# The Effect of Real Return Bond on Asset Allocation

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PROJECT SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF BUSINESS ADMINISTRITION

In the Faculty

of

Business Administration

Financial Risk Management Program



SIMON FRASER UNIVERSITY

Summer 2011

# Approval

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**Degree: Master of Business Administration**

**Title of Project: The Effect of Real Return Bond on Asset Allocation**

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# The Effect of Real Return Bond on Asset Allocation


## Abstract

The Canada Treasury began issuing 30-year maturity inflation-protected securities with principal and interest payments linked to the Canadian Consumer Price Index from the year of 1991. In our study, we examined whether and how the availability of inflation protected securities might affect investors' asset allocation decisions such as whether investors should hold a different mix of stocks and bonds in the presence of inflation protected bonds of the period from 2001 to 2011. Our study found out that when we add inflation-protected bond into investment portfolio with an investment horizon of both one and five years, at least in Canada market, there is not so much improvement as some of the literatures mentioned especially in mid-term or long-term investment.



**Key Words:** Inflation-Protected Security, Real Return Bond, Asset Allocation, Optimization

## Acknowledgements

We would like to express gratitude to our supervisor, Dr. Christina Atanasova and second reader, Andrey Pavlov, whose invaluable support, comments and encouragement helped us through all the research and writing of this thesis and especial thanks to Dr. Peter Klein for his kind support and stimulating suggestions.

We also thank our beloved parents for supporting us all the way through our study for many years.

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## Introduction:

At the year 1991, the Canada Treasury began issuing 30-year maturity inflation-protected securities with principal and interest payments linked to the Canadian Consumer Price Index (CPI). In Canada, the inflation-protected securities are called RRB that is short form of real return bonds. And the Canada Treasury only issues the RRB with a maturity of 25-30 years. Government of Canada pays semi-annual interest based on a real interest rate. Unlike standard fixed-coupon marketable bonds, interest payments on RRBs are adjusted for changes in the consumer price index RRBs give you payments in two different ways:

1. Interest: Twice a year (June 1 and December 1) you receive a payment for an amount equal to the inflation-adjusted principal multiplied by the coupon rate.

2.Final Payment: The principal or par value is continuously adjusted by an amount equal to the CPI but is payable only when the bond is sold or matures.

An example of how the real return bond works in practice is as below: holding a real return bond with 100 dollars par value. The coupon is paid twice a year in reality, while in this example we assume the

coupon is paid annually with 10% of the principle. If inflation rate is 2 percent annually, then terminal principle value will be adjusted to 102 dollars after one year, and lender will get a 10% of the 102 dollars as the coupon payment. And if there is an inflation of 1% for the second year, then principle value will be adjusted to 103.02 dollars that equal to 102 dollar multiplied by 1.1 percent. In the situation of deflation, if bond principle drops to 90 dollar after experiencing deflation, then the final coupon payment that is ten percent of the 90 dollars principle will be 9 dollars. However, for the principle, lender will get 100-dollar par value back rather than 90 dollars because the Canadian treasury guarantees that you will get either the accumulated inflation adjusted principle or the par value depending on which one is higher. Therefore, the investors are not just protected from inflation but also protected from deflation.

Inflation protected securities are highly attractive to investors, private and institutional, who need to be certain that their investments will retain their real value over the long term. These include private investors saving for retirement and, most importantly, institutional investors wishing to match their investment income with long-term future inflation-linked liabilities such as pension payments. By adding inflation-

protected bonds to a fixed income portfolio, investors can increase their return while reducing risk.

## Literature Review

There has been a large amount of published research about inflation-protected bonds all over the world. Most of the literature studies the demand and supply for inflation-protected bonds and the major reasons of demand are (1) uncertainty about inflation, (2) the lack of other financial instruments that provide investors with a good hedge against inflation, (3) the usefulness of index-linked bonds for pension funds. Some other thesis study the cost of issuing inflation-protected bonds versus conventional nominal bonds, and also the behavior of inflation-protected bond prices such as David W. Peters (2006) studied the behavior of government of Canada real return bond returns and found out that the real return bond holding period returns were positively related to changes in the year-over-year inflation rate but with a lagged effect, were negatively related to changes in nominal interest rates, but were unrelated to changes in either the stock exchange index or the value of the Canadian dollar.

There are also some researches studying the inflation-protected bond in asset allocation framework. S. P. Kothari and Jay Shanken (2004) studied Asset Allocation with Inflation-Protected Bonds in US market. They found that the real returns on inflation-protected bonds are less volatile than the returns of conventional bond with similar maturity. Moreover the correlation with stock returns is much lower for the inflation-protected bonds. Therefore, they concluded that substantial weights should be given to inflation-protected bonds in an efficient portfolio consisting of stocks, inflation-protected bonds, conventional bonds and a riskless asset. In addition, Ivan Rudolph-Shabinsky (2000) studied inflation-protected bonds in US market and got almost same result as S. P. Kothari and Jay Shanken (2004).

However, only a few of the researches in this field study the effect of Canadian inflation-protected bond that is real return bond on asset allocation. Therefore, our project mainly focuses on this subject.

## Real Return Bond in Canadian Market

Based on most of researches, inflation-protected bonds look very attractive, since the bond offers investors attractive real yield, inflation

protection and government guarantee. While, in this research, we find out that the real return bonds in Canadian market are not so attractive as their performance in US or other major markets. This conclusion is drawn from the following aspects.

1. Full Inflation Protection cannot be guaranteed due to the taxation policy. Assume the inflation rate is 4% annually, and then real return bond buyers will get 4% inflation protection. But what comes after the inflation is the interest rate shifting up. Assume there is a 2% interest rate shift up, and then the drop in the value of your bond would be 2% multiplied by the duration of the real return bond. Therefore, the real return of RRB will be negative sometimes. On the other hand, according to the taxation policy in Canada, the inflation adjustment for the principle of RRB is treated as taxable income. So when the real return bonds experience a surprisingly high inflation, the investors will enjoy some inflation protection but it will be taxed. In such scenario, the investor will not get full inflation protection.

2. Deflation protection may not be worth much. When experiencing deflation, investors will see a drop in the principal and thus a reduction in their coupons. Only the original par value will be guaranteed. Although

the real returns bonds are using accumulated inflation adjustment, and only long-term deflation will cause principle to drop below par value, there is still small probability of this risk.

3. The size of Canadian real return bonds market is quite small. The global inflation-linked bond market has grown significantly over the past 10 years as more governments and corporates have issued inflation-linked debt. The market value of the global inflation-linked bond market now totals $1.4 trillion. The US, European, UK and Japanese governments are the major issuers. Demand has increased from investors with inflation-linked liabilities (for example some pension funds) as well as investors with large nominal bond exposures who want to hedge some of this exposure against rising inflation.

While the Canada treasury only issues limited amount of real return bond from time to time, and only with long-term maturities. Table 1 shows that there were only two of the Canadian real return bonds traded last year and the trading value covers only 0.04 percent. Comparing with other sectors, real return bonds represent very small percentage of the Canadian fixed income market.

**Table 1 Composites of Canadian Fixed Income Market (2010)**

| | Number of issues traded | Market Value Traded (Billions) | Trading percentage |
|---|---|---|---|
| **Canada T-Bills** | 18 | 1.80 | 7.42% |
| **Provincial T-Bills** | 1 | 0.00 | 0.00% |
| **Government of Canada / Federal Bonds** | 63 | 20.80 | 85.70% |
| **Real Return Bonds** | 2 | 0.01 | 0.04% |
| **Provincial Bonds** | 131 | 1.36 | 5.60% |
| **Municipal Bonds** | 16 | 0.00 | 0.00% |
| **Corporate Bonds** | 199 | 0.30 | 1.24% |
| **Mortgage Backed Securities (MBS)** | 0 | 0.00 | 0.00% |

4. RRB demand is higher than supply. Since the demand is higher than the supply of real return bonds. People can also sell this kind of bond on a secondary market with a much higher price than its cost. Therefore, the profit will be much less.

## The Effect of RRB on Asset Allocation

After studying the Real Return Bond in Canadian Market, we try to implement all these unique conditions into asset allocation to see how the availability of RRB can achieve higher rate of return for a given level of risk in a portfolio and how optimal asset allocation is affected.

In asset allocation process, the first thing we need to do is to define the inputs of the asset allocation optimizer such as the expected return, corresponding risk, and the correlations of different assets in the portfolio. In our research, we simplified the classification of assets and assume that there are only four kinds of assets in the market, which are Treasury Bills, Conventional Long-term Bond with comparable maturity as Real Return Bond, Real Return Bond (RRB) and stocks.

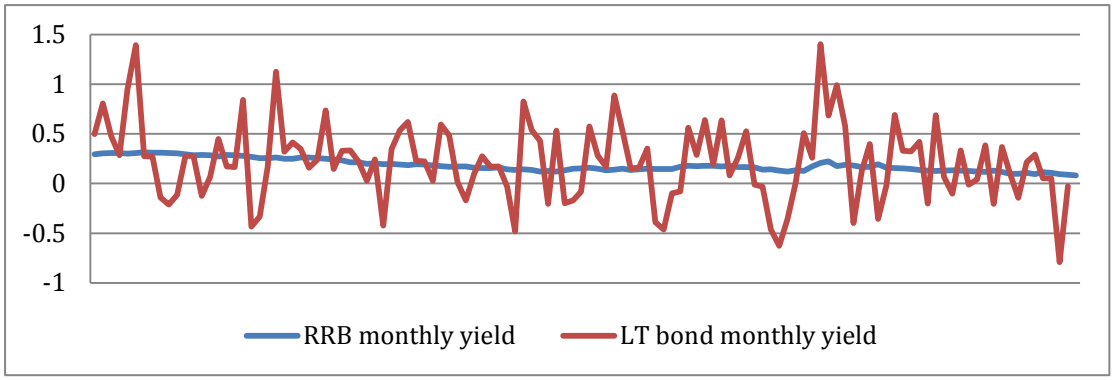
All the expected returns used in the asset allocation optimizer are the real returns of each asset which are the returns deflated using inflation rate of the corresponding time point. In most of the researches we studied, the authors ignore the factor of the inflation and use a nominal framework. However, analyzing asset allocation in real terms will allow portfolio managers to make a more reasonable comparison between the real returns bonds and other assets with deflated real returns. In this research, we calculated Canadian inflation rate using 10-year historical CPI data. The average inflation rate for the past 10 years is 1.95 percent.

We studied 10-year historical data in the period of 2001 to 2011 from the source of Bank of Canada and Yahoo Finance website. After deflating, the average annual real return of each asset is: Treasury Bills,

0.75 percent; Conventional Long-term Bond, 2.61 percent; Real Return Bond, 2.22 percent; and stocks which is represented by S&P/TSX, 4.02 percent. The real return of Real Return Bond is almost half of that of stocks but its return is similar as the return of Conventional Long-term Bond.

The real risk which is defined as standard deviation relative to annual real return of each asset class is shown as below: Treasury Bills with one-year maturity, 1.37 percent; Conventional Long-term Bond, 1.35 percent; Real Return Bond, 0.22 percent; and stocks, 14.81 percent. We can see that the risk of Real Return Bond is significantly lower than the other assets. This result can be better showed in Figure 1. Yield on Conventional Long-term Bond of more than 10-year maturity was much more volatile than the yields on Real Return Bond so that Real Return Bond had much less risk.

**Figure 1: Real Yield for Conventional Long-term Bond and Real Return Bond in the period of 2001-2011**




Next, the real return correlations among these asset classes are shown in Table 2. When stocks returns rise, the returns of other three assets usually decline and vice versa. The correlation between T-bill and long-term bond are highly positive. However, the correlations between Real Return Bond and T-bill, long-term bond are very low.

**Table 2: Historical Real Correlations for T-bill, LT Bond, Canadian stocks and RRB in period of 2001-2011**

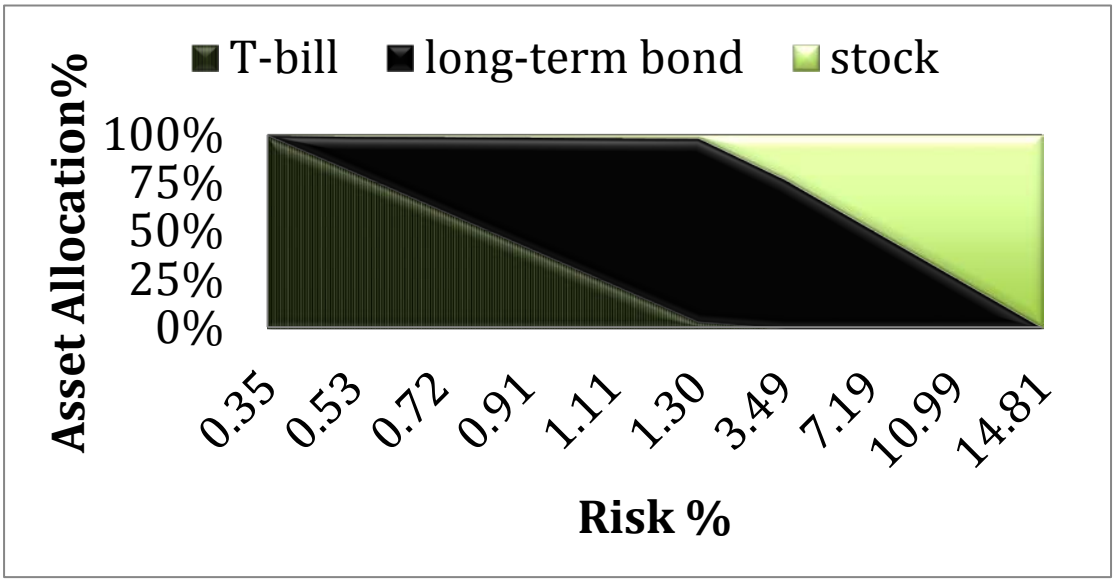
| | T-bill | LT Bond | Stocks | RRB |
|---|---|---|---|---|
| **T-bill** | 1 | | | |
| **LT Bond** | 0.97 | 1 | | |
| **Stocks** | -0.09 | -0.08 | 1 | |
| **RRB** | 0.16 | 0.24 | -0.12 | 1 |

Based on the expected returns, corresponding risks, correlations data for the three assets and given a one year horizon, the Matlab optimization function ‘frontcon’ will identify the optimal asset allocation and efficient frontiers of those assets.

In the following part, we will figure out how RRB affects asset allocation by comparing the results of the portfolio with and without RRB.

First, we consider a portfolio with three asset classes: T-bills with one-year maturity, Long-Term Bonds and TSX Index. After using optimization function, we get the optimal portfolio weights, as shown in Figure 2.

**Figure 2: Conventional Asset Allocation in a Real Framework for One-Year Horizon**

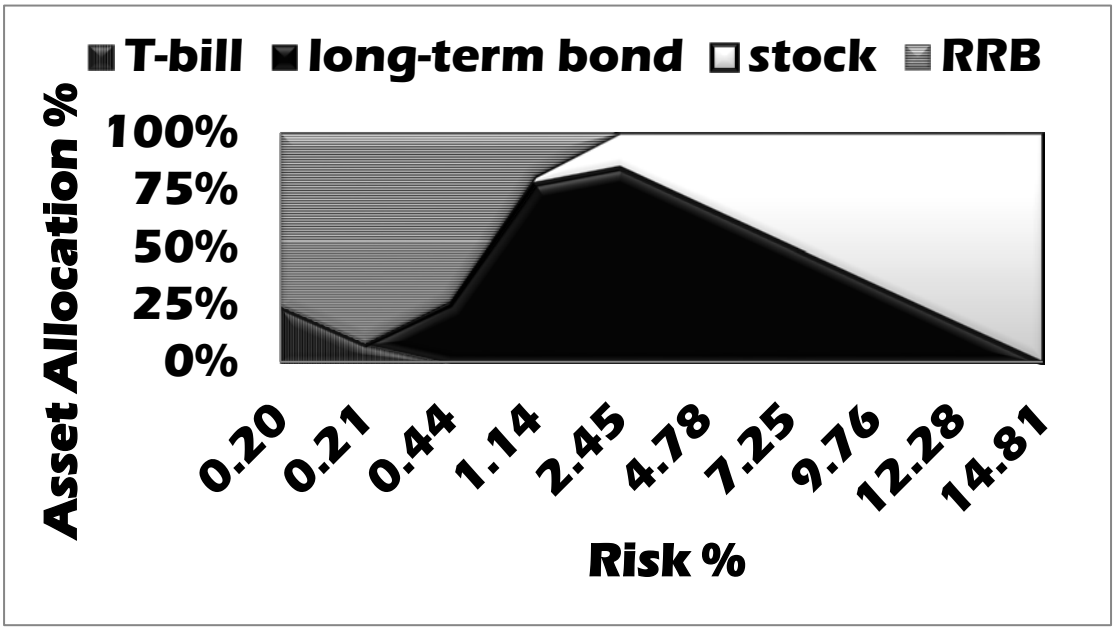



We can see from Figure 2 that when portfolio return and risk increase, the weight of T-bill which is the gray part with vertical lines decreases, and the black part which represents the weight of long-term bond also decreases, but the weights of stock which is the white part increases. And the chart shows the investors with an average risk

tolerance would have almost all the weights in conventional long-term bond. The investors with lower risk tolerance would invest most of wealth in T-bills and less wealth in long-term bond and the aggressive investors who have higher risk tolerance would invest most of wealth in stocks and less in long-term bond.

Then, we add RRB to our portfolio. Therefore, we now have all four kinds of assets in our portfolio. The effect of RRB on optimal portfolio weights is shown in Figure 3.

**Figure 3: Asset Allocation with Real Return Bond in a Real Framework for One-Year Horizon**

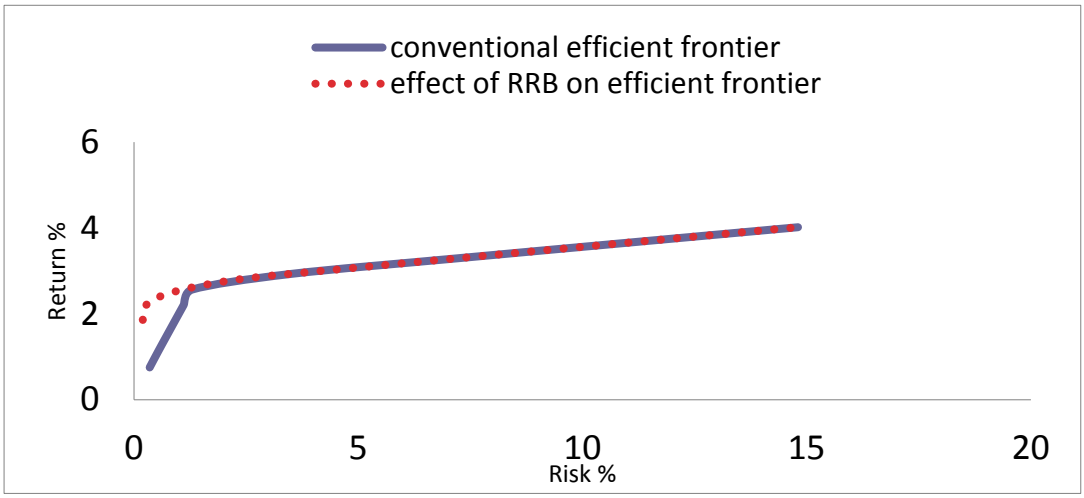



From Figure 3, we can conclude that when portfolio return and risk increase, the weight of T-bill decreases but most of T-bill weights are

replaced by real return bond comparing with Figure 2. And the weight of long-term bond also decreases when portfolio risk increases, but the weights of stock increases which is the same as Figure 2.

In conclusion, the chart shows the investors with average risk tolerance would still have almost all the weights in conventional long-term bond. The investors with lower risk tolerance would invest most of wealth in real return bond and less wealth in long-term bond and T-bills. The more risk-tolerant investors would still invest most of wealth in stocks and less money in long-term bond.

**Figure 4: Comparison of two efficient frontiers**




In the chart above, only when portfolios have low risk, the portfolio with real return bond has higher return, but most of time these two efficient frontiers are perfectly overlapped. So when we add real return bond into investment portfolio, at least in Canadian market, there is not

so much improvement in the low risk part of the efficient frontier as some of the literatures mentioned. Moreover, in this research, conventional long-term bond is the only alternative of real return bond. But if other assets such as mortgage-back securities and corporate bonds which offer higher yield are taken into consideration, the Real Return Bonds may look even less attractive.

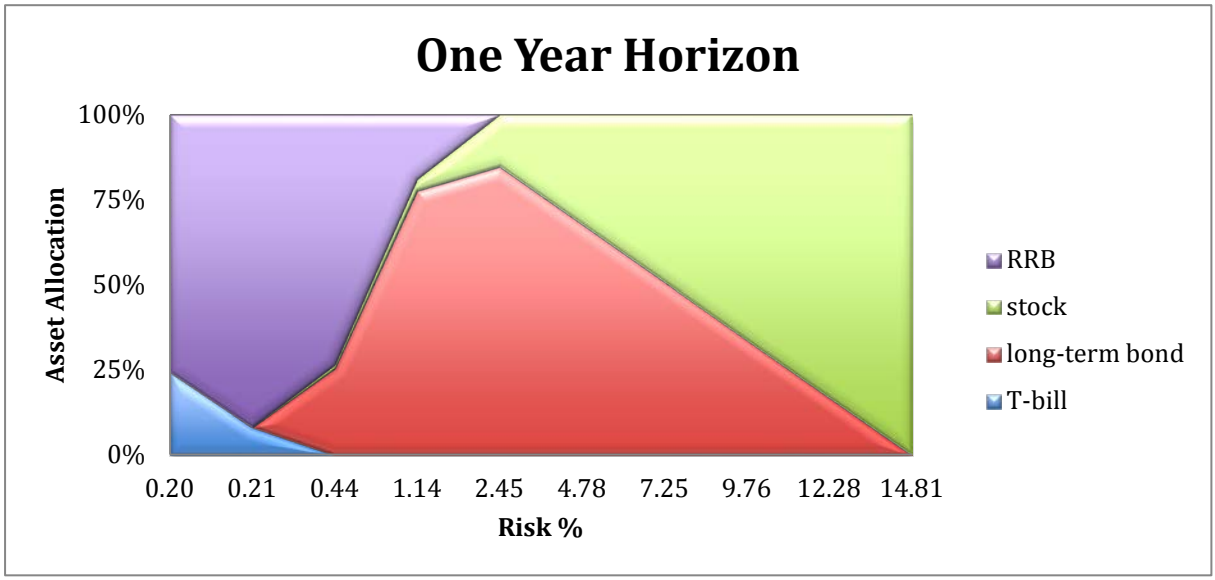
However, a longer time horizon would be more consistent with what most of the investors want. After changing the time horizon in a real framework, we need to identify how the inputs will change when the time expectation extends.

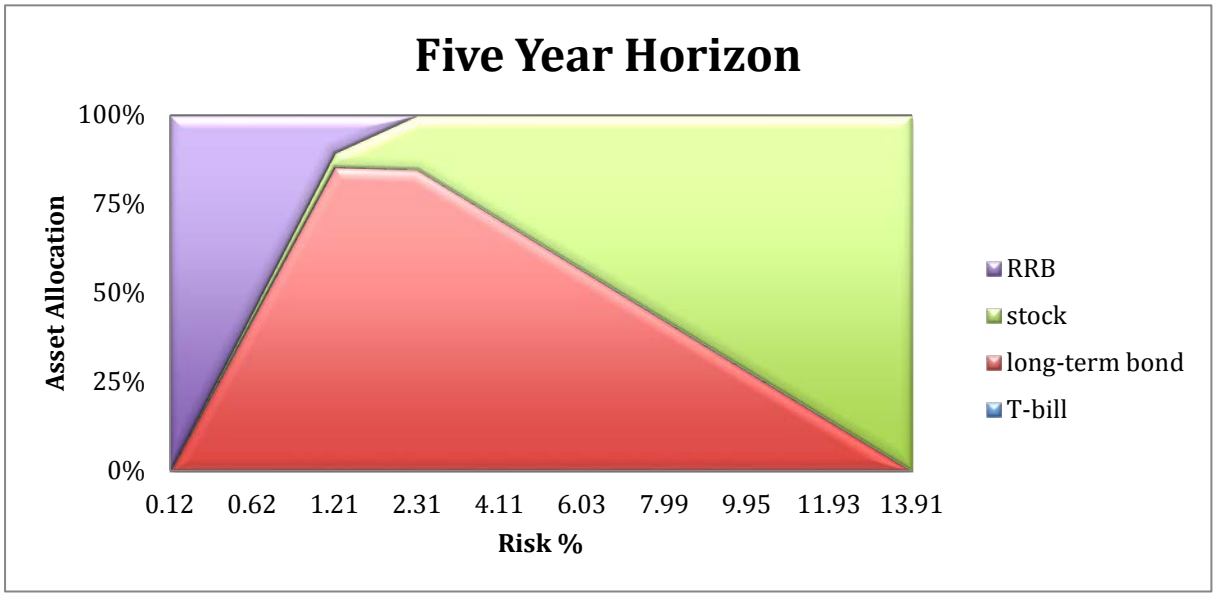
The main changes we do is when calculating the volatility of each asset we take the average of the standard deviation of every five year historical data instead of taking the average of every one year standard deviation which is the way we do when calculating the one year horizon inputs. The tables below are the effect of the time horizon on expected risk of each asset and the asset allocations result with different time horizon inputs.

**Table 3 Effect of Horizon on Expected Real Risk**

| | One –Year Horizon | Five-Year Horizon |
|---|---|---|
| T-bills | 1.2993% | 1.3281% |
| long-term bonds | 1.2926% | 1.3062% |
| stocks | 13.4000% | 13.9058% |
| RRB | 0.0562% | 0.1255% |

**Figure 5 Effect of RRB on Asset Allocation with different horizon**



The result does not change much for the higher risk part of the efficient frontier since stocks will still dominant other assets because of its high risk high return compared to other assets. The main difference of the result is on the low risk part of the portfolio. The return of T-bills is primarily related to two factors – short-term interest rates and inflation rate. Since those two factors can be predicted with confidence over only a short time horizon, the expected risk of T-bills will be higher when the time period extends. That is the reason why the Real Return Bonds take a even more dominant role in the low risk part of the efficient frontier. The Real Return Bond will not just kick out most of LT bonds, but will also take over some portion of T-bills.

## Limitations

Several extensions to this study may be suggested. Only four types of investments are considered in our mean variance analysis and other alternatives such as mortgage-backed securities, corporate bonds that offer higher yields than government issued bonds are neglected in our research in order to simplify. Moreover, real estate, derivatives and private equity with longer time horizons may be other asset choices to

consider. In addition, the impact of taxes is an important point but it has not been addressed in this research.

## Extensions

The demand of RRB is mainly from pension funds that are bond-like liabilities. Historically, pension funds are bonded with equity and most of them use equity to hedge against inflation. However, comparing to equity, RRB can better match the pension funds' time horizon. In this research, we have only four asset classes in the framework. To make it better, we can add liability to our portfolio which may result in higher weights in RRB because of the better time horizon matching with the liabilities.

## Conclusions

Earlier studies about asset allocation with inflation-protected securities mainly discussed the results in US market and most of them report that inflation-protected bonds look very attractive, since the bond offers investors attractive real yield, inflation protection and government guarantee. While, in this research, we find out that the real return bonds in Canadian market are not so attractive as their performance in US or

other major markets. Moreover, real return bond mainly take effect when portfolio risk is low. However, when portfolio risk ranges from average to high, real return bond hardly affect the results of asset allocation.

If an investor demands high consistency of low risk, then Real Return Bonds might be a good asset choice for the investor’s portfolio. However, the theoretical framework provided does not suggest high allocation to Real Returns Bonds.

# Reference List

1. Ivan Rudolph-shabinsky, 2000, Association for Investment Management and Research, “Inflation-Protected Securities in an Asset Allocation Framework”

2. Ian Christensen, Frederic Dion, and Christopher Reid, 2004-43, “Real Return Bonds, Inflation Expectations, and the Break-Even Inflation Rate”, Working Paper, Bank of Canada

3. S. P. Kothari and Jay Shanken, 2004, “Asset Allocation with Inflation-Protected Bonds”, *Financial Analysts Journal*, Vol. 60, No. 1 (Jan. - Feb., 2004), 54-70

4. David W. Peters, 2007, “ The behavior of government of Canada real return bond returns”, *International Review of Financial Analysis*, Vol. 16, 152– 171

5. Riley, William B Jr., Chow, K Victor, 1992, “Asset Allocation and Individual Risk Aversion”, *Financial Analysts Journal*, Vol. 48, No. 6 (Nov. - Dec., 1992), 32

6. Fischer Black, Robert Litterman, 1992, “ Global Portfolio Optimization”, *Financial Analysts Journal*, (Sep. - Oct., 1992), 28-37

7. Unknown, 2008, “Insight education on Inflation-Linked Bond”, *FIL Investment Management Ltd.*

# Appendix

## Appendix 1 Asset Allocation Results of Optimization Function

## (Portfolio with T-bill, LT Bond and Stock)

| Port Return | Port Risk | Weights | | |
|---|---|---|---|---|
| | | T-bill | LT bond | Stock |
| 0.755858119 | 0.349642437 | 0.997372834 | 0 | 0.002627166 |
| 1.118695604 | 0.533735041 | 0.806285787 | 0.185644595 | 0.008069619 |
| 1.481533089 | 0.723456911 | 0.613242684 | 0.375813183 | 0.010944133 |
| 1.844370573 | 0.914489108 | 0.420199581 | 0.565981772 | 0.013818648 |
| 2.207208058 | 1.106152962 | 0.227156478 | 0.75615036 | 0.016693162 |
| 2.570045543 | 1.298168726 | 0.034113375 | 0.946318948 | 0.019567677 |
| 2.932883028 | 3.491304133 | 0 | 0.768912631 | 0.231087369 |
| 3.295720512 | 7.19172037 | 0 | 0.51260842 | 0.48739158 |
| 3.658557997 | 10.98814806 | 0 | 0.25630421 | 0.74369579 |
| 4.021395482 | 14.80691974 | 0 | 2.78E-16 | 1 |

## Appendix 2 Asset Allocation Results of Optimization Function

## (Portfolio with T-bill, LT Bond, Stock and RRB)

| Port Return | Port Risk | Weights | | | |
|---|---|---|---|---|---|
| | | T-bill | LT bond | Stock | RRB |
| 1.862390133 | 0.196319708 | 0.24527126 | 0 | 0.002005006 | 0.752723734 |
| 2.102279617 | 0.206064664 | 0.082517889 | 0 | 0.002113533 | 0.915368578 |
| 2.3421691 | 0.436586293 | 0 | 0.255895897 | 0.013022594 | 0.731081509 |
| 2.582058583 | 1.136393031 | 0 | 0.776697578 | 0.034668846 | 0.188633576 |
| 2.821948066 | 2.447160771 | 0 | 0.847275807 | 0.152724193 | 0 |
| 3.061837549 | 4.781355364 | 0 | 0.677820645 | 0.322179355 | 0 |
| 3.301727032 | 7.254196607 | 0 | 0.508365484 | 0.491634516 | 0 |
| 3.541616516 | 9.760872077 | 0 | 0.338910323 | 0.661089677 | 0 |
| 3.781505999 | 12.28068097 | 0 | 0.169455161 | 0.830544839 | 0 |
| 4.021395482 | 14.80691974 | 1.91E-17 | 0 | 1 | 0 |