	112.1	184.2	170.5
McLeod, Young, Weir surveys	Pre-Shift 1974:4-1979:3	90-day Finance paper	98.4	118.0	173.1	178.4
		McLeod, Young, Weir 10 industrial bonds	43.5	45.2	95.0	92.3
		McLeod, Young, Weir 10 provincial bonds	46.7	49.0	99.7	93.8
	Post-Shift[c] 1979:4-1985:2	90-day Finance paper	265.2	282.1	344.8	343.6
	1979:4-1982:4	McLeod, Young, Weir 10 industrial bonds	193.3	191.1	242.3	240.0
	1979:4-1982:4	McLeod, Young, Weir 10 provincial bonds	187.4	194.5	231.6	236.1

a DRI and the Conference Board forecast the average value of the interest rate during the quarter. The realization, in calculating the forecast errors, is set equal to the average value of the interest rate during the quarter to which the recorded forecast pertains. In the McLeod, Young, Weir surveys, it is the end-of-quarter interest rate that is being forecast, and the realizations used are the rates prevailing on the last Wednesday of the quarter for which the forecast is made. Forecast dates for the recorded figures vary within the quarter and are thus not strictly comparable across forecast sources. Forecast errors, in basis points, are expressed at annual rates.

b Observations for 1979:2 and 1981:3 were unavailable.

c Starting in 1983:1, the survey no longer requested participants to forecast the long-term provincial and corporate bond rates.

Table 2A

Success of the Recorded Forecasts in Predicting Turning Points

Source	Sample	Series	Fraction of Forecast Changes that Are Correctly Signed: One-Period Horizon[a]	Two-Period Horizon[b]
Data Resources of Canada	Pre-Shift 1975:2-1979:3	90-day Treasury bills	14/18	12/18
		90-day Finance paper	11/18	11/18
		Long-term Canada bonds	12/18	13/18
		McLeod, Young, Weir 10 industrial bonds	7/18	10/18
		McLeod, Young, Weir 10 provincial bonds	9/18	13/18
	Post-Shift 1979:4-1985:2	90-day Treasury bills	14/23	14/23
		90-day Finance paper	14/23	14/23
		Long-term Canada bonds	12/23	11/23
		McLeod, Young, Weir 10 industrial bonds	10/23	13/23
		McLeod, Young, Weir 10 provincial bonds	10/23	11/23
The Conference Board in Canada	Pre-Shift[c] 1975:1-1979:3	90-day Finance paper	11/18	11/18
		McLeod, Young, Weir 10 industrial bonds	11/18	11/18
	Post-Shift 1979:4-1984:4	90-day Finance paper	14/20	11/20
		McLeod, Young, Weir 10 industrial bonds	12/20	11/20
McLeod, Young, Weir surveys	Pre-Shift 1974:4-1979:3	90-day Finance paper	14/20	15/20
		McLeod, Young, Weir 10 industrial bonds	12/20	13/20
		McLeod, Young, Weir 10 provincial bonds	12/20	13/20
	Post-Shift[c] 1979:4-1985:2	90-day Finance paper	10/23	11/23
	1979:4-1982:4	McLeod, Young, Weir 10 industrial bonds	4/13	7/13
	1979:4-1982:4	McLeod, Young, Weir 10 provincial bonds	4/13	8/13

a $E_t(R^{(j)}_{t+1}) - R^{(j)}_t$.

b $E_t(R^{(j)}_{t+2}) - R^{(j)}_t$.

c Observations for 1979:2 and 1981:3 were unavailable.

ranges from 0.415 (DRI, industrial bond rate) to 0.605 (Conference Board, industrial bond rate). For four of the six sets of forecasts, the direction of change in the long-term rate is predicted correctly less than one-half of the time. This is true in the post-shift period as well as in the combined sample period. In short, there is nothing in the assessment of their directional accuracy to overturn the prior conclusion that the performance of the recorded forecasts is poor.

The fraction of the recorded forecasts of the change in the short-term rate that are correctly signed is higher, in both the pre-shift and the post-shift periods. For three of the four data sets, the direction of change is correctly predicted more than one-half of the time in the post-shift period. However, this appears to be the only - and quite modest - success of the forecasters in predicting short-term rates during the post-shift period.

In spite of their lack of success in the post-shift period, it is instructive to examine two other features of the recorded forecasts. The first is the size of the forecast changes in the long-term rates. If these are large relative to those associated with the rational expectations model, then either those making the forecasts implicitly assume (1) the market is not efficient in its use of information or (2) time-varying term premiums do exist and are "forecastable." Second, it is useful to identify the excess returns (i.e., the holding-period yield on long-term bonds less the corresponding short-term rate) that are implicit in the recorded forecasts. If the market is efficient in its use of information, these excess returns reflect the term premiums anticipated by those making the forecasts. The question of whether these <u>forecast</u> excess returns reflect any systematic component that exists in <u>realized</u> excess returns merits investigation.

The mean absolute values of the forecast changes in the long-term rates are presented in Table 3, for both the pre-shift and post-shift periods. For all three sets of recorded forecasts, these mean absolute changes are far greater than those implied by the rational expectations model. During the post-shift period, for example, the mean absolute changes in the long-term Canada rate forecast by DRI, one and two quarters ahead, were 66.7 basis points and 32.8 basis points, respectively.[14] These forecast changes far exceed the mean absolute change of 6.4 basis points implied by the rational expectations model during this post-shift period.

For all three sets of recorded forecasts, the mean absolute values of the predicted changes in long-term rates are also greater in the post-shift than in the pre-shift period. In effect, this indicates that the forecasters deemed the rational expectations model to fit less well in the post-shift period. The results reported in Table 3 suggest that either forecasters view the market as inefficient in its use of information and/or believe that time-varying (and forecastable) term premiums contribute importantly to the movement in long-term interest rates. If these forecasters believe the capital market to be efficient, the implication is that they assign increased importance to the role of time-varying term premiums in the post-shift period. As noted, this possibility is raised frequently in the financial press.

The large values of the forecast changes in long-term rates correspond to substantial capital gains and losses, and hence to implicit forecasts of holding-period yields on long-term bonds which vary across a wide range. Using the linearized expression for the holding-period yield (equation (2)), we have calculated the implicit forecasts of the holding-period yield on long-term bonds as well as their excess return. The latter equals the forecast holding-period yield less the corresponding short-term rate at the beginning of the forecast period (i.e., $E_t(H_t^{(n)}) - r_t$).

Table 3

Mean Absolute Values of Forecast Quarterly Changes in Long-term Interest Rates

Source	Sample	Series	Mean Absolute Values of Forecast Changes: One Quarter Ahead	Mean Absolute Values of Forecast Changes: Two Quarters Ahead
Data Resources of Canada[a]	1975:2-1979:3	Long-term Canada bonds	22.2	19.4
	1979:4-1985:2		66.7	32.8
	1975:2-1979:3	McLeod, Young, Weir 10 industrial bonds	18.4	14.9
	1979:4-1985:2		75.0	30.5
	1975:2-1979:3	McLeod, Young, Weir 10 provincial bonds	19.8	18.9
	1979:4-1985:2		76.8	31.4
The Conference Board in Canada[b]	1975:1-1979:3	McLeod, Young, Weir 10 industrial bonds	16.1	13.5
	1979:4-1984:4		34.9	20.4
McLeod, Young, Weir, surveys	1975:1-1979:3	McLeod, Young, Weir 10 industrial bonds	16.0	12.5
	1979:4-1982:4		60.9	27.8
	1975:1-1979:3	McLeod, Young, Weir 10 provincial bonds	14.8	11.6
	1979:4-1982:4		62.1	23.0

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a For the DRI and the Conference Board in Canada, the last quarter's value as reported by the forecaster is subtracted from the one-quarter-ahead forecast to obtain the one-quarter-ahead forecast change. For the McLeod, Young, Weir surveys, the base rate reported in the surveys is used. Forecast changes are in basis points at annual rates.

b Observations for 1979:2 and 1981:3 were unavailable.

From Table 3, it is clear that the predicted changes in long-term rates are smaller, and hence the implied capital gains and losses are smaller, in the two-quarters-ahead forecasts. Thus the two-quarters-ahead forecasts of the holding-period yields are likely to vary across a narrower range than the one-quarter ahead forecasts. Because the two-quarter-ahead changes are more precisely measured (since there is no uncertainty about the base rate used in their construction), it is useful to focus on the two-quarter-ahead forecasts of holding-period yields and excess returns. If their variation is large, so must be the variation in (the less precisely measured) one-quarter-ahead forecasts.

These two-quarters-ahead forecasts are presented in Table 4. Note that the variation in predicted holding-period yields and excess returns is large, especially in the post-shift period. Consider, again, the DRI forecast of the long-term Canada rate. In the pre-shift period, the implied forecast of the quarterly holding-period yield on long-term Canada bonds has a mean of 12.82%, and a range of -0.94% to 27.53%. In the post-shift period, the implied forecast has a mean of 16.42%, with a range of -9.08% to 29.57%. The implied excess return has a mean of 4.08% and range of -9.74% to 18.67% in the pre-shift period, and a mean of 4.10% and a range of -21.09% to 19.34% in the post-shift period.

In short, the excess returns on long-term bonds implicit in the recorded forecasts vary across a wide range. If those making these forecasts view the market as efficient, this variation suggests that they anticipate large quarter-to-quarter movements in time-varying term premiums.[15]

Finally, it is interesting to note that practitioners sometimes criticize forecasters for predicting changes in long-term rates that are too small relative to observed changes. Melton (1986), for example, observes critically (page 3):

Table 4

Holding-Period Yields and Excess Returns Implicit in the Recorded Forecasts[a]

Source	Sample	Series	Holding-Period Yield on Long-term Bonds		Excess Return on Long-term Bonds	
			Mean	Range	Mean	Range
Data Resources of Canada	1975:2-1979:3	Long-term Canada bonds	12.82	-0.94 to 27.53	4.08	-9.74 to 18.67
	1979:4-1985:2		16.42	-9.08 to 29.58	4.10	-21.08 to 19.34
	1975:2-1979:3	McLeod, Young, Weir 10 industrial bonds	12.63	1.91 to 25.89	3.38	-7.61 to 13.96
	1979:4-1985:2		17.30	-6.65 to 30.91	4.68	-19.15 to 20.45
The Conference Board in Canada[b]	1975:1-1979:3	McLeod, Young, Weir 10 industrial bonds	10.30	0.71 to 31.90	1.50	-8.41 to 25.98
	1979:4-1984:4		16.18	6.31 to 26.32	3.32	-12.92 to 16.50
McLeod, Young, Weir, surveys	1975:1-1979:3	McLeod, Young, Weir 10 industrial bonds	13.06	6.85 to 20.34	4.08	-1.51 to 8.05
	1979:4-1982:4		15.82	2.20 to 29.69	1.60	-12.80 to 13.50

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a Data refer to holding-period yields and excess returns based on the two-quarter-ahead forecasts of interest rate changes, as shown in Table 3. Holding-period yields and excess returns are expressed as percentage points at annual rates.

b Observations for 1979:2 and 1981:3 were unavailable.

> "...in the five years that Institutional Investor has surveyed economists concerning their expectations for interest rates, the average absolute forecast...was 97 basis points, compared to 173 basis points in reality!"

Melton subsequently analyses (page 10) the "persistent tendency for some economists to understate the magnitude of future changes of interest rates."

The criticism that forecasters understate the actual volatility of long-term interest rates is, of course, dramatically at odds with the message from the rational expectations model. Such critics would appear to implicitly reject the hypothesis that capital markets are efficient, since the variation in ex post returns on long-term bonds is far greater than that which one might reasonably assign to the role of a time-varying term premium. The predicted annual changes in the long-term rate cited in the previous quotation imply that the excess return on long-term relative to short-term bonds is forecast to vary over a wide range. It seems fair to ask whether forecasts that the excess return on common stocks relative to short-term bonds will vary over a comparable range would be assigned much credibility by market participants.

IV. The Slope of the Yield Curve and the "Forecastability" of Changes in the Long-term Interest Rate

Implicit in the rational expectations model is a positive relationship between the current slope of the yield curve and the subsequent movement in the long-term interest rate. When the term structure has a positive slope (that is, when the long-term rate exceeds the short-term rate), the prediction of the rational expectations model is that the long-term rate will subsequently rise. The anticipated capital loss is necessary to equalize - up to the time-invariant term premium - the holding-period return on short- and long-term bonds.

However, as Shiller (1979) has noted using interest rate data drawn from both the United States and the United Kingdom, the empirical relationship appears to be the opposite. Subsequent movements in long-term rates are negatively related to the current slope of the yield curve. None of the data sets examined by Shiller extend beyond 1977, so his evidence does not pertain to the post-shift period.[16] Under the null hypothesis of market efficiency, the implication of the "perverse" forecasting result identified by Shiller is that a time-varying term premium does exist, and is positively related to the slope of the yield curve. When the long-term rate exceeds the short-term rate, long-term bonds are priced by the market to provide an excess return that exceeds that implied by equation (1); that is, $E_t(H_t^{(n)}) > r_t + \phi^{(n)}$ if $R_t^{(n)} > r_t$.[17]

Does this "perverse" forecasting relationship exist in the Canadian data, in both the pre- and post-shift periods? This question is readily answered. Regressions of the future change in the long-term rate on the current slope of the yield curve, for both the Canada and the corporate bonds, are presented in Table 5. For long-term Canada bonds, the relationship between the subsequent change in the long-term rate and the current slope of the yield curve is negative, in the pre-shift, post-shift and combined sample periods. In no sample period, however, is the coefficient of the yield curve significantly different from zero.[18] For the corporate bonds, the negative relationship exists in all three periods, and is significant in the pre-shift and the combined sample periods.

Regressions of the excess returns of these long-term bonds on the slope of the yield curve are also presented in Table 5. They, of course, provide similar results. In all cases, the slope coefficients are positive, indicating that excess returns vary positively with the long-short spread.

Table 5

The Predictive Content of the Slope of the Yield Curve

	Dependent Variable	Sample Period	Constant Term	Coeff. of $R_t^{(n)}-r_t$	R^2	S.E.E.	D.W.
1.	$R_{t+1}^{(n)} - R_t^{(n)}$ (Canada bonds)	1957:1-1985:2	12.99 (1.56)	-0.061 (1.33)	0.015	69.94	2.17
2.	" "	1957:1-1979:3	10.81 (1.85)	-0.021 (0.62)	0.004	36.13	1.73
3.	" "	1979:4-1985:2	3.41 (0.12)	-0.132 (0.94)	0.040	141.51	2.33
4.	$R_{t+1}^{(n)} - R_t^{(n)}$ (Corporate bonds)	1957:1-1985:2	19.61 (2.30)*	-0.111 (2.56)*	0.055	69.64	2.17
5.	" "	1957:1-1979:3	14.82 (3.04)*	-0.055 (2.06)*	0.046	31.71	1.56
6.	" "	1979:4-1985:2	16.65 (0.50)	-0.185 (1.38)	0.083	144.72	2.31
7.	$H_t^{(n)} - r_t$ (Canada bonds)	1957:1-1985:2	-441 (1.74)	2.717 (1.94)	0.033	2120	2.07
8.	" "	1957:1-1979:3	-433 (1.85)	1.843 (1.35)	0.020	1446	1.73
9.	" "	1979:4-1985:2	-92 (0.11)	4.563 (1.20)	0.064	3830	2.33
10.	$H_t^{(n)} - r_t$ (Corporate bonds)	1957:1-1985:2	-617 (2.59)*	4.181 (3.45)*	0.096	1945	2.06
11.	" "	1957:1-1979:3	-558 (3.04)*	3.079 (3.06)*	0.095	1193	1.56
12.	" "	1979:4-1985:2	-427 (0.50)	5.748 (1.67)	0.117	3711	2.31

Notes: Interest rates or holding-period yields are expressed in basis points at annual rates.
Bracketed figures are t-statistics. Asterisks indicate coefficients which are significantly different from zero at the 95% confidence level.

The relationship is significant for the corporate bonds, but only in the pre-shift and combined sample periods. One cannot, however, reject the null hypothesis that the relationship between future changes in the corporate bond rate and the slope of the yield curve is the same in the pre- and post-shift periods.[19] This suggests that the relationship may prove to be useful in a forecasting context. Further, as evidenced by the magnitude of the point estimate of the slope coefficient, this relationship may be quantitatively important. In the pre-shift period, for which this point estimate is the smallest, it nonetheless equals 3.079. This implies that a one hundred basis point increase in the long-short spread is associated with a 307.9 basis point increase in the excess return on long-term corporate bonds.

As highlighted by the excess return regressions, even a small correlation between the future change in the long-term rate and the current slope of the yield curve may be important in an economic sense. It is thus instructive to determine whether the observed relationships are sufficiently stable so as to be useful in a forecasting context. A natural breakpoint in the sample is the apparent shift in the monetary regime which occurred in the third quarter of 1979. Equations (2) and (5) in Table 5 were thus used to generate forecasts of the change in the long-term Canada and corporate rates, respectively, in the post-shift period. The root-mean-square errors of this forecasting procedure were then compared to those of the no-change prediction of the martingale model.

For both the Canada and the corporate bonds, the predicted changes using the "slope" regressions are more accurate than the no-change predictions, but only modestly so. For the Canada bonds, the root-mean-square error for the period 1979:4-1985:2 is 137.7 basis points, compared to 139.4 basis points for the martingale model. For the corporate bonds, the corresponding figures are 141.8 basis points and 145.7 basis points.

The predicted changes from the "slope" regressions are considerably more accurate than the recorded forecasts. However, this is due - in the main - to the inferiority of the recorded forecasts relative to the no-change prediction. For the McLeod, Young, Weir surveys, the root-mean-square error of the one-quarter ahead forecasts of the corporate rate for the period 1979:4-1982:4 (the period for which the survey data are available) equals 193.3 basis points, compared to 174.7 basis points for the "slope" regression. For the one-quarter ahead DRI forecasts of the Canada rate, the margin of superiority for the "slope" regression is 107.9 basis points to 124.4 basis points.[20] And so on.

Finally, it is instructive to examine the relationship between the change in the long rate implicit in the recorded forecasts and the slope of the yield curve. Regressions of the one-quarter-ahead and two-quarter ahead implicit forecasts of the change in the long-term rate on, respectively, the current slope and the one-quarter-ahead forecast slope of the yield curve are presented in Table 6. Interestingly, in the two cases in which a significant relationship exists, it is in the direction required by the rational expectations model. When the long rate exceeds the short rate, the forecast is that the long rate will rise, and conversely. This is not, however, the relationship that exists in the actual data.

V. Summary and Conclusions

The substantive results contained in this paper can be summarized succinctly. First, in spite of the increase in both the level and the volatility of interest rates in Canada following the October 1979 shift in the monetary regime in the United States, the anticipated quarterly changes in long-term rates implied by the rational expectations model remain "small."

Table 6

The Recorded Forecasts and the Slope of the Yield Curve

	Dependent Variable	Forecaster	Constant Term	Coeff.[a] $R_t^{(f)} - r_t$	R^2	Sample Period
1.	$E_t(R_{t+1}^{(n)}) - R_t^{(n)}$ (Corporate bonds)	Conference Board	-5.89 (0.55)	-0.04 (0.80)	0.018	1975:1-1984:4[b]
2.	" "	Data Resources Inc.	-36.65 (3.00)*	0.15 (2.69)*	0.156	1975:2-1985:2
3.	" "	McLeod, Young, Weir surveys	-25.17 (2.10)	0.01 (0.09)	0.000	1974:4-1982:4
4.	$E_t(R_{t+1}^{(n)}) - R_t^{(n)}$ (Canada bonds)	Data Resources Inc.	-17.80 (1.77)	0.09 (1.46)	0.052	1975:2-1985:2
5.	$E_t(R_{t+2}^{(n)} - R_{t+1}^{(n)})$ (Corporate bonds)	Conference Board	-0.64 (0.15)	-0.04 (1.75)	0.078	1975:1-1984:4[b]
6.	" "	Data Resources Inc.	-13.46 (2.57)*	0.02 (0.97)	0.024	1975:2-1985:2
7.	" "	McLeod, Young, Weir surveys	-12.96 (3.20)*	0.06 (2.82)*	0.204	1974:4-1982:4
8.	$E_t(R_{t+2}^{(n)} - R_{t+1}^{(n)})$ (Canada bonds)	Data Resources Inc.	-13.81 (2.75)*	0.04 (1.18)	0.035	1975:2-1985:2

Notes:

a For equations 5 through 8, this "slope" variable equals $E_t(R_{t+1}^{(n)} - r_{t+1})$.

b Observations for 1979:2 and 1981:3 were unavailable.

Bracketed figures are t-statistics. Asterisks indicate coefficients which are significantly different from zero at the 95% level.

This suggests that the no-change prediction remains a close approximation to the rational expectations model, at least over quarterly forecast horizons. Second, recorded forecasts of long-term interest rates in Canada during this post-shift period prove to be less accurate than the no-change prediction. Third, these recorded forecasts of the level of long-term rates imply forecast changes in these rates far in excess of those associated with the rational expectations model. The implication is that the excess return on long-term relative to short-term bonds is forecast to vary over a wide range. Such variation may be associated with a belief that a time-varying term premium contributes importantly to the movement in the long-term interest rate.[21] There is nothing in the performance of the recorded forecasts, however, to suggest that the systematic element of a term premium - if it exists - has been identified by the forecasters.[22]

Finally, in both the pre- and post-shift period, the subsequent movement in long-term rates is negatively correlated with the long-short spread. This is, of course, the opposite of the relationship implied by the rational expectations model, and invites the interpretation that a time-varying term premium is linked to the slope of the yield curve. Nonetheless, this negative relationship is statistically significant only for the corporate bond rate, and not in the post-shift period. This "perverse" relationship between the current slope of the yield curve and the subsequent movement in the long-term rate is, at least for Canadian data, of only modest value in a forecasting context. Somewhat paradoxically, the forecasts of the change in the long-term rate that are implicit in the recorded forecasts, when significantly related to the slope of the yield curve, are in the direction required by the rational expectations model.

FOOTNOTES

1. The increased volatility of interest rates in the United States in the period subsequent to the October 1979 shift in policy has received considerable attention. See, for example, Roley (1983) and Walsh (1984).

2 During the six years prior to the shift in policy (1973:4-1979:3), the 90-day bill rate had a quarterly mean of 8.38% and a standard deviation of 1.49%. During the six years subsequent to the shift in policy (1979:4-1985:3), these rose to 12.52% and 3.31%. For long-term Government of Canada bonds, the mean interest rate rose from 9.12% to 12.97%, while the standard deviation rose from 0.61% to 1.76%.

3. For the pre-shift period 1975-1978, Pesando (1981) examined the accuracy of the short- and long-term interest rate predictions of Data Resources Incorporated of Canada, the Conference Board in Canada, and the McLeod, Young, Weir surveys. These recorded forecasts, updated to the post-shift period, are examined in the present study.

4. As is well known (Cox, Ingersoll and Ross (1981)), the several different formulations of the pure expectations model of the term structure are - due to Jensen's Inequality - inconsistent if interest rates are random.

5. Shiller (1979) shows that the approximation error resulting from this linearization is not large, a point emphasized more recently by Campbell (1984).

6. The corporate bond series in the McLeod, Young, Weir 10 industrials, compiled by McLeod, Young, Weir and Company Limited. The other series are compiled by the Bank of Canada. The corporate bond rates are those prevailing on the last business day in the quarter. All of the other

rates are those prevailing on the last Wednesday in the quarter. For corporate bonds, the reported term to maturity figure of 17 years is clouded by the existence of call options and sinking funds. The maturity figures are reported under the convention that the maturity of a bond equals its maturity date if the bond is trading beneath par, and equals its earliest call date if the bond is trading above par. For this reason, one has more confidence in the constructed series of the anticipated changes in the long-term Canada rate.

7. The value of this term rose by 47.1% for the Canada bonds, and by 46.0% for the corporate bonds.

8. Intuitively, it is the percentage change in the long-term rate which produces the anticipated gain or loss. The higher is the level of the long-term rate, the larger must be the absolute change in the long-term rate to produce this percentage change.

9. We also calculated the anticipated change in one of the most actively traded long-term Canada bonds (the 9.5's of 2001), again as implied by the alternative of holding a 90-day Treasury bill. For this calculation, we incorporated the fact that the maturity of the bond declines by one quarter with each observation. For this bond, the average absolute value of the anticipated change for the period 1979:4 to 1985:3 equalled 5.65 basis points, which is close to the figure of 6.39 basis points obtained for the index of long-term Canada rates.

10. If, contrary to most empirical studies, the term premium is set equal to zero (i.e., the pure expectations hypothesis is assumed), the mean absolute anticipated changes in the long-term rate in the post-shift period rise to 6.93 and 8.37 basis points for Canada and corporate bonds, respectively. These higher values reflect the tendency of long-

term to exceed short-term rates, which thus requires - on average - ex ante increases in long-term rates to produce the capital losses necessary to equilibrate ex ante returns.

11. Both maximums occur in 1981:1. In this quarter, the bill rate equalled 16.44% and the Canada bond rate equalled 13.48%. An anticipated decline in the long-term rate of 0.1763% or 17.63 basis points is necessary to produce the anticipated capital gain required by equation (1), given our estimate of the term premium.

12. The forecasts of DRI and the Conference Board are for the average interest rate to prevail in the quarter, while the survey forecasts compiled by McLeod, Young, Weir are for end-of-quarter interest rates. To calculate the forecast errors for DRI and the Conference Board, realizations were set equal to the average interest rate in the quarter, as measured by the average of the interest rates on the last Wednesday in each month during the quarter. To calculate the forecast errors for the McLeod, Young, Weir surveys, realizations were set equal to the interest rate on the last Wednesday in the quarter.

13. The root-mean-square errors reported for the pre-shift sample in Table 2, for both the recorded forecasts and the martingale model, are larger - often considerably so - than the errors reported for a roughly similar period in Pesando (1981). The increased errors reflected the typically large errors that occurred in the first three quarters of 1979, which were not included in the earlier paper.

14. For the DRI and Conference Board forecasts, the one-quarter-ahead changes are calculated by subtracting the value in the current quarter as reported by the forecaster from the one-quarter-ahead forecast of the average level of the interest rate. The one-quarter-ahead changes were

also calculated by subtracting the interest rate at the end of the month which served as the base period for the forecast. In all cases except for the one-quarter-ahead change in the McLeod, Young, Weir 10 industrials forecast by DRI, the mean absolute values of the forecast changes were greater using the latter procedure, and thus greater than the changes reported in Table 3.

15. There also exists the possibility that the forecasters are unaware of this implication of their predictions about the future levels of interest rates. In light of this possibility, it might prove useful for forecasters to calculate the holding-period yields and excess returns implicit in their predictions of interest rate levels.

16. Campbell and Shiller (1984) find continuing evidence of this "perverse" forecasting relationship when they regress the excess monthly return on a twenty-year bond relative to a one-month bill on the long-short spread for the period 1955:1 to 1979:3. Shiller, Campbell and Schoenholtz (1983) find this "perverse" relationship continues to hold when the U.S. data are updated through mid-1982.

17. For a review of recent evidence regarding the existence of time-varying term premiums, see Melino (1986).

18. This is the relevant benchmark, given our interest in looking for stable relationships which might prove useful in a forecasting context. One might also be interested, for example, in the size (and significance) of the slope coefficient relative to the value predicted by the rational expectations model. See, for example, Shiller, Campbell and Schoenholtz (1983) and Pesando (1981, footnote 7).

19. As shown in Schmidt and Sickles (1977), the Chow test for structural breaks can be unreliable when, as in the cases arising here, variances

and sample sizes differ in the two subperiods. We thus performed an asymptotic F-test (Amemiya 1985, pp. 31-38). For corporate bonds, the relevant test statistic, which is distributed F(2, 110)), equalled 0.409. One cannot reject the null hypothesis of an unchanged relationship for Canada bonds as well (F(2, 110) = 0.392). This latter result is less interesting in view of the lack of statistical significance of the slope coefficients.

20. Because DRI and the Conference Board forecast the average value of the interest rate during the quarter, the regressions were rerun with quarterly averaged data and then used to generate the corresponding out-of-sample forecasts.

21. It is useful to compare these results with those of Kane (1983), who also examines survey data on interest rate forecasts. Kane concludes that time-varying term premiums do exist and vary positively with the level of interest rates. However, Kane further observes that such variation is small relative to observed quarter-to-quarter changes in long-term rates. He thus concludes that his results provide only qualified support for the proposition that interest rate movements are forecastable. The forecasts examined in this study indicate, under the null hypothesis of market efficiency, a relatively more important role for time-varying term premiums.

22. There is one anomaly in the behaviour of long-term rates in Canada during the post-shift period that merits note. During this period, there is a significant correlation between the current change in the long-term Canada rate and the lagged long-term U.S. Government rate. Indeed, the lagged U.S. rate explains a full 22 per cent of the variance of the change in the long-term Canada rate during this period of

volatile rates. This relationship does not, however, exist in the pre-shift period. A regression of the excess return on long-term Canada bonds on the lagged U.S. rate indicates that a one basis point rise in the latter is associated with a 13.9 basis points rise in the excess return during the post-shift period. We suspect that this relationship is likely to prove to have been unique to this period, and thus not to be useful in a forecasting context. Interestingly, the DRI forecasts of changes in the long-term Canada rate are not influenced significantly by the lagged U.S. rate. To the extent that the DRI forecasts are so influenced, the relationship is in fact stronger in the pre-shift period.

REFERENCES

Amemiya, Takeshi (1985). Advanced Econometrics (Cambridge, Mass.: Harvard University Press).

Cox, John, Jonathan Ingersoll and Stephen Ross (1981). "A Re-examination of Traditional Hypotheses about the Term Structure of Interest Rates," Journal of Finance, 36 (September): 769-799.

Campbell, John (1984). "A Defense of Traditional Hypotheses About the Term Structure of Interest Rates." National Bureau of Economic Research Working Paper No. 1508 (November).

_____ and Robert J. Shiller (1984). "A Simple Account of the Behavior of Long-term Interest Rates," American Economic Review, 74 (May): 44-48.

Kane, Edward J. (1983). "Nested Tests of Alternative Term-Structure Theories," Review of Economics and Statistics, LXV (February): 115-123.

McCulloch, J. Huston (1975). "An Estimate of the Liquidity Premium," Journal of Political Economy, 83 (February): 95-119.

Melino, Angelo (1986). "The Term Structure of Interest Rates: Evidence and Theory," Department of Economics and Institute for Policy Analysis Working Paper No. 8601, University of Toronto.

Melton, William C. (1986). "Evaluating Interest Rate Forecasts and Forecasters." Paper presented to the Conference Board 1986 Financial Outlook Conference, New York, February 26.

Pesando, James E. (1978). "On the Efficiency of the Bond Market: Some Canadian Evidence," Journal of Political Economy, 86 (December): 1057-1076.

Pesando, James E. (1979). "On the Random Walk Characteristics of Short- and Long-term Interest Rates in an Efficient Market," Journal of Money, Credit and Banking, XI (February): 457-466.

_____ (1981). "On Forecasting Interest Rates: An Efficient Markets Perspective," Journal of Monetary Economics, 8 (November): 305-318.

Roley, V. Vance (1983). "The Response of Short-Term Interest Rates to Weekly Money Announcements," Journal of Money, Credit and Banking, 15 (August): 344-354.

Sargent, Thomas J. (1976). "A Classical Macroeconometric Model for the United States," Journal of Political Economy, 84 (April): 207-237.

Schmidt, Peter, and Robin Sickles (1977). "Some Further Evidence on the Use of the Chow Test under Heteroskedasticity," Econometrica, 45 (July): 1293-1298.

Shiller, Robert J. (1979). "The Volatility of Long-term Interest Rates and Expectations Models of the Term Structure," Journal of Political Economy, 87 (December): 1190-1219.

_____, John Campbell and Kermit Schoenholtz (1983). "Forward Rates and Future Policy: Interpreting the Term Structure of Interest Rates. Brookings Paper on Economic Activity, 1: 173-217.

Walsh, Carl E. (1984). "Interest Rate Volatility and Monetary Policy," Journal of Money, Credit and Banking, 16 (May): 133-150.