RIDING THE CANADIAN YIELD CURVE

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ABSTRACT

Riding the yield curve, a trading strategy of buying long-term securities and sell them before maturity, has been a popular way to achieve excess returns. Our empirical results indicate that the riding strategy does not stochastically dominate the buy-and-hold strategy. Moreover, the excess returns are very sensitive to the particular period and subsample. Our evidence, overall, does not show a superior performance by implementing the riding strategy over the past 15 years in Canadian market.

Keywords: (yield curve, Canadian).

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1. INTRODUCTION

Riding the yield curve refers to a trading strategy in which portfolio managers buy long-term bills and sell them before maturity in order to generate any term premiums and also provide liquidity to the whole portfolio.

Theoretically, in periods of upward sloping yield curves, there are opportunities to generate excess returns by implementing the riding strategy instead of the buy-and-hold strategy. However, such a strategy does not always enhance returns. First, the expectation hypothesis theory states that the expected forward rate is the good predictor of the future spot rate. Therefore, no excess returns can be generated if the riding strategy is pursued. Second, liquidity theory tells that people expect to receive any liquidity premium to offset the higher risks when holding the long-term securities. The yield curve is possible to be upward sloping even with expectations of falling interest rates when liquidity premium is included.

The previous studies have found the riding strategy is possible to earn excess returns during periods when the yield curve was upward sloping. The studies also found the most profitable trading when there was a very steep yield curve. However, in recent years, we have observed flat yield curve in Canada. Under this circumstance, we try to examine whether riding the yield curve strategy still offer good opportunities to earn abnormal returns in Canadian market?

Dyl and Joehnk (1981) introduced a simple filter rule. The filter allows one to ride the yield curve when the curve has a positive slope greater than some critical threshold. A

common measure of this is the margin of safety (MOS) and is used extensively in the riding literatures to identify potentially profitable trades. In our paper, we use a recently available 15 years data set to examine the efficacy of riding the yield curve. Our data do not provide evidence that the riding strategy is superior to the buy-and-hold strategy in the full sample period.

Our results are robust to studying different subperiods, focusing on bonds with different maturities, allowing for overlapping and non-overlapping observations. Subperiod (1992 – 1997) showed the highest mean excess returns because the yield curve was upward sloping during that time. When the yield curve has become flat in other two subperiods, the results do not suggest the profitable trading.

The rest of the project proceeds as follows. Section 2 presents literature surveys; Section 3 shows data and summary statistics; Section 4 discusses methodology; Section 5 presents empirical results and Section 6 draws conclusions.

2. LITERATURE SURVEYS

Several past literatures have shown the contradictory views to the expectation hypothesis. Dyl and Joehnk (1981) compare the riding and buy-and-hold strategies. They choose to ride the yield curve by using short-term securities because short-term securities are more liquid and less volatile. The assumption they make is that the yield curve remains stable over holding period. The test covers the period from 1970 through 1975. The margin of safety (a measure of the steepness of the yield curve and is used as a cut-off to identify potentially profitable yield curve riding strategies) they use in riding the yield curve is the percentage difference between the forward rate and the discount rate when securities are sold. It is calculated as follows:

$$MOS = \frac{R_s^* - E(R_s)}{E(R_s)} \qquad (1)$$

$E(R_s)$ is the expected yield on the security when it is sold and R_s^* is the breakeven level of interest rates.

The results overall suggest that riding the yield curve is a profitable investment management technique when the margin of safety is high, but the average excess return from the riding strategy are very small. They conclude that the combination of a high margin of safety and a long maturity T-bill will produce the best results, but, in the meantime, risk of doing so has been increased as well. The risk-adjusted return of riding the yield curve may be negative.

Grieves and Marcus (1992) examine the efficacy of riding the yield curve for the period 1949-1988. They use end-of-month prices for three-month, six-month, nine-month, and twelve-month zero-coupon bonds. They examine non-overlapping three-month returns of two competing strategies. The benchmark strategy was to buy and hold three-month bills. The alternative strategy is to hold longer-maturity bills and roll them over every three months. They also use the filter rule that was established by Dyl and Joehnk (1981). If margin of safety is exceeded, the riding strategy can be pursued. Otherwise, they still choose the buy-and-hold strategy. Their results show that the frequency of riding six-month bills falls from 100% to 69% when margin of safety rises from -1.0 to 0.025. The success increases from 66% to 71% as margin of safety rises to zero, but then falls back to 70% when margin of safety increases to 0.025. Moreover, the results of the increment to average quarterly return and standard deviation over buy-and-hold strategy show that riding the yield curve generally increases both average return and intraperiod volatility. Their paper concludes that overall riding strategy does not generate abnormal return based on return-risk trade-off analysis.

Pelaez (1997) tries to fill the gap by testing the results of riding the longer-term bond. He thinks that previous papers only examine the rides of few weeks and he will like to purchase a two-year bond and roll over after one year. Based on the expectation hypothesis, riding strategy will not produce the abnormal profit. The liquidity theory also indicates that riding will not enhance the risk-adjusted return.

Ang, Alles and Allen (1998) examined the riding the yield curve strategy that is proved to generate excess returns in previous research papers. To distinguish from the previous papers, they include other markets besides US market because US market is

fairly liquid and efficient. They want to examine whether riding the yield curve strategy also works in other world financial markets that are not as efficient as US market, so Australia, Canada and United Kingdom are included. The other difference is that they examine the profitability of riding strategies for holding periods that extend to one year. They use overlapping three-month and one-year holding periods to examine two strategies. One strategy is to buy and hold three-month bills or tenders. The other strategy is to purchase six-month bills and roll them over after three months. In the bond market, the benchmark strategy is to buy and hold one-year bonds, while the other strategy is to buy two-year bond and roll them over after one year. Based on the full sample results, they find out that when transaction costs are beyond 0.125 basis points, the riding strategy does not perform better than the buy-and-hold strategy. Without the transaction costs, the results are still the same. The results are varying in different subsample period. The reason is that the returns are influenced by country-specific factors that are themselves sensitive to sub-periods. US is the most frequent country to choose riding the yield curve and UK is the least one to do so. This paper is not able to prove stochastic dominance in the return distributions from riding the yield curve over buy-and-hold distributions within the sample period in the US market. Other markets have the similar conclusion. The excess return of riding the yield curve that maybe observed from time to time can be very sensitive to the particular sample and subperiod.

Bieri and Chincarini (2005) examine the riding strategy for maturity beyond one year, for different currencies, and compared rides between risk-free government securities and risky securities, such as LIBOR-based deposits and swaps. Their findings found that the riding strategy could outperform the buy-and-hold strategy. Moreover,

filter rules enhance the excess return even more based on their data. They were able to show the riding yield curve is also a superior investment strategy on a risk-adjusted basis by introducing the concept of duration-neutral riding.

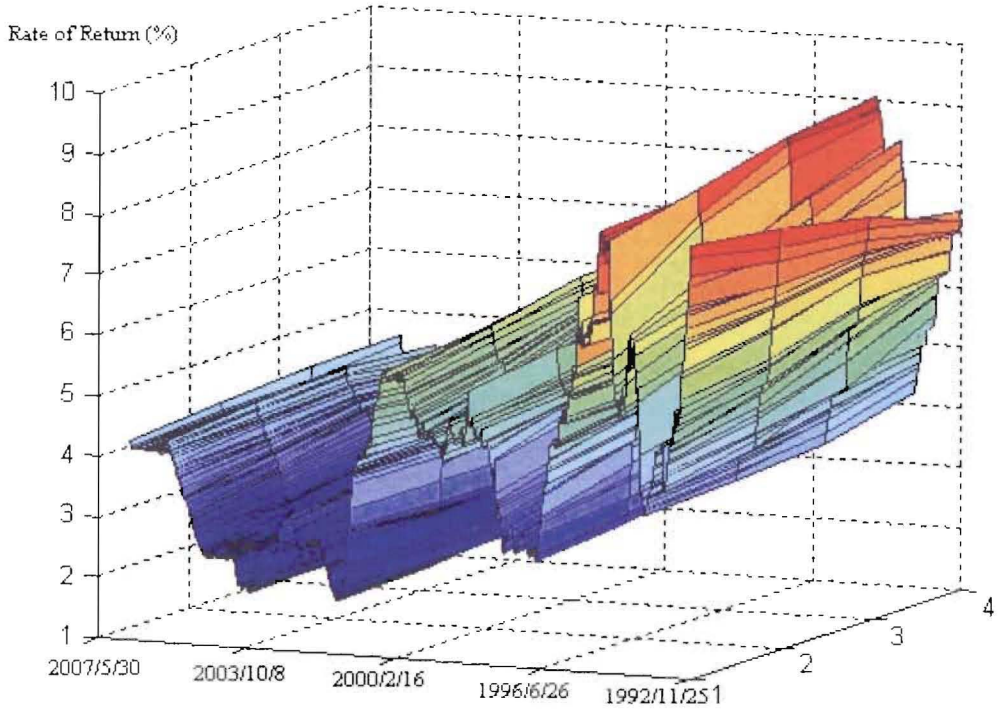
The literature surveys show that most previous papers focus on the US data. Ang, Alles and Allen (1998) have done some researches based on Canadian data, but their time span is only from 1985 to 1996. The objective of our paper is to use the most updated data from November 1992 to May 2007, including both full example and sub-samples, to test whether the riding strategy is superior to the buy and hold strategy in the Canadian market by examining overlapping and non-overlapping three-month bills and one-year bonds separately

3. DATA AND SUMMARY STATISTICS

In our empirical analysis, we focus on three markets: the Treasury bill market, the auction market, and the bond market. The interest rate data consist of 3-month, 6-month and 1-year treasury bills auction rates, 3-month, 6-month and 1-year treasury bills rates and 2-year government bond rates from 1992/11/24 to 2007/06/05. Auction bills data are released every Tuesday and Treasury bills are based on Wednesday yields. Auction treasury bills data are only released every two week after 1997/09/23. The whole sample period is divided into three subperiods, 1992/11-1997/11, 1997/12-2002/11 and 2002/12-2006/5. The data are collected from CANSIM at Statistics Canada.

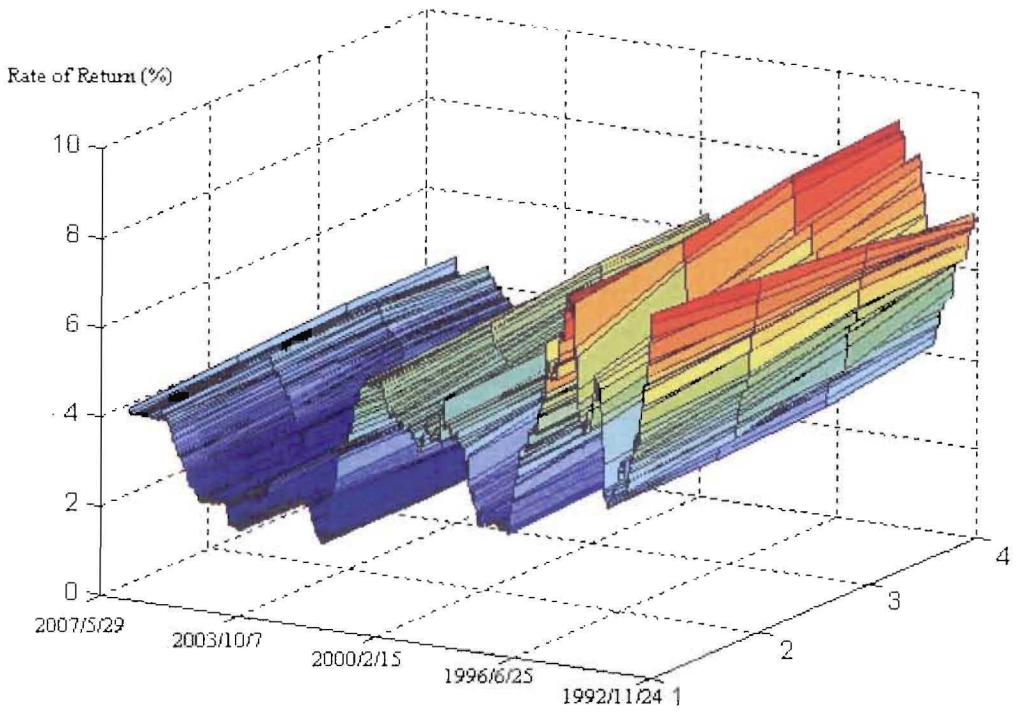
We report summary statistics in Table 1. In Panel A we note that the average three-month yield is 4.1535 and average six-month yield is 4.3351 in bills markets; average one-year return is 4.5849 and average two-year return is 4.8275 in bond market. The differences between average long-term rates and short-term rates are not significantly big, so we can conclude that the Canadian yield curve is flat. The tender rates in Panel B also imply a flat yield curve for the full sample period. However, the yield curve is slightly upward sloping during the period 1992/11-1997/11 (Panel A-1 and Panel B-1). Figure 1 and 2 show the three-dimension yield curves and The yield curves are quite flat especially for the recent 5 years despite the fact that the level of interest rates has varied in the past 15 years. Figure 3 is a typical representation of flat Canadian yield curve.

Figure 1 Treasury Bills and Bonds Yield Curve (1992/11/25 – 2007/5/30)



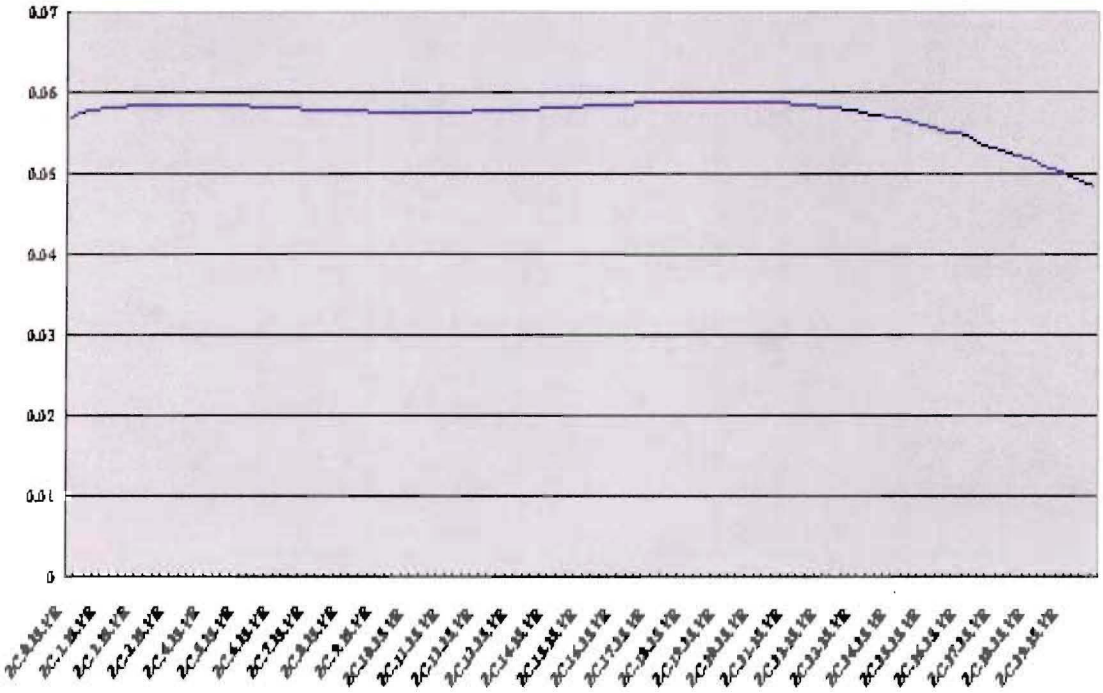
Notes:
This figure is generated by using data from 1992 to 2007. The numbers 1, 2, 3 and 4 on the Z axis denote 3-month, 6-month, 1-year T-Bills and 2-year T-bond respectively.

Figure 2 Treasury Bills and Bonds (tender) Yield Curve (1992/11/24 – 2007/5/29)



Notes:
This figure is generated by using data from 1992 to 2007. The numbers 1, 2, 3 and 4 on the Z axis denote 3-month, 6-month, 1-year T-Bills and 2-year T-bond respectively.

Figure 3 Zero Coupon Yield Curve (2002/01/01)



Note: The figure plots the zero-coupon yield curve, with terms to maturity ranging from 0.25 years to 30.00 years.

4. METHODOLOGY

Using overlapping and non-overlapping three-month and one-year holding periods, we examine two competing strategies. In the bill and tender markets, the benchmark strategy is to buy and hold three-month bills or tender, respectively. The other strategy is to buy the six-month bills and roll over after three months. In the bond and auction markets, the benchmark strategy is to buy and hold one-year bonds and the alternative strategy is to ride the yield curve by holding two-year bonds and rolling them over after one year.

Our approach to compare the buy-and-hold strategy with the riding the yield curve strategy is based on filter rule introduced by Dyl and Joehnk (1981). If we purchase a three-month Treasury bills and hold it until maturity, the return we will realize is the yield on three-month T-bill. However, assuming that the yield curve is upward sloping, purchasing a six-month T-bill when the yield on long-term maturity securities is higher than that on short-term maturity securities, we actually buy at a lower price and sell it at a higher price after three-month. The profit from the riding strategy is the excess return over buying a three-month T-bill and holding it until maturity. The return from riding the yield curve should be greater than the yield on the T-bills at the end of holding period,

$$R_s^* = R_0 + (R_0 - R_{bh})H/(M - H) \qquad (2)$$

R_s^* is the breakeven level of interest rates when we sell and R_{bh} is the yield that could be obtained by buying and holding. R_0 is the original yield on the security purchased. M is the maturity of the bill/bond ridden and H is the holding period. The breakeven level of

interest rate can also be seen as the forward rate, which is used to determine the potential increase in return from riding the yield curve.

Recall the definition of the MOS from equation (1). The margin of safety (MOS) in riding the yield curve is the percentage difference between the forward rate and the discount rate when securities are sold. We use MOS= 0 (the usual strategy of riding the yield curve when it is upward-sloping over the maturities of interest) and higher MOS (0.5, 0.1 and 0.2) to show the robust results. The bigger the difference between forward and spot rate, the more likely that the riding strategy will generate higher returns than simply buy-and-hold strategy. The whole purpose of riding the yield curve is trying to achieve the abnormal return. The actual yield on riding the yield curve is

$$R_{yc} = R_0 + (R_0 - R_s)(M - H)/H \qquad (3)$$

Where R_{yc} is the actual return from riding strategy, R_s is the actual rate on the T-bill or T-bond when it is sold at the end of the holding period.

Because higher transaction costs incurred when securities are sold before maturity, we need to subtract the transaction costs to realize the true excess returns. Grieves and Marcus (1992) use the transaction costs between 0.8 and 3.25 basis points on yearly basis; Ang, Alles and Allen (1997) assume that the transaction costs are 0.25 percent on weekly basis to be compatible with the charges imposed by the Reserve Bank of Australia for the sale of commonwealth bonds by investors. We choose to use 0.5, 1 and 3.25 basis points on weekly basis. In order to show the robust results, the higher transaction cost is included in our analysis.

Therefore, we subtract transaction costs 0.5, 1 and 3.25 basis points from the calculated return each week on the riding strategy

5. EMPIRICAL RESULTS

We define that the "frequency" is the fraction of weeks in the full sample and each sub-sample in which riding strategy is pursued, and the "success" is the percentage of those rides that generate excess returns. In Table 2, Panel A and B present evidence on the efficacy of the margin of safety filter for non-overlapping three-month and one-year holding period (full sample and subsamples) in the bill and bond markets. In the bill market, for three-month T-bills, when MOS=0, the number of rides are 52 (frequency = 0.90) and the number of successful rides are 40(success=0.69). These numbers show that investors would have ridden the yield curve in 90% of the weeks in this fifteen-year period and of these rides, only 69%-71% would have provided returns in excess of the buy-and-hold strategy. For 1-year T-bonds, the successful rides account for 50% of the weeks. The table shows that as MOS increases, the frequency and success rate of riding the yield curve drop significantly. For example, the success rate of riding the yield curve reduces from 0.71 to 0.03 for 3-month T-bills (full sample). Moreover, one observation from Table 2 is that success rates are not significantly affected by the transaction costs.

Panel A also provides the information of frequency and success rate of riding the yield curve for three sub-periods. The success rate for the first sub-period (1992-1997) non-overlapping three-month T-Bills is 0.76. For the non-overlapping one-year T-Bonds in Panel B, the success rate is only 0.50. These results show that the percentage of success rides in the bill market is larger than that in the bond market. Dyl and Joehnk (1981) mentioned that riding the yield curve with investments in short-term securities is

much less risky than with long-term investments, because major swings in interest rates are less likely in the short run and because short term securities are less volatile than long-term securities.

In addition, as MOS increases, the success rates decrease because the chances that you are going to ride the yield curve based on high MOS are smaller. For Three-month T-bills (non-overlapping), when MOS is greater than and equal to 0.2, no riding strategy is being used during the subperiod 1997-2002 and 2002-2006. This is due to the flat the yield curve in Canada from 1997-2006 and the riding strategy cannot help generate excess returns.

Another result we find out is that the success rates for the first sub-period from 1992 to 1997 are higher than for the other two sub-periods. Shown in Table 2, the success rate (MOS is greater than and equal to zero and transaction cost is equal to 0.01) is 0.76 for first sub-period three-month non-overlapping T-Bills while the rates are 0.75 and 0.53 for the other two sub-periods. Overlapping data produce the similar results as non-overlapping data. This may result from the upward sloping yield curve between 1992 and 1997 and managers chose to ride the yield curve to generate abnormal returns.

Overlapping data results are presented in Panel C and D. The frequency and success rates are very close to those results generated from the non-overlapping data. No significant difference between these two data sets.

Table 3 presents evidence on the efficacy of the margin of safety filter for non-overlapping and overlapping three-month and one-year holding period (full-sample and sub-samples) in the auction market. The results are quite similar to those in bill and bond

markets. We also observe zero frequency and success rates for the three-month tenders from 1997-2006. The main reason is the flat Canadian yield curve within these ten years.

Table 4 and Table 5 present the mean excess returns from riding the yield curve with full sample and sub-samples. These tables include the results for both non-overlapping and overlapping data. For three-month overlapping T-bills and tenders, the excess returns are 0.3988 and 0.4266 respectively, when the transaction cost is 0.5 basis points and MOS is greater than and equal to zero. As the transaction cost has been increased to 1 basis point, the returns have been reduced to 0.3938 and 0.4216 respectively. In the bill and bond markets, we observe that the riding strategies generate higher excess returns at higher margins of safety from time to time. Transaction costs affect the mean excess returns; the higher the transaction costs, the lower the mean excess returns. Therefore, riding the long-term yield curve generates higher mean excess returns. The mean excess returns do not uniformly increase as MOS increases. For example, three-month T-bill (full example) excess returns decrease first when MOS is greater than and equal to 0.05 and then increase when MOS is greater than and equal to 0.1.

Overall, the excess returns are considered small and cannot show that the riding strategy is superior to the buy-and-hold strategy. Indeed, they are consistent with a standard risk-return trade-off. Grieves and Marcus (1992) shows that their results do not indicate any abnormal performance form riding the yield curve. In Table 4 and 5, we use Sharpe ratios to characterize how well the return compensates the investor for the risk taken. As we all know, the higher Sharpe ratio indicates more return for the same risk. The ratios for three-month and one-year non-overlapping and overlapping are around 0.2 and transaction costs do not have a big impact on the ratios.

In Table 4, Panel A and B show the non-overlapping and overlapping mean excess returns for three sub-periods. The first sub-period (1992-1997) returns are highest among the three sub-periods in the bill market, while the last period (2002-2006) mean excess returns are the lowest in both bill and bond markets. Like the full sample results, there is no specific trend (increasing or decreasing) of mean excess returns as MOS increases, but the transaction costs reduce the mean excess returns.

Figure 4 presents the cumulative probability distributions of full sample returns from riding with six month bills and the buy-and-hold strategy with MOS greater than and equal to zero and 0.5 basis point transaction cost. The figure shows that the buy-and-hold strategy dominates the riding strategy at high levels of returns, but there is a crossover at low levels of returns. Figure 5 presents the cumulative probability distributions of full sample returns from riding with one year bond and the buy-and-hold strategy with MOS greater than and equal to zero and 0.5 basis point transaction cost. We observe that the riding strategy dominates the buy-and-hold strategy at low levels of returns while the buy-and-hold strategy dominates the riding strategy at high levels of returns

Figure 4 Cumulative Probability Distribution 3-month Bills Overlapping (Full Sample)

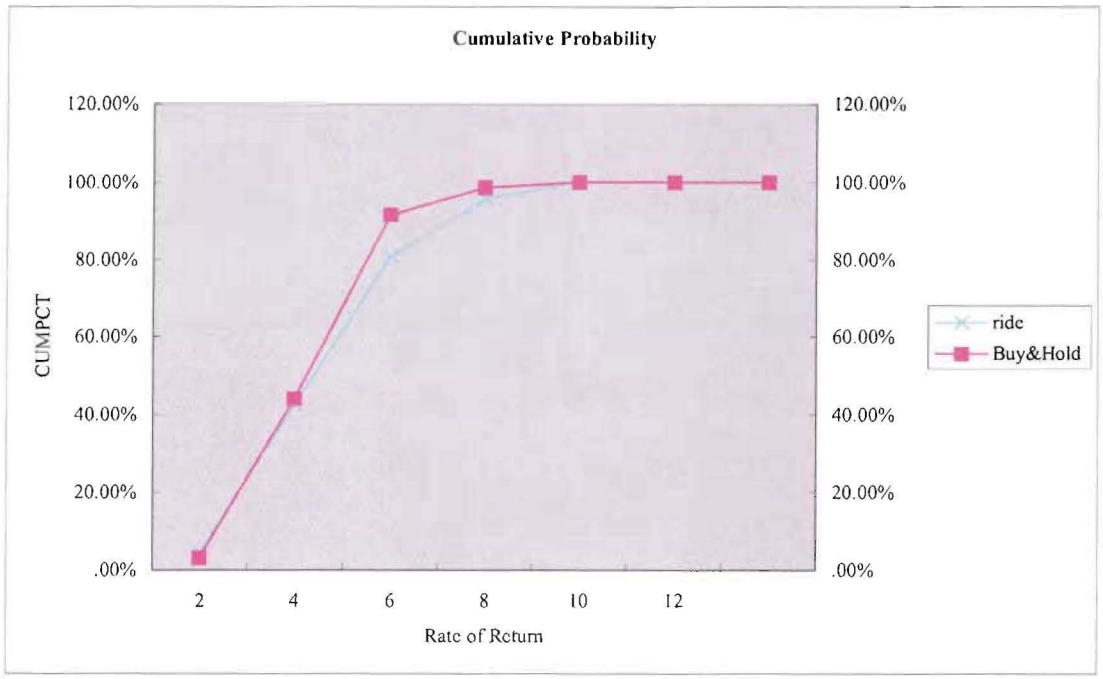
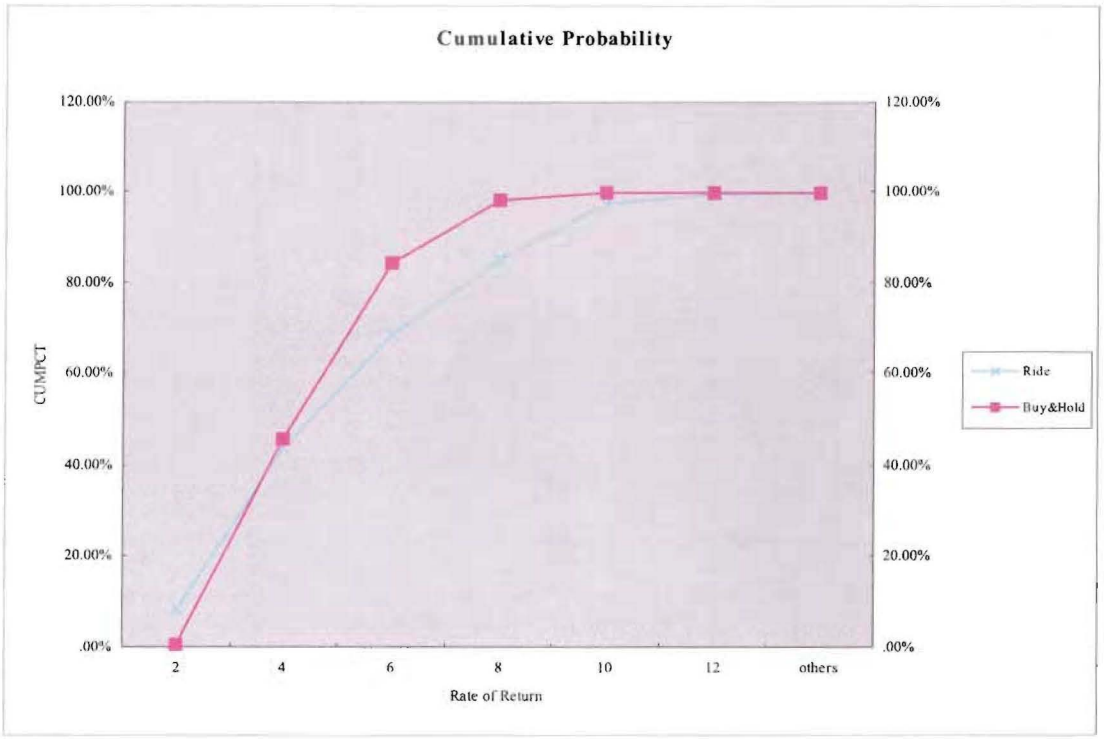


Figure 5 Cumulative Probability Distribution of 1- year bonds Overlapping (Full Sample)



6. CONCLUSION

In this paper, we have examined the profitability of riding the yield curve with 3-month holding periods and six-month securities and one-year holding periods and two-year securities. We have found that the riding the yield curve strategy does offer very small excess returns, but these excess returns show that neither strategy stochastically dominates the other. Riding the long-term securities generates slightly higher return than riding the short-term securities, but the abnormal performance of longer-maturity bills may be viewed as the price of the liquidity attribute. Moreover, these excess returns are very sensitive to the particular sample and subperiod. Since the yield curve is quite flat in Canada for the past ten years, the riding strategy does not provide the optimistic results to the portfolio managers. Therefore, portfolio managers should be cautious when using the riding strategy.

APPENDIX

Table 1 Summary Statistics

	3-Month	6-Month	1-Year	2Year
Panel A: Full Sample (1997/11 - 2007/5)				
Mean	4.1535	4.3351	4.5849	4.8275
Std.	1.4290	1.4691	1.4997	1.4561
Panel A-1: Sub-Sample I (1992/11 - 1997/11)				
Mean	5.0314	5.3279	5.7025	6.0804
Std.	1.5245	1.4909	1.4511	1.3314
Panel A-2: Sub-Sample II (1997/11 - 2002/11)				
Mean	4.2762	4.4270	4.6442	4.8529
Std.	1.1016	1.1227	1.1039	0.8848
Panel A-3: Sub-Sample III (2002/11 - 2007/5)				
Mean	3.0523	3.1410	3.2889	3.4197
Std.	0.7556	0.7476	0.6963	0.5117
Panel B: Full Sample (1997/11 - 2007/5)				
Mean	4.1710	4.3599	4.6092	4.8275
Std.	1.4300	1.4748	1.5023	1.4561
Panel B-1: Sub-Sample I (1992/11 - 1997/11)				
Mean	5.0440	5.3495	5.7241	6.0804
Std.	1.5253	1.5043	1.4594	1.3314
Panel B-2: Sub-Sample II (1997/11 - 2002/11)				
Mean	4.3067	4.4684	4.6833	4.8529
Std.	1.1012	1.1189	1.0956	0.8848
Panel B-3: Sub-Sample III (1997/11 - 2002/11)				
Mean	3.0606	3.1510	3.3001	3.4197
Std.	0.7507	0.7392	0.6884	0.5117

Notes:
Panel A presents the mean and standard deviation calculated in bill and bond markets. Panel B shows the mean and standard deviation computed in auction market.

Table 2 Frequency and Success Rate of Riding the Yield Curve

	MOS>=0				MOS>=0.05				MOS>=0.1				MOS>=0.2			
	Frequency	Success			Frequency	Success			Frequency	Success			Frequency	Success		
		0.005	0.01	0.0325		0.005	0.01	0.0325		0.005	0.01	0.0325		0.005	0.01	0.0325
Panel A 3-month holding period non-overlapping																
Full sample	0.90	0.71	0.69	0.69	0.66	0.48	0.48	0.48	0.45	0.31	0.31	0.31	0.07	0.03	0.03	0.03
1992-1997	0.90	0.76	0.76	0.76	0.81	0.67	0.67	0.67	0.67	0.52	0.52	0.52	0.19	0.10	0.10	0.10
1997-2002	0.90	0.75	0.75	0.75	0.50	0.40	0.40	0.40	0.35	0.25	0.25	0.25	0.00	0.00	0.00	0.00
2002-2007	0.88	0.59	0.53	0.53	0.65	0.35	0.35	0.35	0.29	0.12	0.12	0.12	0.00	0.00	0.00	0.00
Panel B 1 year holding period non-overlapping																
Full Sample	0.79	0.50	0.50	0.50	0.64	0.43	0.43	0.43	0.57	0.36	0.36	0.36	0.29	0.29	0.29	0.29
1992-1997	0.83	0.50	0.50	0.50	0.67	0.33	0.33	0.33	0.67	0.33	0.33	0.33	0.17	0.17	0.17	0.17
1997-2002	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
2002-2005	1.00	0.33	0.33	0.33	0.67	0.33	0.33	0.33	0.67	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Panel C 3-month holding period overlapping																
Full sample	0.90	0.71	0.71	0.68	0.68	0.51	0.51	0.49	0.41	0.30	0.30	0.29	0.12	0.09	0.09	0.08
1992-1997	0.94	0.80	0.80	0.80	0.81	0.67	0.67	0.67	0.61	0.50	0.50	0.49	0.27	0.20	0.20	0.19
1997-2002	0.87	0.74	0.74	0.73	0.60	0.52	0.52	0.51	0.32	0.26	0.26	0.26	0.06	0.05	0.05	0.04
2002-2007	0.89	0.58	0.56	0.50	0.61	0.33	0.32	0.28	0.28	0.12	0.12	0.10	0.01	0.00	0.00	0.00
Panel D 1 year holding period overlapping																
Full Sample	0.79	0.53	0.53	0.53	0.66	0.45	0.45	0.45	0.54	0.38	0.38	0.38	0.32	0.25	0.25	0.25
1992-1997	0.88	0.57	0.57	0.56	0.75	0.45	0.45	0.44	0.64	0.37	0.37	0.37	0.38	0.26	0.26	0.26
1997-2002	0.67	0.54	0.53	0.53	0.50	0.44	0.43	0.43	0.37	0.37	0.37	0.37	0.23	0.23	0.23	0.23
2002-2006	0.83	0.48	0.48	0.48	0.75	0.47	0.47	0.47	0.64	0.42	0.42	0.42	0.35	0.28	0.28	0.28

Notes:

1. The margin of safety (MOS) in riding the yield curve is the percentage difference between the forward rate and the discount rate when securities are sold. $MOS = \frac{R_s^* - E(R_s)}{E(R_s)}$. We pursue the riding strategy only conditional on a filter; that is, MOS≥0, MOS≥0.05, MOS≥0.10 and MOS≥0.20.The frequencies state the percentage of riding operations under each filter, and then we calculate the percentage of successful riding operations (R_{yc} - R_s – transaction cost ≥0), considering the transaction costs of 0.5, 1 and 3.25 basis points.

Where R_{yc} is the actual return from riding strategy, R_s is the actual rate on the T-bill or T-bond when it is sold at the end of the holding period.

2. In Table2, we use the weekly Treasury Bill Market data from 1992/11/25 to 2007/5/30, and divide the full sample data to three sub periods.

Table 3 Frequency and Success Rate of Riding the Yield Curve (Auction Market)

	MOS>=0				MOS>=0.05				MOS>=0.1				MOS>=0.2			
	frequency	Success			frequency	Success			frequency	Success			frequency	Success		
		0.005	0.01	0.0325		0.005	0.01	0.0325		0.005	0.01	0.0325		0.005	0.01	0.0325
Panel A 3-month holding period non-overlapping																
Full sample	0.93	0.74	0.74	0.69	0.69	0.50	0.50	0.47	0.40	0.28	0.28	0.26	0.07	0.05	0.05	0.05
1992-1997	1.00	0.86	0.86	0.86	0.81	0.67	0.67	0.67	0.62	0.48	0.48	0.48	0.19	0.14	0.14	0.14
1997-2002	0.85	0.75	0.75	0.70	0.65	0.55	0.55	0.50	0.30	0.25	0.25	0.20	0.00	0.00	0.00	0.00
2002-2007	0.94	0.59	0.59	0.47	0.59	0.24	0.24	0.18	0.24	0.06	0.06	0.06	0.00	0.00	0.00	0.00
Panel B 1 year holding period non-overlapping																
Full sample	0.79	0.57	0.57	0.50	0.71	0.50	0.50	0.43	0.50	0.43	0.43	0.43	0.36	0.36	0.36	0.36
1992-1997	0.83	0.50	0.50	0.50	0.67	0.33	0.33	0.33	0.50	0.33	0.33	0.33	0.17	0.17	0.17	0.17
1997-2002	0.60	0.60	0.60	0.40	0.60	0.60	0.60	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
2002-2007	1.00	0.67	0.67	0.67	1.00	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Panel C 3-month holding period overlapping																
Full sample	0.91	0.72	0.72	0.70	0.69	0.52	0.52	0.51	0.41	0.31	0.31	0.30	0.12	0.09	0.09	0.09
1992-1997	0.95	0.80	0.80	0.80	0.82	0.67	0.67	0.67	0.62	0.49	0.49	0.49	0.27	0.20	0.20	0.20
1997-2002	0.90	0.78	0.78	0.77	0.65	0.56	0.56	0.55	0.32	0.28	0.28	0.27	0.05	0.05	0.05	0.05
2002-2007	0.88	0.57	0.55	0.49	0.59	0.30	0.29	0.27	0.29	0.14	0.13	0.12	0.02	0.01	0.01	0.01
Panel D 1 year holding period overlapping																
Full sample	0.75	0.51	0.51	0.50	0.63	0.43	0.43	0.42	0.51	0.37	0.37	0.36	0.29	0.24	0.24	0.24
1992-1997	0.87	0.57	0.57	0.56	0.73	0.45	0.45	0.44	0.60	0.37	0.37	0.36	0.36	0.25	0.25	0.24
1997-2002	0.58	0.48	0.48	0.47	0.46	0.40	0.40	0.39	0.37	0.35	0.35	0.34	0.21	0.21	0.21	0.20
2002-2007	0.82	0.47	0.47	0.47	0.72	0.45	0.45	0.45	0.59	0.40	0.40	0.40	0.33	0.28	0.28	0.28

Notes:

1. The margin of safety (MOS) in riding the yield curve is the percentage difference between the forward rate and the discount rate when securities are sold. $MOS = \frac{R_s^* - E(R_s)}{E(R_s)}$. We pursue the riding strategy only conditional on a filter; that is, MOS≥0, MOS≥0.05, MOS≥0.10 and MOS≥0.20.The frequencies state the percentage of riding operations under each filter, and then we calculate the percentage of successful riding operations (R_{yc} - R_s – transaction cost ≥0), considering the transaction costs of 0.5, 1 and 3.25 basis points.

Where R_{yc} is the actual return from riding strategy, R_s is the actual rate on the T-bill or T-bond when it is sold at the end of the holding period.

2. In Table3, we use the weekly Action Market data from 1992/11/24 to 2007/5/29, and divide the full sample data to three sub periods.

Table 4 Mean Excess Returns from Riding the Yield Curve

	MOS>=0			MOS>=0.05			MOS>=0.1			MOS>=0.2		
	0.005	0.01	0.0325	0.005	0.01	0.0325	0.005	0.01	0.0325	0.005	0.01	0.0325
Panel A 3-month holding period non-overlapping												
Full sample	0.3915	0.3865	0.3640	0.3892	0.3842	0.3617	0.3854	0.3804	0.3579	0.0650	0.0600	0.0375
(Sharp Ratio)	0.2344	0.2314	0.2180	0.2326	0.2296	0.2162	0.2140	0.2113	0.1988	0.1139	0.1052	0.0657
1992-1997	0.6450	0.6400	0.6175	0.6209	0.6159	0.5934	0.5686	0.5636	0.5411	0.0650	0.0600	0.0375
1997-2002	0.3650	0.3600	0.3375	0.3010	0.2960	0.2735	0.2721	0.2671	0.2446	-	-	-
2002-2007	0.1023	0.0973	0.0748	0.1114	0.1064	0.0839	0.0310	0.0260	0.0035	-	-	-
Panel B 1 year holding period non-overlapping												
Full sample	0.4968	0.4918	0.4693	0.3072	0.3022	0.2797	0.3338	0.3288	0.3063	0.6150	0.6100	0.5875
(Sharp Ratio)	0.2044	0.2023	0.1931	0.1450	0.1427	0.1321	0.1515	0.1493	0.1391	2.2842	2.2656	2.1820
1992-1997	0.7130	0.7080	0.6855	0.1225	0.1175	0.0950	0.1225	0.1175	0.0950	0.2250	0.2200	0.1975
1997-2002	0.5250	0.5200	0.4975	0.5250	0.5200	0.4975	0.7400	0.7350	0.7125	0.7400	0.7350	0.7125
2002-2007	0.1083	0.1033	0.0808	0.3500	0.3450	0.3225	0.3500	0.3450	0.3225	0.7550	0.7500	0.7275
Panel C 3-month holding period overlapping												
Full sample	0.3988	0.3938	0.3713	0.3848	0.3798	0.3573	0.4266	0.4216	0.3991	0.3750	0.3700	0.3475
(Sharp Ratio)	0.2235	0.2207	0.2081	0.2213	0.2185	0.2055	0.2493	0.2464	0.2332	0.2160	0.2131	0.2002
1992-1997	0.7171	0.7121	0.6896	0.6726	0.6676	0.6451	0.6664	0.6614	0.6389	0.4284	0.4234	0.4009
1997-2002	0.3311	0.3261	0.3036	0.2901	0.2851	0.2626	0.2629	0.2579	0.2354	0.2175	0.2125	0.1900
2002-2007	0.0837	0.0787	0.0562	0.0493	0.0443	0.0218	0.0295	0.0245	0.0020	-0.0317	-0.0367	-0.0592
Panel D 1 year holding period overlapping												
Full sample	0.6442	0.6392	0.6167	0.5761	0.5711	0.5486	0.5809	0.5759	0.5534	0.8002	0.7952	0.7727
(Sharp Ratio)	0.2632	0.2611	0.2519	0.2535	0.2513	0.2414	0.2679	0.2656	0.2552	0.4145	0.4119	0.4003
1992-1997	0.7874	0.7824	0.7599	0.5320	0.5270	0.5045	0.3923	0.3873	0.3648	0.7458	0.7408	0.7183
1997-2002	0.8835	0.8785	0.8560	0.9966	0.9916	0.9691	1.2505	1.2455	1.2230	1.2578	1.2528	1.2303
2002-2007	0.1608	0.1558	0.1333	0.2457	0.2407	0.2182	0.2973	0.2923	0.2698	0.4598	0.4548	0.4323

Notes:

1. The mean excess return of riding the yield curve is computed based on successful riding strategies under each filter and transaction costs.
2. In Panel A, when MOS≥0.20, there is no successful riding operations for sub periods of 1997-2002 and 2002-2007.
3. Sharp ratio is calculated as following: (R_{yc} - R_s – transaction cost)/standard deviation of R_{yc}. We only calculate the sharp ration for full sample.
4. In Table 4, we use the weekly Treasury Bill Market data from 1992/11/25 to 2007/5/30, and divide the full sample data to three sub periods.

Table 5 Mean Excess Returns from Riding the Yield Curve (Auction Market)

	MOS>=0			MOS>=0.05			MOS>=0.1			MOS>=0.2		
	0.005	0.01	0.0325	0.005	0.01	0.0325	0.005	0.01	0.0325	0.005	0.01	0.0325
Panel A 3-month holding period non-overlapping												
Full sample	0.4334	0.4284	0.4059	0.3529	0.3479	0.3254	0.3380	0.3330	0.3105	0.2765	0.2715	0.2490
(Sharp Ratio)	0.2181	0.2156	0.2042	0.2062	0.2033	0.1901	0.1952	0.1923	0.1793	0.2195	0.2156	0.1977
1992-1997	0.7447	0.7397	0.7172	0.6029	0.5979	0.5754	0.4932	0.4882	0.4657	0.2765	0.2715	0.2490
1997-2002	0.3665	0.3615	0.3390	0.2575	0.2525	0.2300	0.2223	0.2173	0.1948	-	-	-
2002-2007	0.0961	0.0911	0.0686	0.0518	0.0468	0.0243	0.0068	0.0018	-0.0208	-	-	-
Panel B 1 year holding period non-overlapping												
Full sample	0.4582	0.4532	0.4307	0.2107	0.2057	0.1832	0.4091	0.4041	0.3816	0.5194	0.5144	0.4919
(Sharp Ratio)	0.1903	0.1882	0.1788	0.1051	0.1026	0.0914	0.1744	0.1723	0.1627	1.4809	1.4666	1.4025
1992-1997	0.5730	0.5680	0.5455	-0.0170	-0.0220	-0.0445	0.1187	0.1137	0.0912	0.0890	0.0840	0.0615
1997-2002	0.4980	0.4930	0.4705	0.4980	0.4930	0.4705	0.7420	0.7370	0.7145	0.7420	0.7370	0.7145
2002-2007	0.2270	0.2220	0.1995	0.2270	0.2220	0.1995	0.5120	0.5070	0.4845	0.5120	0.5070	0.4845
Panel C 3-month holding period overlapping												
Full sample	0.4266	0.4216	0.3991	0.3855	0.3805	0.3580	0.4412	0.4362	0.4137	0.4223	0.4173	0.3948
(Sharp Ratio)	0.2341	0.2314	0.2190	0.2184	0.2155	0.2028	0.2545	0.2517	0.2387	0.2314	0.2286	0.2163
1992-1997	0.7453	0.7403	0.7178	0.6802	0.6752	0.6527	0.6822	0.6772	0.6547	0.4779	0.4729	0.4504
1997-2002	0.3764	0.3714	0.3489	0.2738	0.2688	0.2463	0.2686	0.2636	0.2411	0.2512	0.2462	0.2237
2002-2007	0.0833	0.0783	0.0558	0.0514	0.0464	0.0239	0.0616	0.0566	0.0341	0.0340	0.0290	0.0065
Panel D 1 year holding period overlapping												
Full sample	0.6172	0.6122	0.5897	0.5496	0.5446	0.5221	0.5648	0.5598	0.5373	0.7343	0.7293	0.7068
(Sharp Ratio)	0.2501	0.2481	0.2390	0.2421	0.2399	0.2300	0.2644	0.2621	0.2516	0.3736	0.3711	0.3596
1992-1997	0.7604	0.7554	0.7329	0.5214	0.5164	0.4939	0.4425	0.4375	0.4150	0.6258	0.6208	0.5983
1997-2002	0.8678	0.8628	0.8403	0.9584	0.9534	0.9309	1.1061	1.1011	1.0786	1.1732	1.1682	1.1457
2002-2007	0.1520	0.1470	0.1245	0.2242	0.2192	0.1967	0.2708	0.2658	0.2433	0.5112	0.5062	0.4837

Notes:

1. The mean excess return of riding the yield curve is computed based on successful riding strategies under each filter and transaction costs.
2. In Panel A, when MOS≥0.20, there is no successful riding operations for sub periods of 1997-2002 and 2002-2007.
3. Sharp ratio is calculated as following: (R_{yc} - R_s – transaction cost)/standard deviation of R_{yc}. We only calculate the sharp ration for full sample.
4. In Table 4, we use the weekly Treasury Bill Market data from 1992/11/25 to 2007/5/30, and divide the full sample data to three sub periods.

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