INCENTIVE FEES - IMPACT ON PERFORMANCE MEASUREMENT OF HEDGE FUNDS

by

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ABSTRACT

This paper expands on the work of Amenc, Martellini and Ziemann (2009) that studies Inflation-Hedging Properties of Real Assets and Implications for Asset-Liability Management Decisions. Their results suggest that liability hedging investment solutions, including commodities and real estate (Alternative Investments) in addition to inflation-linked securities(TIPS), can be designed to decrease the cost of inflation insurance for long-horizon investors. The increased expected return potential generated through the introduction of Alternative Investments to TIPS also allows global performance expectation and better risk management properties. This paper extends their strategy to Canadian market, but for the different investor group – general investors without active liability management needs. My study focuses on the inflation hedging capacity and the optimal asset mix of the investment portfolio including Canadian Real Return Bonds added by Real Estates and Commodities. The results support that those investment portfolios offer cost effective protection for Canadian investors during inflationary periods and also provide some diversification benefits.

Inflation Hedging and Optimal Asset Allocation for Canadian investors

1. Introduction

Since the Global Financial Markets turmoil in 2008, governments introduced forceful measures from profound fiscal stimuli to extensive monetary easing to rescue their economy. As a result, the longer-term inflationary consequences of central bank's rescue efforts and enormous deficits become a major concern to the investors. Although inflation is unlikely immediate problem, it is general consensus that it's prudent to look for an insurance against inflation risk.

Inflation hedging is particularly important for pension funds facing pension payments that are indexed with respect to consumer price or wage level indices. (Amenc *et al.*, 2009) However, general investors with diversified portfolios are also looking for the protection from inflation risk as the traditional financial investments consisted of stocks and bonds are not perceived to provide sufficient protection for their investments.

The Government of Canada first issued real return bonds (RRBs), commonly referred to as index-linked bonds in December 1991. RRBs consist of bonds for which the principal is adjusted in response to changes in the Consumer Price Index (CPI). They are viewed as an insurance against unexpected inflation for the investors. However, investors buying RRBs transfer the inflation risk to the issuer and pay a higher price for

it as compared to a nominal bond. The coupon rate of a RRB remains the same, but, the actual interest payment rises with inflation (Lemaire and Plante, 2009)

In US Market, a variety of cash instruments such a Treasury inflation-protected securities (TIPS), as well as dedicated OTC derivatives, such as inflation swaps, are typically used to tailor customized inflation exposures that are suited to each particular pension fund liability profile. One outstanding problem, however, is that the capacity of the inflation linked-securities market is not sufficient to meet the collective demand of institutional and private investors, while the OTC inflation derivatives market suffers from a perceived increase in counterparty risk. In addition, real returns on inflation-protected securities, negatively impacted by the presence of a significant inflation risk premium, are typically very low, which implies that investing in inflation linked securities, when feasible, is a costly option for pension funds and their sponsor companies. In this context, it has been argued that some other asset classes, such as stocks and nominal bonds, but also real estate or commodities, could provide useful, albeit imperfect, inflation protection at a lower cost compared to investing in TIPS. (Amenc *et al*., 2009)

This paper investigates the relationship between various investment returns and inflations in Canadian market. The objective is to establish whether alternative investments in real estates and commodities provide a reliable inflation hedge complementing inflation-indexed securities (RRB). Regression results show that returns on REITs and commodity index are positively correlated with the historical

inflations and the correlations become higher as time horizon increased. Besides, the markets for REITs and commodities are much bigger and more liquid than the markets for Real Return Bonds. Therefore, those investments may offer cost effective protection combined with RRB during inflationary periods and also provide diversification benefits for investment portfolio. I also ran optimizer trying to find optimal asset allocations incorporating inflation hedging portfolio with different allocation ratios of alternative investments in order to maximize return while providing inflation hedge and minimizing portfolio risk.

Precedent of this paper is the article “Inflation-Hedging Properties of Real Assets and Implications for Asset-Liability Management Decisions (2009)” written by Amenc, Martellini and Ziemann. In their study, they examined the relationship between inflation-driven liabilities and asset returns on bonds, stocks, commodities, and real estate at various horizons. Their study was mainly on the asset-liability management decisions of institutional investors such as pension funds which have liabilities of which payments are indexed with respect to consumer price or wage level indices. On the other hand, my study is manly for the asset mix decision of general investors who do not have active liability management needs but still need to protect their assets from the inflation risks. Both of our studies focus on a set of traditional and alternative asset classes and limit to opportunity set to liquid and publicly traded assets. Their empirical analysis used the CRSP value-weighted stock index, S&P Goldman Sachs Commodity Index, FTSE NAREIT Index, the Lehman Long U.S. Treasury Index as well as the one-month Treasury bill rate and inflation proxy represented by the consumer

price index. In my analysis I used the equivalent data in Canadian market except for the commodities, where I used commodities proxied by Dow Jones UBS Commodity Index adjusted for USD/CAD FX rates. Amenc *et al*. first compared volatility and correlations of different asset classes for the different time horizons up to 120 quarters while I covered time horizons up to 60 months in my study. Then they established liability hedging portfolio (LHP) which is consisted of TIPS as Inflation Indexed Securities in US and alternative investment (AI) portfolio of Commodity and Real Estates while I used Real Return Bonds replacing TIPS in my inflation hedging portfolio for Canadian investors. They also examined the Liability-hedging capacity for the LHP and the PSP (Performance Seeking Portfolio; stocks and bonds, according to the allocation that maximizes Sharp ratio) using Mean Funding Ratio and the Probability of Shortfall and Probability of Severe Shortfall. The study further examined how the liability hedging capacity is enhanced by adding more AI to the LHP. In my study I followed the same concept but compared changes in volatilities and correlations with inflation of the investment portfolios as a measure of inflation hedging capacity. While they examined how the investors can reduce the allocation to PSP portfolio as a way to improve ALM risk budget I tried to find optimal asset allocation mix to improve risk/return efficiency.

2. Literature Review

There were many studies to investigate the relationship between various investments with inflation to identify the effective ways to hedge inflation risk and to reduce the overall portfolio risks.

Froot (1995) examined the properties of a variety of asset classes that might broadly be thought of as "real" assets. It looked at how closely correlated these classes are with inflation, as well as how effectively they help insure major financial asset classes against adverse shocks. It also examined how inflation hedges might be combined in a portfolio. According to his research levered positions in commodities with a high energy component and a hypothetical CPI-linked bond exhibit strong hedging properties.

Adrangi, Chatrath and Raffiee (2004) examined Equities and Mortgage REITs from 1972 to 1999 and investigated the relationship between their returns and inflation with objective to establish whether securitized real estate investments provide a reliable inflation hedge. Regression results showed that real REIT returns are negatively correlated with the unexpected component of inflation. Therefore, equity and mortgage REIT investments may not offer a safe haven during inflationary periods. Chow tests confirm that there is evidence of a decoupling of REITs from the general stock market for more recent intervals.

Glassman (2006) discusses ways to help stock and bond investors protect themselves against inflation and also profit from it. He suggested that stocks do better to counter inflation because they represent a claim on the profits of a business and it is wise to own stocks than bonds especially stocks of companies that appear to have the power to raise their prices without much resistance, such as soft drink company Coca-Cola.

Although the price of bonds declines with rising inflation, the income from those bonds can increase if they are managed well.

Le Moigne and Viveiros (2008) used correlations and time-series regressions to revisit the inflation-hedging ability of Canadian direct real estate over the 1973-2007 periods. Full-period results show that real estate hedges against inflation, and both expected and unexpected inflation. However, these results are strongly driven by the 1973-1984 sub-period, a high inflation environment. From 1985 to 2007 in a low inflation environment, no province or property type hedges against inflation and unexpected inflation, while exclusively British Columbia's and Quebec's real estate hedge against expected inflation. Additional tests suggest that the introduction of an "inflation targeting" policy by the Bank of Canada in 1991 might explain the vanishing of the inflation-hedging ability of direct real estate in Canada.

Hoevenaars *et al.*(2008) studied the strategic asset allocation for an investor with risky liabilities which are subject to inflation and real interest rate risk and who invest in stocks, government bonds, corporate bonds, T-bills, listed real estate, commodities and hedge funds. They found that the covariance structure exhibits horizon effects regarding the inflation hedge and interest hedging qualities of the additional assets. Commodities help in hedging inflation risk, as they move closely with inflation in the short and long run. They have also the best risk diversifying properties among the assets due to little correlation with stocks and bonds. Hedge funds have good inflation hedging qualities in the long run, but also much exposure to stocks and bonds. Term

structure properties of listed real estate are mostly captured by traditional asset classes such as stocks and bonds. Credits are similar to bonds: inflation hedging qualities of both credits and bonds are good in the long run, but poor in the short run. Both asset classes also have good real interest rate hedging qualities.

Amenc, Martellini, and Ziemann (2009) studied the relationship between inflation-driven liabilities and asset returns on bonds, stocks, commodities, and real estate at various horizons. Their results suggest that novel liability hedging investment solutions, including commodities and real estate in addition to inflation-linked securities, can be designed to decrease the cost of inflation insurance for long-horizon investors. Such solutions are shown to achieve satisfactory levels of inflation hedging over the long term at a lower cost compared to a solution solely based on TIPS or inflation swaps. The increased expected return potential generated through the introduction of commodities and real estate in addition to TIPS in the LHP(Liability Hedging Portfolio) allows for a reduced global allocation to the PSP(Performance Seeking Portfolio) while meeting the global performance expectations and, in turn, allows for better risk management properties.

3. Data & Methodology

My empirical analysis focuses on a set of returns on traditional and alternative asset classes. Stock returns are represented by the annualized returns of Standard and

Poor's/Toronto stock Exchange Composite Index (TSE 300) from Dec. 1991 to Dec. 2009 and Corporate Bonds are represented by the annualized returns of Scotia Universe Bond index. Commodities are proxied by the Dow Jones-UBS Commodity Index Total Return which reflects the return on fully collateralized positions in the underlying commodity Futures and those returns were adjusted for USD/CAD FX rates. Sector sub-index weightings are Agriculture (31.09%), Energy (31.09%), Industrial Metals (18.25%), Precious Metals (13.04%) and Livestock (6.54%). Real estate investments are represented by the REITs listed on TSE (iShares S&P/TSX Capped REIT Index). I thus limit the opportunity set to liquid and publicly traded assets. Finally, I added the one-month and 3-month Treasury bills. Inflation rates are represented by Canada Consumer Price Index, all-items, seasonally adjusted. RRB returns are after inflation adjustments.

For those asset classes I calculated average annual returns, variances and correlation coefficient with CPI for the period from 1991 to 2009 using EXCEL spreadsheet. R2 numbers were also calculated using "least-squares" method to estimate the "good of fit" of the model. This analysis is performed for different time horizons – monthly, quarterly, yearly, 3 years and 5 years. Then the returns on inflation hedging portfolios consisted of Real Return Bonds and alternative investments are also analyzed for the same horizons to identify the effectiveness of inflation hedging from adding alternative investments (REITs and Commodity index) to traditional hedging vehicle (Real Return Bonds). I also ran Optimizer to find the optimal asset allocations for the investment portfolios consisted of traditional financial investments and inflation hedging portfolio

with different allocation ratios of alternative investment. For this purpose I set the asset limits for Stocks at 30-40%, Bonds at 30-40%, 3 month T-Bills at 5-15% and Investment Hedging Portfolio 10%-30%, which may represent conventional investors with medium risk preference. In this practice, Variance-Covariance between inflation hedging portfolio (IHP) and other asset classes were also calculated and the Risk/Return of Optimal Portfolio choices were reviewed to identify the diversification benefits of IHP with different allocation ratios to AI. When we add the inflation hedging assets with higher volatility the portfolio risk and return will increase with the inflating hedging capicity. The study of Amenc *et al.* addressed this issue by including liabilities and show how the alternative investments contribute in hedging liabilities. In my study, I addressed the same issue by doing optimizations in real terms – i.e. Optimizer used real returns (nominal returns deflated by CPI) to produce the optimization results aiming that the test results show the diversification effects without the presence of liabilities.

4. Results and Discussion

Exhibits 1 present summary statistics for annual returns during the entire 1991 – 2009 periods. Exhibits 2 present Annualized Volatilities for different time horizons. Each graph shows how the volatility changes over the time horizon. Commodity Index followed by Stocks and REITs shows highest volatility for the short term horizon and it become lower as horizon become longer. Annualized Volatility of DJ Commodity Index for one month horizon is 0.645 and it's reduced to 0.068 for 5 year horizon whereas

annualized volatilities of Government Bonds show almost no changes through out the different horizons with range from 0.017 to 0.018. In Amenc *et al.*(2009) the VECM – implied volatilities of liabilities, T-bills and real estate investments appear to be more risky in the long run, while bonds, stocks, and commodities exhibit a downward-sloping volatility structure, especially from very short- to medium-term horizons. Overall, two studies show consistent results for the trends in horizons except for real estates, of which volatility shows upward sloping in Amenc et al.'s study while it shows downward sloping in my study. It is also noted that the differences in volatilities of different asset classes are much higher in my study especially for short term horizon. For the case of Stocks the volatilities are ranged between 0.15 to 0.11 in 0 – 120 quarters horizon whereas Stock's volatilities ranged from 0.33 to 0.05 in 1 – 20 quarters. Similarily, Commodities ranged between 0.17 to 0.12 in Amenc *et al.* and they are ranged between 0.42 to 0.07 in my study.

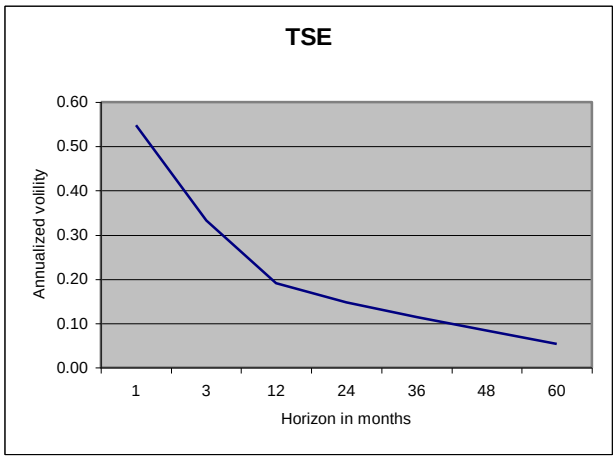
Exhibit 1 Summary statistics for annual returns during the entire 1991– 2009

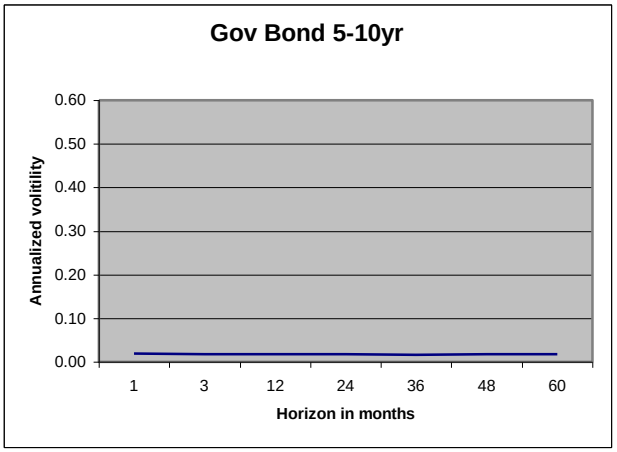
(unit: %)	TSE	Gov Bond 5-10yr	Gov Bond LT	RRB*	CPI (ses adj)	Tbill 1M	Tbill 3M	Corp Bonds	Canadian REITs	DJComm Index(C$)
1991	9.42	9.36	9.76	8.98	1.53	9.48	8.83	12.79	8.69	-5.97
1992	-8.43	8.16	8.77	8.55	2.10	6.50	6.51	10.06	0.38	-7.20
1993	32.06	7.24	7.85	6.81	1.28	5.54	4.93	8.89	19.22	-3.06
1994	-12.55	8.26	8.63	6.91	0.58	4.59	5.42	-0.34	-1.54	7.14
1995	21.24	7.93	8.28	7.61	1.64	7.12	6.98	1.59	14.19	19.27
1996	20.68	6.86	7.50	7.27	2.08	4.80	4.31	0.98	13.92	21.87
1997	9.23	5.87	6.42	5.23	1.12	2.78	3.21	0.78	8.60	-11.31
1998	0.44	5.26	5.47	3.80	0.64	4.56	4.74	0.74	4.51	-35.48
1999	23.13	5.56	5.69	5.65	2.27	4.58	4.70	-0.09	15.07	25.79
2000	9.45	5.96	5.71	6.63	2.94	5.22	5.45	11.02	22.89	21.42
2001	-19.79	5.32	5.76	4.92	1.33	3.80	3.74	7.23	16.14	-24.27
2002	-15.21	5.08	5.68	7.79	4.29	2.40	2.55	7.35	-3.60	28.39
2003	26.01	4.54	5.34	4.31	1.26	2.81	2.85	8.61	17.41	39.98
2004	7.71	4.34	5.14	4.34	2.00	2.12	2.22	6.53	4.26	9.04
2005	26.07	3.89	4.40	4.71	2.89	2.56	2.73	4.68	16.78	27.09
2006	8.72	4.18	4.28	2.88	1.19	3.93	4.04	4.43	16.22	-3.17
2007	0.92	4.25	4.32	4.14	2.15	4.05	4.12	1.44	-21.89	35.81
2008	-41.41	3.36	4.05	2.96	1.06	2.24	2.30	-0.11	-50.29	-63.70
2009	24.37	2.84	3.90	3.82	1.91	0.25	0.32	15.63	37.62	33.56
Average	6.43	5.70	6.15	5.65	1.80	4.18	4.21	5.38	7.29	6.06
Volatilities	19.11	1.83	1.79	1.88	0.89	2.10	1.96	4.89	18.62	26.97
$\rho 1$**	8.39	-16.41	-17.65	31.61	100.00	-14.91	-16.84	28.55	9.94	54.84
R2	0.70	2.69	3.11	9.99	100.00	2.22	2.84	8.15	0.99	30.08

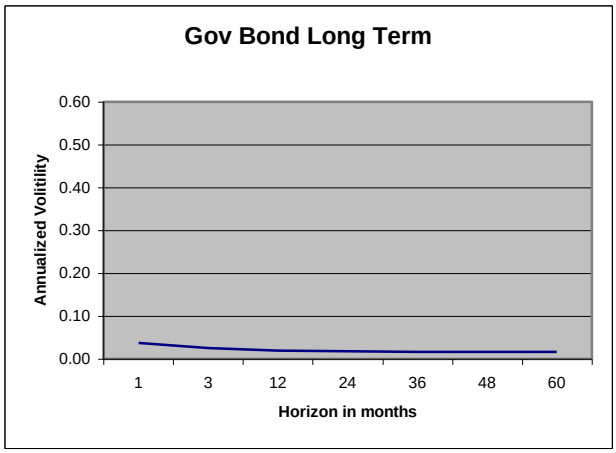
* RRB after inflation adjustment

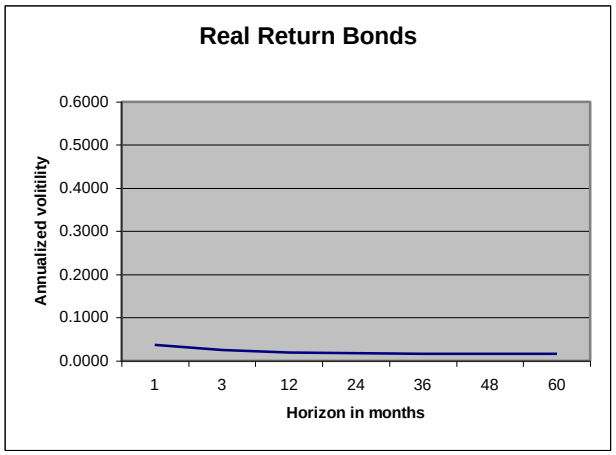
** $\rho 1$ indicates the correlation coefficient with CPI

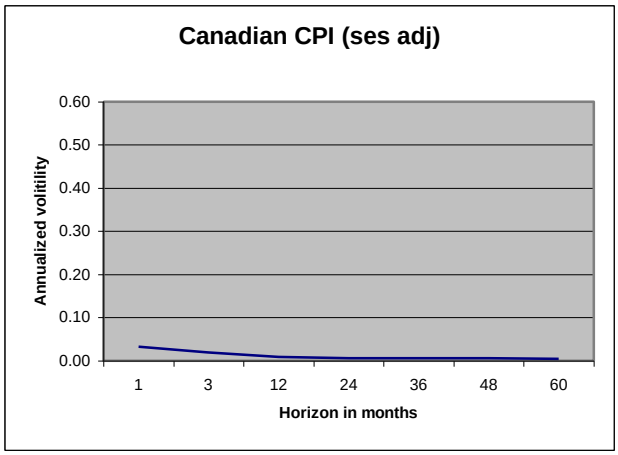
Exhibit 2
Annualized Volitilities

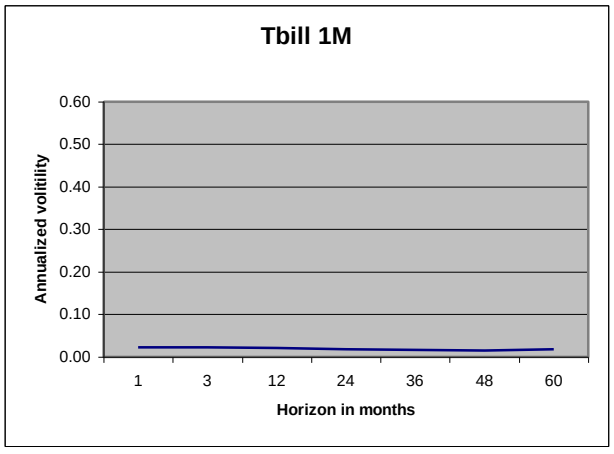


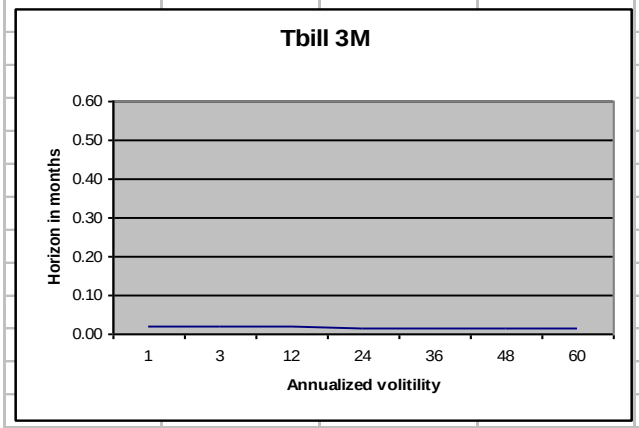


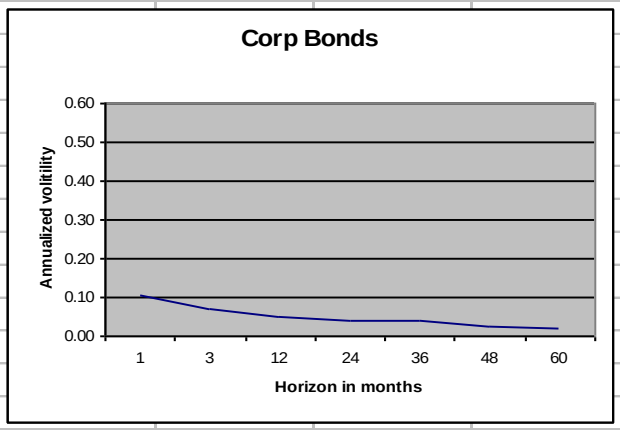


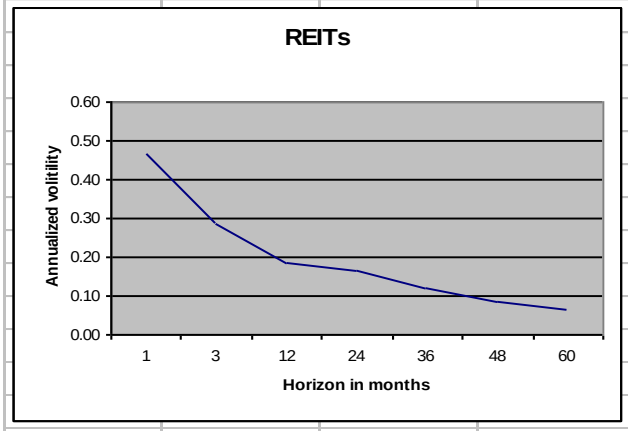


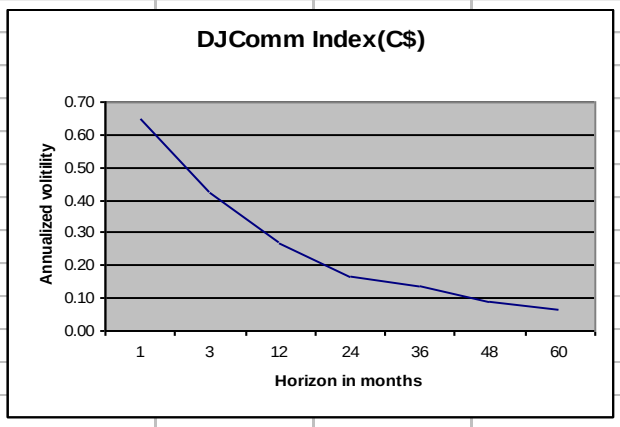





Tbill 3M
Horizon in months
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1
3
12
24
36
48
60
Annualized volitility


Corp Bonds
Annualized volitility
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1
3
12
24
36
48
60
Horizon in months


REITs
Annualized volitility
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1
3
12
24
36
48
60
Horizon in months


DJComm Index(C$)
Annualized volitility
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1
3
12
24
36
48
60
Horizon in months

Exhibits 3 summary statistics for variances, Correlations with CPI for different horizons.

	TSE	Gov Bond 5-10yr	Gov Bond L	Real Return Bonds	Canadian CPI (ses adj)	Tbill 1M	Tbill 3M	Corp Bonds	REITs	DJComm Index(C$)
Monthly										
20 Yr Average	0.064	0.057	0.062	0.056	0.018	0.042	0.042	0.054	0.073	0.061
Volatility	0.547	0.018	0.018	0.037	0.033	0.023	0.020	0.103	0.465	0.645
Corr w/Inflation	0.058	-0.009	-0.026	0.875	1.000	0.016	0.020	-0.095	0.096	0.357
R2	0.003	0.000	0.001	0.765	1.000	0.000	0.000	0.009	0.009	0.128
Quarterly										
20 Yr Average	0.064	0.057	0.062	0.056	0.018	0.042	0.042	0.054	0.073	0.061
Variance	0.110	0.000	0.000	0.001	0.000	0.000	0.000	0.005	0.080	0.179
Volatility	0.332	0.018	0.018	0.025	0.019	0.022	0.020	0.068	0.283	0.423
Corr w/Inflation	0.090	-0.030	-0.057	0.696	1.000	0.015	0.016	0.000	0.160	0.478
R2	0.008	0.001	0.003	0.484	1.000	0.000	0.000	0.000	0.026	0.228
Yearly										
20 Yr Average	0.064	0.057	0.062	0.056	0.018	0.042	0.042	0.054	0.073	0.061
Volatility	0.191	0.018	0.018	0.019	0.009	0.021	0.020	0.049	0.186	0.270
Corr w/Inflation	0.084	-0.164	-0.176	0.316	1.000	-0.149	-0.168	0.285	0.099	0.548
R2	0.007	0.027	0.031	0.100	1.000	0.022	0.028	0.081	0.010	0.301
2 Years										
20 Yr Average	0.064	0.057	0.062	0.056	0.018	0.042	0.042	0.054	0.073	0.061
Volatility	0.147	0.017	0.017	0.017	0.006	0.018	0.017	0.039	0.163	0.168
Corr w/Inflation	-0.128	-0.199	-0.236	0.143	1.000	-0.053	-0.078	0.362	0.209	0.476
R2	0.016	0.040	0.056	0.020	1.000	0.003	0.006	0.131	0.044	0.227
3 Years										
20 Yr Average	0.064	0.057	0.062	0.056	0.018	0.042	0.042	0.054	0.073	0.061
Volatility	0.114	0.017	0.017	0.017	0.005	0.016	0.015	0.042	0.118	0.138
Corr w/Inflation	-0.291	-0.223	-0.224	0.118	1.000	-0.292	-0.311	0.599	0.357	0.403
R2	0.085	0.050	0.050	0.014	1.000	0.085	0.097	0.359	0.127	0.162
4 Years										
20 Yr Average	0.064	0.057	0.062	0.056	0.018	0.042	0.042	0.054	0.073	0.061
Volatility	0.085	0.017	0.017	0.016	0.005	0.016	0.015	0.026	0.083	0.091
Corr w/Inflation	-0.413	-0.414	-0.477	-0.140	1.000	-0.403	-0.379	0.308	0.272	0.684
R2	0.170	0.171	0.227	0.020	1.000	0.162	0.143	0.095	0.074	0.468
5 Years										
20 Yr Average	0.064	0.057	0.062	0.056	0.018	0.042	0.042	0.054	0.073	0.061
Volatility	0.054	0.018	0.018	0.016	0.004	0.018	0.017	0.019	0.066	0.068
Corr w/Inflation	-0.049	-0.564	-0.535	-0.376	1.000	-0.695	-0.693	0.156	0.376	0.961
R2	0.002	0.318	0.286	0.142	1.000	0.483	0.480	0.024	0.142	0.924

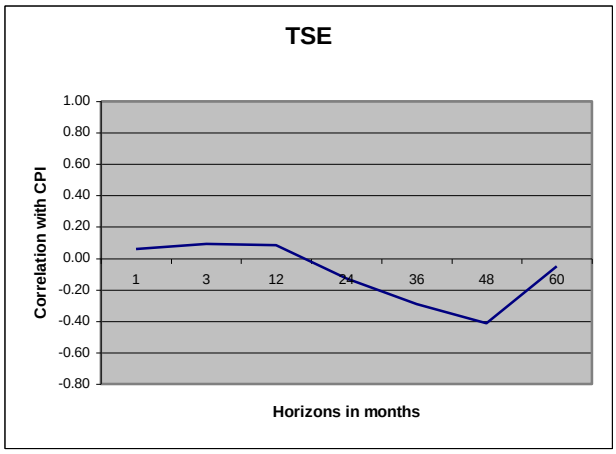
Exhibits 3 present summary statistics for Average Annual Returns, Volatilities, Correlations with CPI and R2 for different horizons. In the study of Amenc et al. correlation coefficients between liability returns and the return on various asset classes were computed to measure the liability hedging capacity of various assets. The return on the liability portfolio was proxied by the return on a constant maturity zero-coupon TIPS assuming that liability payments exhibit unconditional inflation indexation. In my study, correlation coefficient between the return on various asset classes and CPI were calculated to measure the inflation hedging capacity of various assets. Exhibits 4 show the horizon dependant correlations of each asset class with CPI. Overall, stocks and Government bonds show very low or negative correlations with inflations and the results are not statistically significant for shorter term. Correlations for the other asset classes especially for Commodity index are regarded statically significant thru out different horizons. Corporate bonds have the highest correlations with CPI among traditional financial investment. Out of alternative investments, returns of Commodity index are more correlated with CPI than returns of REITs, but have higher risks. Correlations of yearly returns of DJ Commodity Index and CPI is 54.8% as compared of 9.94% for REITs, but the volatilities is much higher -26.97% for DJ Commodity vs. 18.62% for REITs. This analysis shows that RRB returns are highly correlated with CPI for the short term (Monthly 87.5%, Quarterly 69.6% and Yearly 31.6%) but the correlations become weaker for 3 year horizon (11.81%) and even turned into negative (-37.64% for 5 year horizon). This could be partly explained by the changes in real return components of RRB which are negatively affected by inflation in longer term. The graphs in Exhibits 4 also show how the correlations

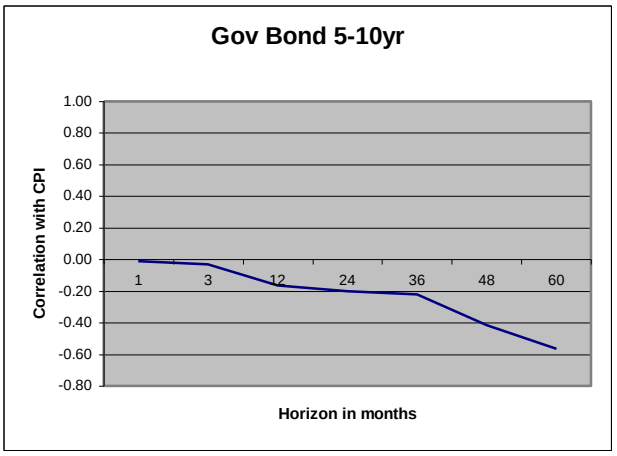
change over the horizons. The plots suggest that the commodities and real estate returns are positively correlated with CPI and show upward-sloping pattern as the investment horizon increases. However, government bonds and Real Return bonds show downward sloping pattern.

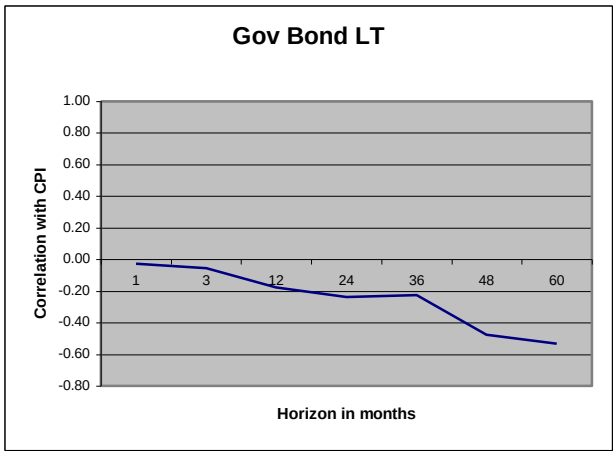
The above test results are consistent with those in Amenc *et al.* for commodities which has positive correlations with liabilities thru out all horizons. However, bond, stocks and real estate returns are negatively correlated with liabilities in the short run, and that the correlation coefficient exhibits an upward-sloping pattern as the investment horizon increases.

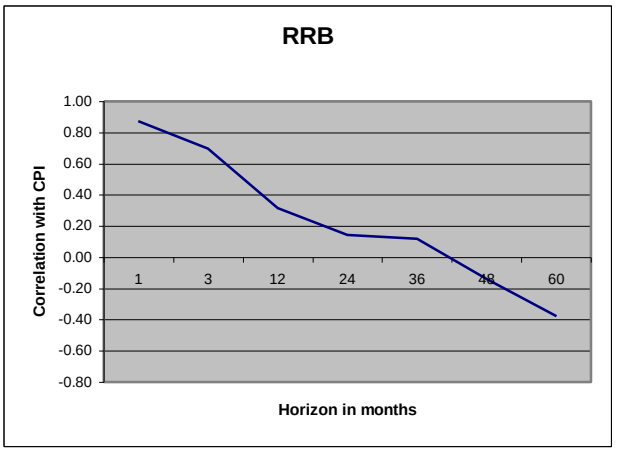
Exhibits 5 represent statistics of Inflation Hedging Portfolio(IHP) with different allocation ratio to Alternative Investments (AI). '0% allocation' represents IHP with Real Return Bonds only. '50% allocation' represents IHP consist of 50% RRB and 50% AI. By allocating Alternative Investments up to 25% of total Inflation Hedging Portfolio the correlation with inflation increased by 25.08% for 3 year horizon and 62.62% for 5 year horizon.

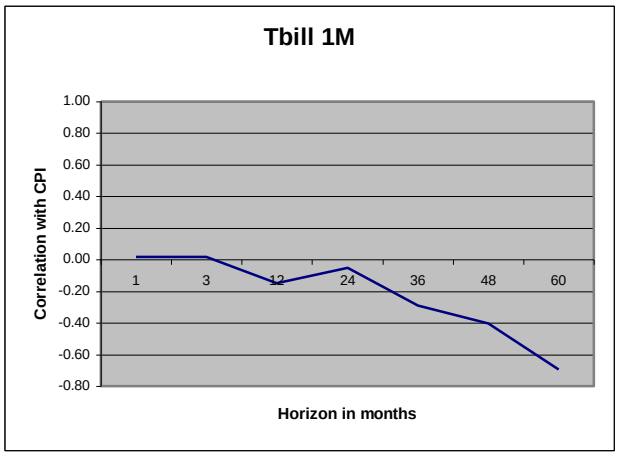
Exhibits 4 Correlations in Different Horizons

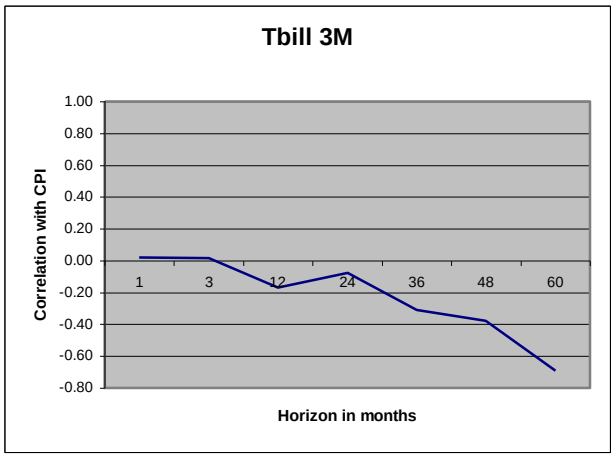


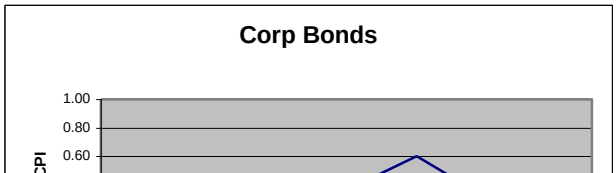


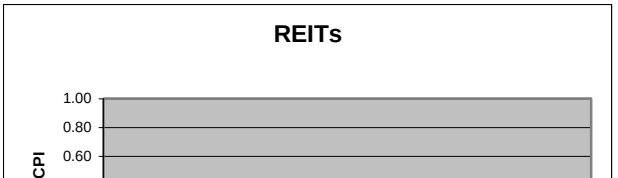


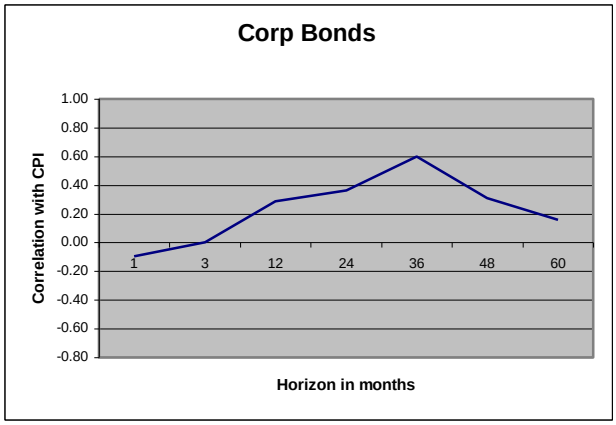


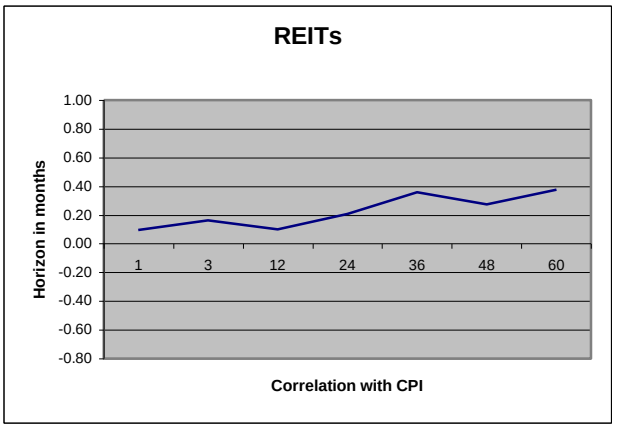


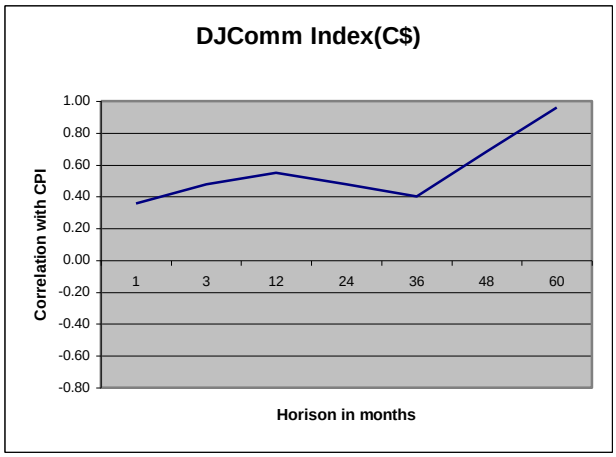







Corp Bonds
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
1
3
12
24
36
48
60
Correlation with CPI
Horizon in months


REITs
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
1
3
12
24
36
48
60
Horizon in months
Correlation with CPI


DJComm Index(C$)
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
1
3
12
24
36
48
60
Correlation with CPI
Horison in months

Exhibits 5 Statistics of Alternative Investments
Inflation Hedging Portfolio with different allocation to AI

		Allocation to Alternative Investment (AI)										
Inv. Horizon		**0%**	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**	**35%**	**40%**	**45%**	**50%**
Monthly	Variance	0.0014	0.0021	0.0038	0.0064	0.0099	0.0143	0.0195	0.0257	0.0328	0.0408	0.0497
	Corr w/CPI	0.8748	0.8136	0.6947	0.6024	0.5376	0.4913	0.4572	0.4312	0.4107	0.3943	0.3808
Quarterly	Variance	0.0006	0.0010	0.0018	0.0031	0.0047	0.0068	0.0094	0.0123	0.0157	0.0195	0.0237
	Corr w/CPI	0.6956	0.7122	0.6530	0.5988	0.5585	0.5287	0.5064	0.4891	0.4753	0.4642	0.4550
Yearly	Variance	0.0003	0.0005	0.0008	0.0013	0.0020	0.0028	0.0038	0.0051	0.0065	0.0081	0.0098
	Corr w/CPI	0.3161	0.4418	0.4764	0.4780	0.4715	0.4639	0.4570	0.4510	0.4459	0.4416	0.4379
3 Year	Variance	0.0003	0.0004	0.0006	0.0008	0.0010	0.0014	0.0017	0.0022	0.0026	0.0032	0.0038
	Corr w/CPI	0.1393	0.2373	0.3030	0.3451	0.3721	0.3901	0.4024	0.4111	0.4174	0.4221	0.4258
5Year	Variance	0.0002	0.0003	0.0003	0.0003	0.0004	0.0004	0.0005	0.0006	0.0007	0.0009	0.0010
	Corr w/CPI	-0.2559	-0.1001	0.0454	0.1733	0.2813	0.3703	0.4429	0.5020	0.5504	0.5903	0.6234

* Alternative Investment consists of 50% to REITs and 50% to DJ Comm Index

** 0% represents 100% in RRB

25% represent 75% in RRB and 25% in AI

50% represent 50% In RRB and 50% in AI

Exhibits 6 summarize the variance-covariance of different asset classes for 1 year horizon and also in 3 year horizon. As it's shown in these tables Inflation Hedging Portfolios added by alternative investments have higher covariance with other asset classes except with T-Bills than Real Return Bonds have. The variance-covariance of RRB and other asset classes are very low (0.0003 for TSE, Bonds and T-Bill for one year horizon) whereas covariance of portfolio with AI allocations and stocks is relative very high (to 0.0077 for AI 25% and to 0.0151 for AI 50%) for the same horizon. Exhibits 7 summarize the variance-covariance of the same asset classes for 1 year and 3 year horizons but these numbers are based on real returns where nominal

returns are deflated by CPI. This table also show that the IHP with Real Return Bonds only has much less covariance with Stocks. This means that the diversification benefits will be reduced when the IHP has more AI allocations as trade-off of having better inflation hedging benefit.

Exhibits 8 show optimal allocation ratios for different time horizons. As indicated earlier Asset Bounds are set as 30-40% for Stocks, 30-40% to Bonds, 5-15% to 3 month T-Bills and 10%-30% to Investment Hedging Portfolio. These asset bounds were designed to represent conventional investors with medium risk preference who generally hold equities up to 45%, bonds up to 45% with remaining portfolio in cash or cash equivalents (T-bills) before adding investment hedging portfolio . It is noted that the portfolio risks increase for the same level of portfolio returns when the portfolio has higher allocation to the alternative investments. For example, risks change from 0.067 for Portfolio with RRB only to 0.071 for Portfolio with 25% AI investments and to 0.0768 with 50% AI investments respectively when portfolio return remains at 0.0587 in case of one year time horizon. In other words, the diversification effect will be reduced to some extent by adding AI portfolio and having better inflation hedge.

Exhibits 9 also show Optimal Asset Allocations for one year and 3 year horizons but it uses the real returns where nominal returns are deflated by CPI. The portfolio risks of the IHP with higher AI allocations become higher when using the real returns as it's shown in Exhibits 8 where nominal returns were used in optimizations. It proves again that the portfolio will have better diversification benefit when the IHP has less

allocation to AI. In Amenc *et al.* there are trade-off between a deviation from the perfect liability match and the resulting return upside potential by including alternative investments in liability hedging portfolio. On the other hand, my study shows that there are trade off between inflation hedging and diversification potentials by including alternative investments in inflation hedging portfolio.

Exhibits 6 Variance-Covariance of different asset classes - Before CPI adjusted

Variance-Covariance between different asset classes (Yearly Returns)

Restricted Portfolio

	TSE	Bonds	T-Bill	RRB only
TSE	0.0365	0.0009	0.0002	0.0003
Bonds	0.0009	0.0004	0.0002	0.0003
T-Bill	0.0002	0.0002	0.0004	0.0003
RRB	0.0003	0.0003	0.0003	0.0004

Unrestricted Portfolio (include 25% AI)

	TSE	Bonds	T-Bill	AI 25%
TSE	0.0365	0.0009	0.0002	0.0077
Bonds	0.0009	0.0004	0.0002	0.0005
T-Bill	0.0002	0.0002	0.0004	0.0001
AI 25%	0.0077	0.0005	0.0001	0.0030

Unrestriced Portfolio (include 50% AI)

	TSE	Bonds	T-Bill	AI 50%
TSE	0.0365	0.0009	0.0002	0.0151
Bonds	0.0009	0.0004	0.0002	0.0008
T-Bill	0.0002	0.0002	0.0004	-0.0000
AI 50%	0.0151	0.0008	-0.0000	0.0104

Variance-Corrivance between Different Asset Classes (3 Years)

Restricted Portfolio

	TSE	Bonds	T-Bill	RRB only
TSE	0.0131	0.0005	0.0001	0.0004
Bonds	0.0005	0.0004	0.0002	0.0003
T-Bill	0.0001	0.0002	0.0002	0.0002
RRB	0.0004	0.0003	0.0002	0.0003

Unrestricted Portfolio (with 25% AI)

		Bonds	T-Bill	AI 25%
TSE	0.0131	0.0005	0.0001	0.0024
Bonds	0.0005	0.0004	0.0002	0.0004
T-Bill	0.0001	0.0002	0.0002	0.0001
AI 25%	0.0024	0.0004	0.0001	0.0012

Unrestricted Portfolio (with 50% AI)

		Bonds	T-Bill	AI 50%
TSE	0.0131	0.0005	0.0001	0.0044
Bonds	0.0005	0.0004	0.0002	0.0005
T-Bill	0.0001	0.0002	0.0002	-0.0001
AI 50%	0.0044	0.0005	-0.0001	0.0037

Exhibits 7 Variance-Covariance of different asset classes - Deflated by CPI

Variance-Covariance between different asset classes (Yearly Returns)

Restricted Portfolio

	TSE	Bonds	T-Bill	RRB only
TSE	0.0363	0.0008	0.0002	0.0002
Bonds	0.0008	0.0005	0.0003	0.0003
T-Bill	0.0002	0.0003	0.0005	0.0003
RRB	0.0002	0.0003	0.0003	0.0003

Unrestricted Portfolio (include 25% AI)

	TSE	Bonds	T-Bill	AI 25%
TSE	0.0363	0.0008	0.0002	0.0075
Bonds	0.0008	0.0005	0.0003	0.0004
T-Bill	0.0002	0.0003	0.0005	0.0000
AI 25%	0.0075	0.0004	0.0000	0.0026

Unrestriced Portfolio (include 50% AI)

	TSE	Bonds	T-Bill	AI 50%
TSE	0.0363	0.0008	0.0002	0.0147
Bonds	0.0008	0.0005	0.0003	0.0005
T-Bill	0.0002	0.0003	0.0005	-0.0003
AI 50%	0.0147	0.0005	-0.0003	0.0096

Variance-Corrivance between Different Asset Classes (3 Years)

Restricted Portfolio

	TSE	Bonds	T-Bill	RRB only
TSE	0.0134	0.0046	0.0003	0.0005
Bonds	0.0046	0.0019	-0.0001	0.0001
T-Bill	0.0003	-0.0001	0.0003	0.0003
RRB	0.0005	0.0001	0.0003	0.0003

Unrestricted Portfolio (with 25% AI)

		Bonds	T-Bill	AI 25%
TSE	0.0134	0.0046	0.0003	0.0025
Bonds	0.0046	0.0019	-0.0001	0.0010
T-Bill	0.0003	-0.0001	0.0003	0.0000
AI 25%	0.0025	0.0010	0.0000	0.0011

Unrestricted Portfolio (with 50% AI)

		Bonds	T-Bill	AI 50%
TSE	0.0134	0.0046	0.0003	0.0045
Bonds	0.0046	0.0019	-0.0001	0.0020
T-Bill	0.0003	-0.0001	0.0003	-0.0002
AI 50%	0.0045	0.0020	-0.0002	0.0034

Exhibits 8 Optimal Allocations – with Returns before Inflation Adjstment

Optimal portfolio choice
(condition: Equity 30-40%, Bonds, 30-40%, Tbill 5-15%, Inf. Hedge 10%-30%)

Horizon Yearly

Risk	Return	TSE	Bonds	T-Bill	RRB only
Restricted Portfolio					
0.0606	0.0569	0.3000	0.3000	0.1500	0.2500
0.0606	0.0572	0.3000	0.3000	0.1322	0.2678
0.0606	0.0575	0.3000	0.3000	0.1143	0.2857
0.0606	0.0577	0.3000	0.3033	0.0967	0.3000
0.0607	0.058	0.3000	0.3201	0.0799	0.3000
0.0608	0.0582	0.3000	0.3368	0.0632	0.3000
0.0612	0.0585	0.3008	0.4000	0.0500	0.2492
0.0672	0.0587	0.3338	0.4000	0.0500	0.2162
0.0733	0.059	0.3669	0.4000	0.0500	0.1831
0.0794	0.0593	0.4000	0.4000	0.0500	0.1500

Unrestricted Portfolio (25% Allocation to AI)

Risk	Return	TSE	Bonds	T-Bill	AI 25%
0.0668	0.0574	0.3000	0.4000	0.1500	0.1500
0.0674	0.0577	0.3000	0.4000	0.1344	0.1656
0.0681	0.0579	0.3000	0.4000	0.1189	0.1811
0.0687	0.0582	0.3000	0.4000	0.1033	0.1967
0.0694	0.0585	0.3000	0.4000	0.0877	0.2123
0.0701	0.0587	0.3000	0.4000	0.0722	0.2278
0.0708	0.059	0.3000	0.4000	0.0566	0.2434
0.0748	0.0593	0.3105	0.3395	0.0500	0.3000
0.0818	0.0595	0.3493	0.3007	0.0500	0.3000
0.0891	0.0598	0.4000	0.3000	0.0500	0.2500

Unrestricted Portfolio (50% Allocation to AI)

Risk	Return	TSE	Bonds	T-Bill	AI 50%
0.0729	0.0578	0.3000	0.4000	0.1500	0.1500
0.0742	0.0581	0.3000	0.4000	0.1350	0.1650
0.0755	0.0584	0.3000	0.4000	0.1200	0.1800
0.0768	0.0587	0.3000	0.4000	0.1051	0.1949
0.0781	0.059	0.3000	0.4000	0.0901	0.2099
0.0794	0.0593	0.3000	0.4000	0.0751	0.2249
0.0808	0.0596	0.3000	0.4000	0.0601	0.2399
0.0836	0.0599	0.3000	0.3773	0.0500	0.2727
0.0905	0.0602	0.3262	0.3238	0.0500	0.3000
0.0996	0.0604	0.4000	0.3000	0.0500	0.2500

Optimal portfolio choice
(condition: Equity 30-40%, Bonds, 30-40%, Tbill 5-15%, Inf. Hedge 10%-30%)

Horizon	Risk	Return	TSE	Bonds	T-Bill	RRB only
3 Year	Restricted Portfolio					
	0.0382	0.0569	0.3000	0.3000	0.1500	0.2500
	0.0382	0.0572	0.3000	0.3000	0.1322	0.2678
	0.0383	0.0575	0.3000	0.3000	0.1143	0.2857
	0.0384	0.0577	0.3000	0.3033	0.0967	0.3000
	0.0385	0.058	0.3000	0.3201	0.0799	0.3000
	0.0386	0.0582	0.3000	0.3368	0.0632	0.3000
	0.0388	0.0585	0.3008	0.4000	0.0500	0.2492
	0.0422	0.0587	0.3338	0.4000	0.0500	0.2162
	0.0457	0.059	0.3669	0.4000	0.0500	0.1831
	0.0491	0.0593	0.4000	0.4000	0.0500	0.1500
	Unrestricted Portfolio (25% Allocation to AI)					
	Risk	Return	TSE	Bonds	T-Bill	AI 25%
	0.041	0.0574	0.3000	0.4000	0.1500	0.1500
	0.0414	0.0577	0.3000	0.4000	0.1344	0.1656
	0.0418	0.0579	0.3000	0.4000	0.1189	0.1811
	0.0421	0.0582	0.3000	0.4000	0.1033	0.1967
	0.0425	0.0585	0.3000	0.4000	0.0877	0.2123
	0.0429	0.0587	0.3000	0.4000	0.0722	0.2278
	0.0432	0.059	0.3000	0.4000	0.0566	0.2434
	0.0453	0.0593	0.3105	0.3395	0.0500	0.3000
	0.0493	0.0595	0.3493	0.3007	0.0500	0.3000
	0.0536	0.0598	0.4000	0.3000	0.0500	0.2500
	Unrestricted Portfolio (50% Allocation to AI)					
	Risk	Return	TSE	Bonds	T-Bill	AI 50%
	0.0439	0.0578	0.3000	0.4000	0.1500	0.1500
	0.0446	0.0581	0.3000	0.4000	0.1350	0.1650
	0.0453	0.0584	0.3000	0.4000	0.1200	0.1800
	0.046	0.0587	0.3000	0.4000	0.1051	0.1949
	0.0467	0.059	0.3000	0.4000	0.0901	0.2099
	0.0474	0.0593	0.3000	0.4000	0.0751	0.2249
	0.0481	0.0596	0.3000	0.4000	0.0601	0.2399
	0.0495	0.0599	0.3000	0.3773	0.0500	0.2727
	0.0533	0.0602	0.3262	0.3238	0.0500	0.3000
	0.0587	0.0604	0.4000	0.3000	0.0500	0.2500

Exhibits 9 Optimal Allocations – with Real Returns(Nominal Returns deflated by CPI)

Optimal portfolio choice
(condition: Equity 30-40%, Bonds, 30-40%, Tbill 5-15%, Inf. Hedge 10%-30%)

Horizon	Risk	Return	TSE	Bonds	T-Bill	RRB only
Yearly	*Restricted Portfolio*					
	0.0602	0.0396	0.3000	0.3000	0.1029	0.2971
	0.0603	0.0398	0.3000	0.3091	0.0909	0.3000
	0.0603	0.04	0.3000	0.3210	0.0790	0.3000
	0.0604	0.0401	0.3000	0.3328	0.0672	0.3000
	0.0604	0.0403	0.3000	0.3446	0.0554	0.3000
	0.0618	0.0405	0.3065	0.4000	0.0500	0.2435
	0.0661	0.0407	0.3299	0.4000	0.0500	0.2201
	0.0704	0.0409	0.3533	0.4000	0.0500	0.1967
	0.0747	0.041	0.3766	0.4000	0.0500	0.1734
	0.079	0.0412	0.4000	0.4000	0.0500	0.1500
	Unrestricted Portfolio (25% Allocation to AI)					
	Risk	Return	TSE	Bonds	T-Bill	AI 25%
	0.0661	0.0394	0.3000	0.4000	0.1500	0.1500
	0.0667	0.0397	0.3000	0.4000	0.1344	0.1656
	0.0673	0.0399	0.3000	0.4000	0.1189	0.1811
	0.068	0.0402	0.3000	0.4000	0.1033	0.1967
	0.0686	0.0404	0.3000	0.4000	0.0877	0.2123
	0.0692	0.0407	0.3000	0.4000	0.0722	0.2278
	0.0698	0.041	0.3000	0.4000	0.0566	0.2434
	0.0738	0.0412	0.3105	0.3395	0.0500	0.3000
	0.0808	0.0415	0.3493	0.3007	0.0500	0.3000
	0.0882	0.0418	0.4000	0.3000	0.0500	0.2500
	Unrestricted Portfolio (50% Allocation to AI)					
	Risk	Return	TSE	Bonds	T-Bill	AI 50%
	0.072	0.0398	0.3000	0.4000	0.1500	0.1500
	0.0732	0.0401	0.3000	0.4000	0.1350	0.1650
	0.0744	0.0404	0.3000	0.4000	0.1200	0.1800
	0.0757	0.0407	0.3000	0.4000	0.1051	0.1949
	0.0769	0.041	0.3000	0.4000	0.0901	0.2099
	0.0782	0.0412	0.3000	0.4000	0.0751	0.2249
	0.0794	0.0415	0.3000	0.4000	0.0601	0.2399
	0.0821	0.0418	0.3000	0.3773	0.0500	0.2727
	0.089	0.0421	0.3262	0.3238	0.0500	0.3000
	0.0983	0.0424	0.4000	0.3000	0.0500	0.2500

Optimal portfolio choice
(condition: Equity 30-40%, Bonds, 30-40%, Tbill 5-15%, Inf. Hedge 10%-30%)

Horizon	Risk	Return	TSE	Bonds	T-Bill	RRB only
3 Year	Restricted Portfolio					
	0.0485	0.0321	0.3000	0.3000	0.1500	0.2500
	0.0486	0.0323	0.3000	0.3000	0.1329	0.2671
	0.0486	0.0326	0.3000	0.3000	0.1158	0.2842
	0.0488	0.0328	0.3009	0.3000	0.0991	0.3000
	0.05	0.033	0.3120	0.3000	0.0880	0.3000
	0.0513	0.0333	0.3231	0.3000	0.0769	0.3000
	0.0525	0.0335	0.3342	0.3000	0.0658	0.3000
	0.0538	0.0338	0.3453	0.3000	0.0547	0.3000
	0.0563	0.034	0.3683	0.3000	0.0500	0.2817
	0.0598	0.0343	0.4000	0.3000	0.0500	0.2500
	Unrestricted Portfolio (25% Allocation to AI)					
	Risk	Return	TSE	Bonds	T-Bill	AI 25%
	0.0532	0.0327	0.3000	0.3000	0.1500	0.2500
	0.0535	0.033	0.3000	0.3000	0.1355	0.2645
	0.0538	0.0332	0.3000	0.3000	0.1210	0.2790
	0.0542	0.0334	0.3000	0.3000	0.1065	0.2935
	0.055	0.0337	0.3062	0.3000	0.0938	0.3000
	0.0563	0.0339	0.3173	0.3000	0.0827	0.3000
	0.0575	0.0342	0.3284	0.3000	0.0716	0.3000
	0.0588	0.0344	0.3395	0.3000	0.0605	0.3000
	0.0602	0.0347	0.3526	0.3000	0.0500	0.2974
	0.0645	0.0349	0.4000	0.3000	0.0500	0.2500
	Unrestricted Portfolio (50% Allocation to AI)					
	Risk	Return	TSE	Bonds	T-Bill	AI 50%
	0.0578	0.0306	0.3000	0.4000	0.1500	0.1500
	0.0579	0.0312	0.3000	0.3798	0.1500	0.1702
	0.058	0.0317	0.3000	0.3595	0.1500	0.1905
	0.058	0.0323	0.3000	0.3393	0.1500	0.2107
	0.0581	0.0328	0.3000	0.3191	0.1500	0.2309
	0.0583	0.0334	0.3000	0.3000	0.1484	0.2516
	0.0596	0.0339	0.3000	0.3000	0.1205	0.2795
	0.0614	0.0345	0.3066	0.3000	0.0934	0.3000
	0.0641	0.035	0.3313	0.3000	0.0687	0.3000
	0.0695	0.0356	0.4000	0.3000	0.0500	0.2500

5. Conclusion

The objective of this paper is to find the effective way of hedging inflation risks by employing alternative investments in REITs and Commodity Index complementing inflation-linked securities such as Real Return Bonds. The other objective is to find the optimal asset allocations which have inflation hedging capacity and can enhance diversification benefits by adding those alternative investments to the traditional financial asset classes.

Regression results show that returns on REITs and commodity index are positively correlated with the historical inflations and the correlations become higher as time horizon increased. The correlations are even higher than those of Real Return Bonds and historical inflations for the longer term time horizons. As the markets for REITs and commodities are much bigger and liquid than those for Real Return Bonds Canadian investors may accomplish inflation hedge at lower costs. Overall, commodity prices as represented by DJ commodity index showed higher correlations with historical inflations but have more volatility as compared to those of REITs especially when the investment horizons increased.

Optimizer results suggest that the alternative investments have less diversification benefits as compared to Real Return Bonds. Except for T-Bills, inflation hedging portfolios which have higher allocations to DJ commodity index and REITs have higher covariance with other asset classes. However, overall portfolio performances were

enhanced by adding more alternative investments in their portfolio. There are clearly trade off between inflation hedging capacity and diversification potentials when the alternative investments are added to inflation hedging portfolio.

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