THE IMPACT OF INFLATION HEDGE ASSETS ON PORTFOLIO OPTIMIZATIONS FOR US AND CANADIAN INVESTORS

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Abstract

The research is based on "Gold: Inflation Hedge and Long-Term Strategic Asset." paper by Dempster and Artigas (2010). Authors used basic portfolio for the US investor, which includes Corporate Bonds, US Treasuries, Equity US and Equity Ex-US. By adding, alternatively, the four potential inflation-hedges, researchers showed Gold as the most appropriate Long-Term Strategic Asset. In our research, we constructed basic investment portfolio for US and Canadian investors. For each case, alternatively, four potential Inflation Hedges, which are Gold, S&P GSCI Index, REITs and TIPS, were added to the basic portfolio. The optimization results are based on the post-crisis period from 2009 to 2016. The final results for the US suggest that Gold should be considered as a strong long-term strategic asset. For the Canadian case, Gold, and S&P GSCI tend to be appropriate long-term strategic assets, which should be added to the basic portfolio. Canadian REITs get allocation under base case assumptions but sensitivity analysis indicates that the results are not robust.

Keywords: Portfolio Optimization, Gold, Commodities, REITs, TIPS, Real Return Bonds, Black-Litterman, US and Canadian investors, Allocation

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First and foremost, we would like to thank Dr. Peter Klein for his continued and unwavering support towards our research project. His presence as a supervisor helped us maintain our direction and his input allowed us to consider several key issues, resulting in a significant improvement in our work. Without his dedication and valuable guidance, this research would not have been possible. We would also like to thank Dr. Derek Yee and Dr. Robert Grauer for their vital efforts towards the learning and development experience of students.

We would also like to thank our parents for their continued support throughout our lives.

Contents

Introduction:

Central bank decisions regarding interest rates are among the most critical pieces of information impacting asset prices in today's markets. With interest rates at all time low levels and expectations of rate hikes in US, investors have mixed perceptions regarding the ability of inflation hedge assets to perform as long term strategic assets. In this research, the capacity of four such assets has been tested by creating a conventional bonds and equities based basic portfolio and adding four inflation hedge assets to our basic portfolio one by one. These four assets include Gold, Commodities Index, Real Estate Investment Trusts (REITs), and inflation protected securities. Portfolios are tested separately for US and Canadian investors in order to gauge how the usefulness of these assets varies between the two types of investors.

In Section 2 of this research, previous literature on these assets has been discussed. The focus is primarily on the work of Dempster and Artigas (2010) in which only the US investors have been considered. In Section 3, the research methodology has been described, including the composition of basic portfolios in both the two cases: US and Canada. Also, a detailed description of the process used to derive input assumptions has also been provided. This section also details the data used for this research along with some key descriptive statistics and a detailed comparison of correlations between different assets. The difference between correlations for the two cases has also been discussed in this section. In Section 4, the characteristics of inflation hedge assets have been discussed. More importantly, in this section, the results of all eight portfolio optimizations have been analyzed, and differences between weight allocations have been discussed. Lastly, in Section 5, the results of the two cases are compared with each other to see if there are any major differences between the perspectives of a Canadian investor as compared to that of a US based investor.

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Literature Review

In this section, the previous literature on inflation hedge assets in basic equity and bonds based portfolios has been discussed. The review is based on papers that were written in different periods of modern finance history. The first part refers to several studies, which used different assumptions, as well as different time frames to test the viability of including these assets in portfolios. The second part describes the findings in the research conducted by Dempster and Artigas (2010), which is the main inspiration for our research.

Part 1 – Review of relevant research on inflation hedge assets

Most of the papers, used in this section, discuss allocation of Gold and Commodities to the basic portfolio. Jaffe (1989) presented one of the earliest works on Gold as a strong diversifier asset by testing four hypothetical portfolios, differentiated based on varying risk levels. The results in each case increased average return while reducing standard deviation (thereby improving information ratio). Bekkers, Doewijk and Lam (2009) developed the view on asset classes that can be added to the traditional portfolio of stocks, bonds, and cash. The results of this research suggested that the most important assets to be included in basic portfolios are Real Estate, Commodities, and High Yield Bonds. Michaud, Michaud and Pulvermacher (2006) studied whether Gold asset might be used as a valuable tactical asset. Researchers used Resampled Efficiency (RE) Optimization, which is based on Monte-Carlo methods. In this research, data for the period from January 1974 to December 2005 was used. Authors examined several cases by adding Gold to portfolios consisting of Equities, Bonds, Real Estate. The results showed that allocation of around 2% to Gold is an efficient component of low risk portfolios. Another interesting study by Ankrim and Hensel (1993) used collateralized commodities as a real-asset alternative to real estate. The

research compared allocations used for two different risk-tolerance levels under constrained and unconstrained portfolios options. The data used for the corresponding study covered the period from 1972 to 1990. The results suggested that for lower of the two risk-tolerance levels, allocation to collateralized commodities was 8.7%, while for higher risk-tolerance level allocation decreased to 4.1% for the portfolio consisting of US Stocks, Non-US Stocks, US Bonds and US Cash. Greer (2007) advised using a commodity index as a diversifier for the basic portfolio, consisting of Stocks, Bonds and TIPS. The mean-variance results for minimum variance portfolio suggested that around 5% should be allocated to stocks, 87% to TIPS and 7% to commodities. The results also indicated that there should be no allocation to bonds. Lastly, Mull and Soenen (1997) discussed whether Real Estate is an attractive asset class in international investment portfolios. The results suggest that for Canadian and US cases, REITs may not be a statistically significant addition to the risk-return framework of a basic bonds and equities portfolio.

Part 2 – Gold: Inflation Hedge and Long-Term Strategic Asset by Dempster and Artigas (2010)

Dempster and Artigas (2010) conducted a detailed research on several inflation hedge assets which served as the main inspiration for this research project. The main problem tested in their research is whether among several inflation-hedges Gold can outperform other financial assets. Interesting data characteristics are analyzed by considering three different periods of monthly returns: January 1974-May 2009, December 1993-May 2009 and March 1997-May 2009. The four inflation hedge assets used by Dempster and Artigas (2010) are Gold, GSCI Index, REITs Index, and TIPS. The differences in real returns as well as in the annualized volatilities for these four assets are discussed. The study makes real return assumptions for all assets used in the research. Alternatively, all four assets are added to the basic portfolio, one by one, which consists of US Equity, Ex-US Equity, US Corporate Bonds and US Treasuries. The results show three efficient allocations using TIPS

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and Gold. The minimum variance portfolio, which includes TIPS, provides weights of 6.2% to US Equity, 6.1% to Ex-US Equity, 38.5% to US Treasuries, 1% to US Corporate Bonds and 48.1% to TIPS. The minimum variance portfolio, which includes Gold provides an allocation of 8.1% to US Equity, 3.8% to Ex-US Equity, 73% to US Treasuries, 4.8% to US Corporate Bonds and 10.3% to Gold. Finally, the optimal portfolio is chosen, which provides the best Reward/Risk proportion out of four available options with Gold, GSCI Index, REIT index and TIPS. The efficient portfolio allocates 10.4% to US Equity, 8.9% to Ex-US Equity, 64.5% to US Treasuries, 9.3% to US Corporate Bonds and 9.9% to Gold. In conclusion, authors state that "Gold has a role to play both as a tactical inflation hedge and as a long-term strategic asset". [1]

Research Methodology:

In this section, we discuss the details regarding our research methodology. It is divided into three subsections. The first part discusses the research process, including the rationale behind some of the most critical assumptions for the portfolio optimization process. This is followed by the data selection and correlation analysis for both US and Canadian data in the second and third parts.

Research Process:

For the purposes of this research, the process was to select a basic portfolio for each case, US and Canada, to have a neutral starting point to which changes were made by adding different assets to test how they impact the optimal portfolio allocation. The basic portfolio for US consisted of four assets: Corporate Bonds, Treasuries, Ex-US Equity, and US Equity. This portfolio set up is based on the research by Dempster and Artigas (2010) along with the data series selected for each of the

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[1] Dempster, N., & Artigas, J. C. (2010). Gold: inflation hedge and long-term strategic asset. The Journal of Wealth Management, 13(2), 69

assets in the basic portfolio. We found this to be the suitable basic portfolio as it appropriately covers the basic investment assets available to investors in US: bonds and equities. Gold, Commodities Index, REITs, and TIPS were used as the alternative securities tested for their capacity as long term strategic assets. All data for this case was in US dollar as the impact on an optimal portfolio of a US investor was being gauged. After selecting the basic portfolio and determining expected return assumptions for each of the assets, a new optimization was run by adding Gold to the portfolio. The changes in optimal portfolio allocation were recorded and then the process was repeated three more times by replacing Gold with another alternate asset from our selected inflation hedges.

In addition to replicating the research by Dempster and Artigas (2010), we also looked at a second case from the perspective of a Canadian investor. In this case, the basic portfolio was based on five assets: Corporate Bonds, Treasuries, Ex-North American Equities, US Equity, and Canadian Equity. For Gold and Commodity Index, the perspective of Canadian investor was reflected by adjusting all the time series for changes in Canadian dollar against US dollar. With respect to REITs and inflation protected government securities, Canadian equivalents were used. Therefore, in the second case, all data series were in Canadian dollar to gauge the impact on optimal portfolio allocation of a Canadian investor. After selecting the basic portfolio and determining expected return assumptions, the same optimization process was conducted four times as in the US case.

It is important to clarify how the expected return assumptions were determined. For both the basic portfolios, we used the Black-Litterman approach by using market capitalizations as measures for market allocations (weights) of each of the assets in our two basic portfolios (US and Canada). Using these weights and a variance-covariance matrix of the assets as our two inputs, we calculated implied returns of each of the assets in our basic portfolio. These returns reflect the market

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expectation of asset returns as reflected in the market capitalizations of these assets. Finally, we made slight adjustments to the returns obtained from this process to reflect our expectations. It is also important to point out that this process was only used for the basic portfolio and not for the inflation hedge assets. The expected return assumptions for these assets could not be based on Black-Litterman approach for the following reason. As they are primarily non-investment assets, their market capitalizations do not only reflect return expectations but also their other applications. For example, commodity index includes a wide variety of commodities, including energy and agricultural products for which market capitalizations will reflect their uses and applications in different industries and only a small proportion of the ownership of those commodities is held by investors. Therefore, we started with historical returns and adjusted them according to our expectations. To maintain consistency, we held the relationships between these alternative asset returns to be the same as those used by Dempster and Artigas (2010). We also maintained a constant spread of 2% for expected returns between the US and Canadian case for assets which only had a currency conversion such as Gold, GSCI Index, and US Equity.

Data Selection – US case

For our research, we selected post-crisis monthly data on asset returns from April 2009 to August 2016. Real returns were calculated by subtracting inflation from nominal returns. This gave us 89 data points for each time series. We chose this period to reflect the most recent data while ignoring the outliers in 2008 data. We used (1) Bloomberg Barclays Global Aggregate – Corporates TR Index [BGLCTRUH], (2) Bloomberg Barclays US Treasury TR Index [LUATTRUU], (3) MSCI Daily TR Net World Ex-USA [NDDUWXUS], and (4) MSCI Daily TR Net USA [NDDUUS] as our basic portfolio representing Corporate Bonds, Treasuries, Ex-US Equity and US Equity. For our set of inflation hedge assets, we used (1) Gold USD Spot [XAU BGN], (2) S&P GSCI TR

Index [SPGSCITR], (3) Bloomberg REITs Index [BBREIT], and (4) Bloomberg Barclays US Inflation Linked Bonds TR [BCIT1T] representing Gold, Commodities Index, Real Estate Investment Trusts, and Inflation-protected Treasury Securities. By using this data set, we updated that results of Dempster and Artigas (2010) in our analysis from the perspective of a US investor.

Exhibit 1 - Annualized Real Returns

| Time Period	Gold	GSCI	REITs	TIPS
Jan 1974 – May 2009	1.96%	2.81%	-	-
Dec 1993 – May 2009	3.52%	2.17%	-2.1%	-
Mar 1997 – May 2009	5.9%	-0.2%	-3.8%	4.0%
Apr 2009 – Aug 2016	1.41%	-9.88%	15.12%	2.45%

Exhibit 2 - Annualized Volatility

Time Period	Gold	GSCI	REITs	TIPS
Jan 1974 – May 2009	19.8%	20.0%	-	-
Dec 1993 – May 2009	14.9%	22.5%	20.5%	-
Mar 1997 – May 2009	16.28%	24.47%	22.25%	6.12%
Apr 2009 – Aug 2016	18.45%	20.50%	19.22%	5.27%

Exhibit 1 and 2 explain the comparative characteristics of data during different time periods. In our selected period from April 2009 to August 2016, commodity cycles appear to have reversed along with REITs returns. More importantly, we see a slight difference in asset volatilities as well where GSCI, REITs, and TIPS volatilities are towards the lower end as compared to the previous periods. Considering our research process and the inputs to our optimization models, it is the change in correlations between different assets that will be the reason for difference of the results.

The chart in Exhibit 3 shows the correlations between Gold, GSCI, REIT, and TIPS versus assets in our US basic portfolio. The chart does not have any major deviations from the time frame used by Dempster and Artigas (2010) in terms of correlation between Gold and the basic portfolio. For GSCI, the situation is very different as its correlation with US Equity is the only correlation coefficient which is consistent over time, and correlation with all other assets in the basic portfolio is inconsistent over time. Specifically, the correlation between GSCI and Ex-US Equity shows substantial change. For the period from April 2009 to August 2016, we report a high correlation coefficient of 0.57 compared to Dempster and Artigas' (2010) chosen time period from March 1997 to May 2009 during which there was a low correlation of 0.28. Correlation coefficients for REITs and TIPS are consistent over these periods. TIPS shows consistently high correlation with Treasuries and Corporate Bonds due to similar nature of these three assets.

Exhibit 3 - Correlations of monthly returns on Gold, GSCI, REITs, and TIPS vs Basic Portfolio assets – US Case
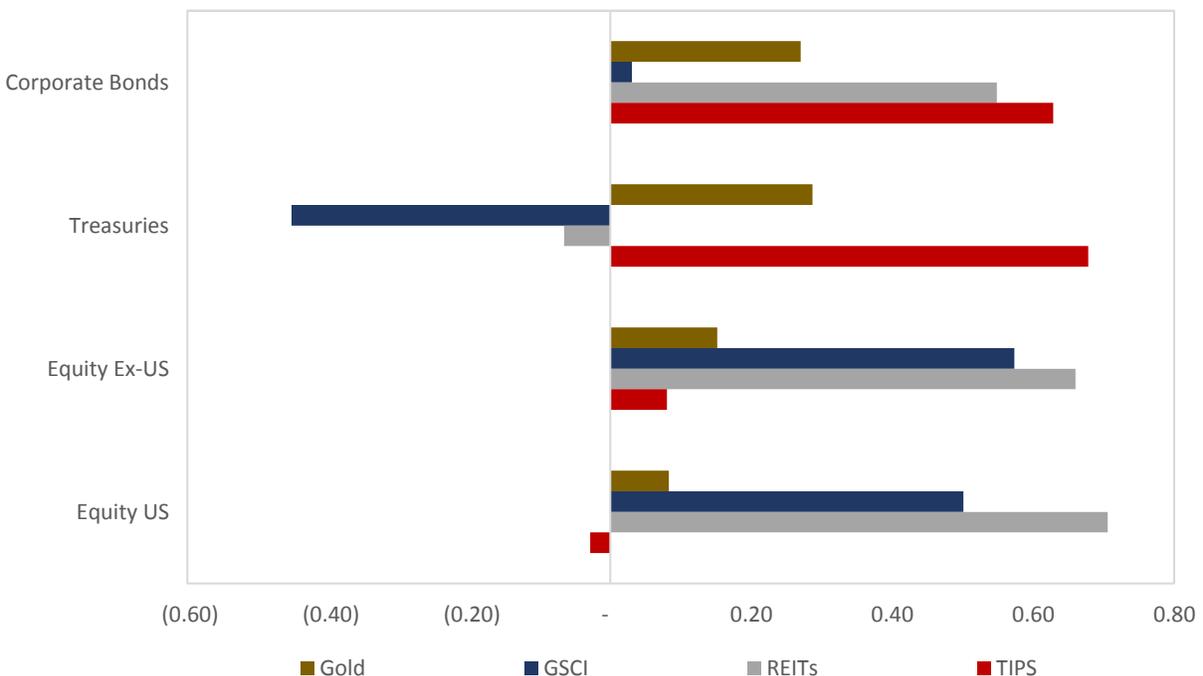
Data Selection – Canada case

For the second case, we consider the perspective of a Canadian investor and consider monthly

returns over the same time period, from April 2009 to August 2016. In this case, we move to a five

asset basic portfolio and used (1) iShares Canadian Corporate Bond Index [XCB CN], (2) iShares

Canadian Government Bond Index [XGB CN], (3) MSCI EAFE Net TR Index [NDDUEAFE

(CAD)], (4) MSCI Daily TR Net USA [NDDUUS (CAD)] and (5) MSCI Canada Net TR Index

[NDDUCA (CAD)] to represent Corporate Bonds, Government Bonds, EAFE Equity, US Equity

and Canadian Equity. For our set of inflation hedge assets, we used (1) Gold Canadian Dollar Spot

[XAUCAD BGN], (2) S&P GSCI TR Index [SPGSCITR (CAD)], (3) S&P/TSX REIT Total

Return Index [STREITSR], and (4) iShares Canadian Real Return Bond Index ETF [XRB CN]

representing Gold, Commodities Index, Real Estate Investment Trusts, and Real Return Bonds.

Exhibit 4 shows annualized returns and volatilities for our basic portfolio and additional assets.

Exhibit 4 - Annualized Real Returns and Volatility – April 2009 to August 2016

	Gold	GSCI	REITs	TIPS
Returns	2.14%	-8.56%	15.35%	1.9%
Volatility	17.73%	15.71%	12.07%	7.95%

Similar return patterns are evident for inflation hedge assets as in the case for US, and no major

fluctuations are visible in the data as far as returns are concerned. Mainly, differences can be

noticed in volatility in returns for GSCI and REITs, which can be explained as follows: Canada,

being a natural resources focused economy, is highly affected by fluctuations in commodity

prices. Particularly, there is an inverse relationship between S&P GSCI Index value and CAD/USD exchange rate (Exhibit 5)

Exhibit 5 - S&P GSCI Index and CAD/USD Spot
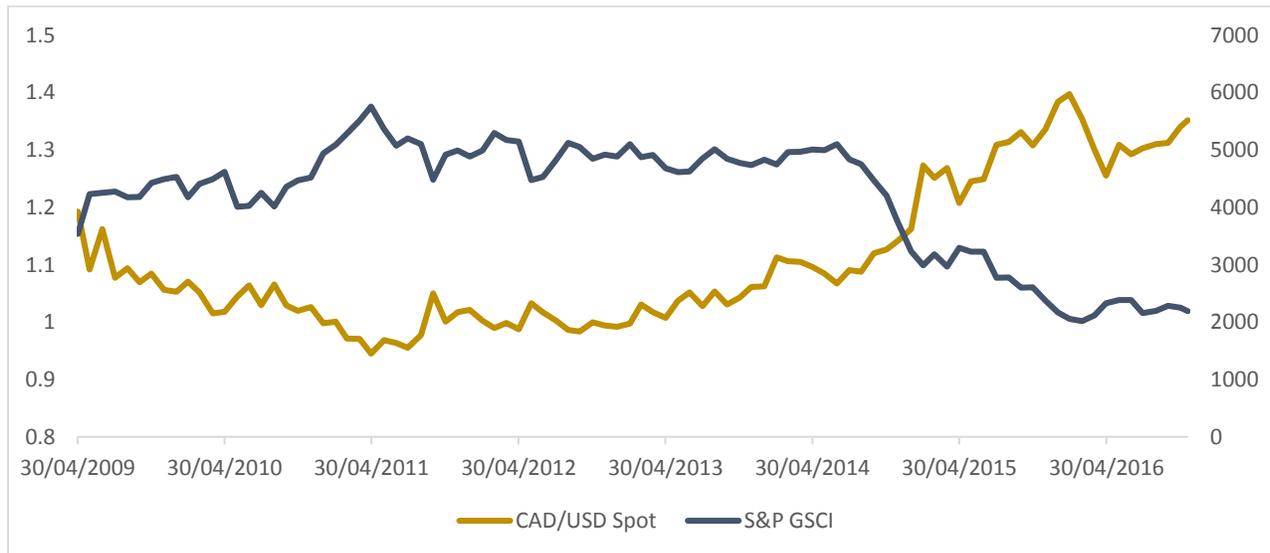
The inverse relationship between S&P GSCI Index and CAD/USD Spot leads to the result that for the Canada case, volatility in returns of S&P GSCI will be lower than for the US case as the corresponding inflation hedge is denominated in Canadian dollar. Particularly, this can be explained when Canadian investor goes long into US currency and then long in the S&P GSCI Index, which originally denominated in the US dollars, the net effect of any change of the S&P GSCI Index leads to the lower volatility of it's returns.

The case for REITs is different primarily because we are looking at two different sets of assets. In commodities index, the only factor separating the perspective of Canadian and US investors was the exchange rate; however, for REITs, Canadian and US REITs are two different regional markets. Li (2012) explains that REITs volatility has a significantly positive relationship with systematic risk. Looking at different time periods, we see that systematic risk of US market is

higher than Canadian markets which explains the high volatility of US REITs as compare to Canadian REITs.

Exhibit 6 - Correlation of monthly returns on Gold, GSCI, REITs, and TIPS vs Basic Portfolio assets – Canada Case
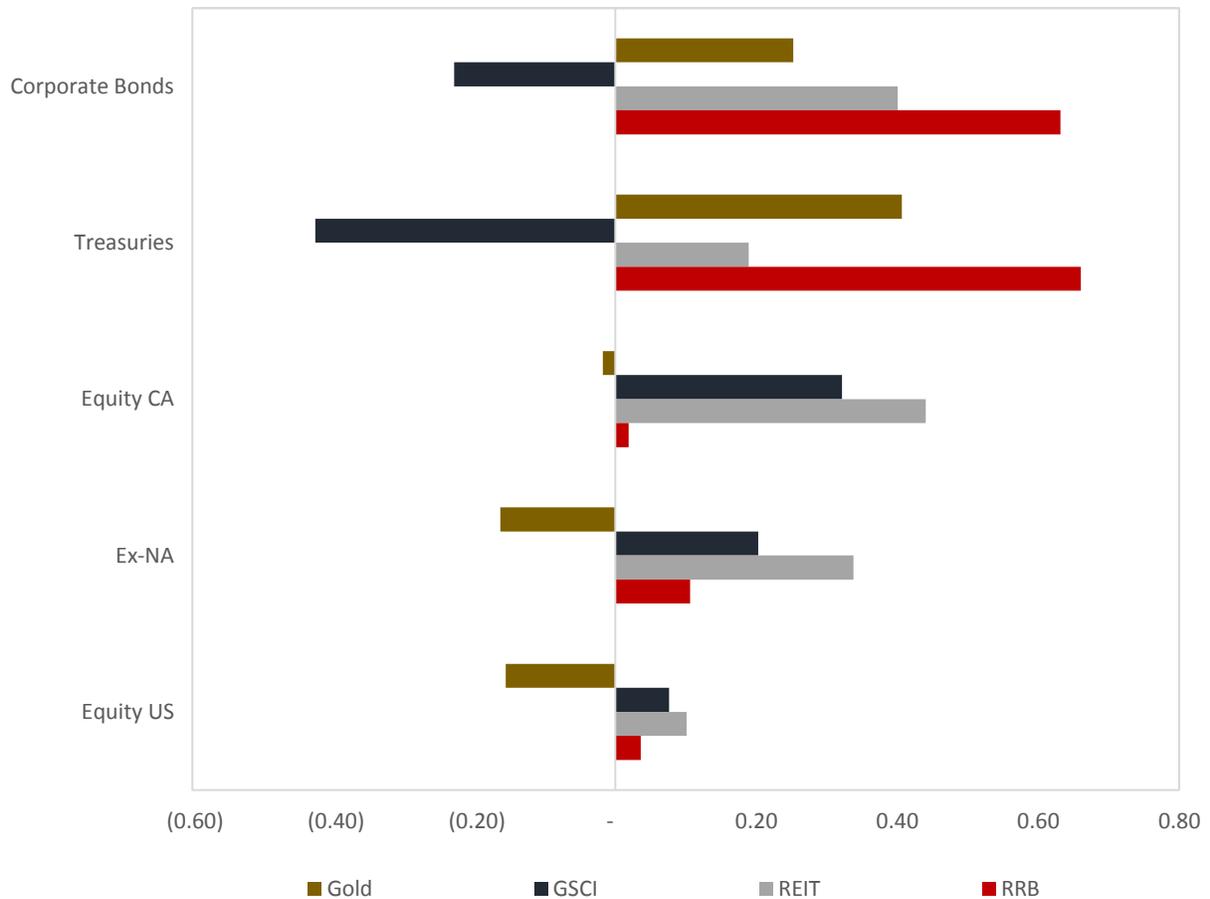
More importantly, Exhibit 6 shows correlations between inflation hedge assets and basic portfolio for Canada case. Over the period under consideration, there is some difference in the degree of correlation between asset returns in Canada as compared with US. The low correlation between all Equities and Gold is stronger from the perspective of a Canadian investor as compared to US investor. On the other hand, the positive relationship of Equities with Commodities and REITs is

stronger for the US investor as compared to the Canadian investor. Real Return Bonds for Canadian investors are just as highly correlated with Corporate and Government bonds as in the case with US investors. These slight differences obviously reflect that the two investors will be facing different sets of risks and returns, and therefore the return assumptions and covariance matrix inputs for portfolio optimization will be completely different for both cases.

Research Findings

US Case:

In this section, we perform similar optimizations as conducted by Dempster and Artigas (2010) for the US investors case. The only major difference will be the time periods as our optimizations are based on variance-covariance from April 2009 to August 2016. The section discusses optimal portfolio allocation results for the basic portfolio, to which we added each of the inflation hedge assets. Expected return projections and annualized standard deviations of returns for the basic portfolio assets as well as for the four inflation-hedge assets are presented under Exhibit 7.

Exhibit 7 - Annualized Market Forecasts

Asset	Real Return Projection	Std. Dev.	Information Ratio
MSCI U.S.	10.00%	15.2%	0.66
MSCI ex-U.S.	12.00%	17.58%	0.68
U.S. Treasuries	1.50%	4.66%	0.32
Corporates	3.30%	5.03%	0.66
TIPS	0.475%	6.37%	0.07
Gold	6.00%	17.58%	0.34
GSCI	6.00%	23.33%	0.26
REITS	6.00%	22.77%	0.26

Portfolio Optimization Results with Gold as Inflation Hedge Asset:

The first inflation-hedge asset added to the basic portfolio of MSCI U.S., MSCI ex-U.S., U.S. Treasuries and Corporates was Gold. By adding the most well-known precious metal to the basic portfolio, the achieved allocation shows conventional results, where 33.61% is allocated to U.S. Treasuries, 5.31% to Corporate Bonds, 13.19% to Equity Ex-US and 41.09% to Equity US. Allocation to inflation-hedge asset, which here is presented by alternative investment in Gold, is 6.8%. Results of Dempster and Artigas (2010) suggest a more conservative composition between combined Equities (MSCI U.S. and MSCI ex-U.S.) and U.S. Treasuries, where 64.5% is allocated to the latter asset, while Gold has an increased weight of 9.9% of total portfolio. Exhibit 8 shows the optimal portfolio allocation for our optimization.

Exhibit 8 – Portfolio Optimization Chart with Gold
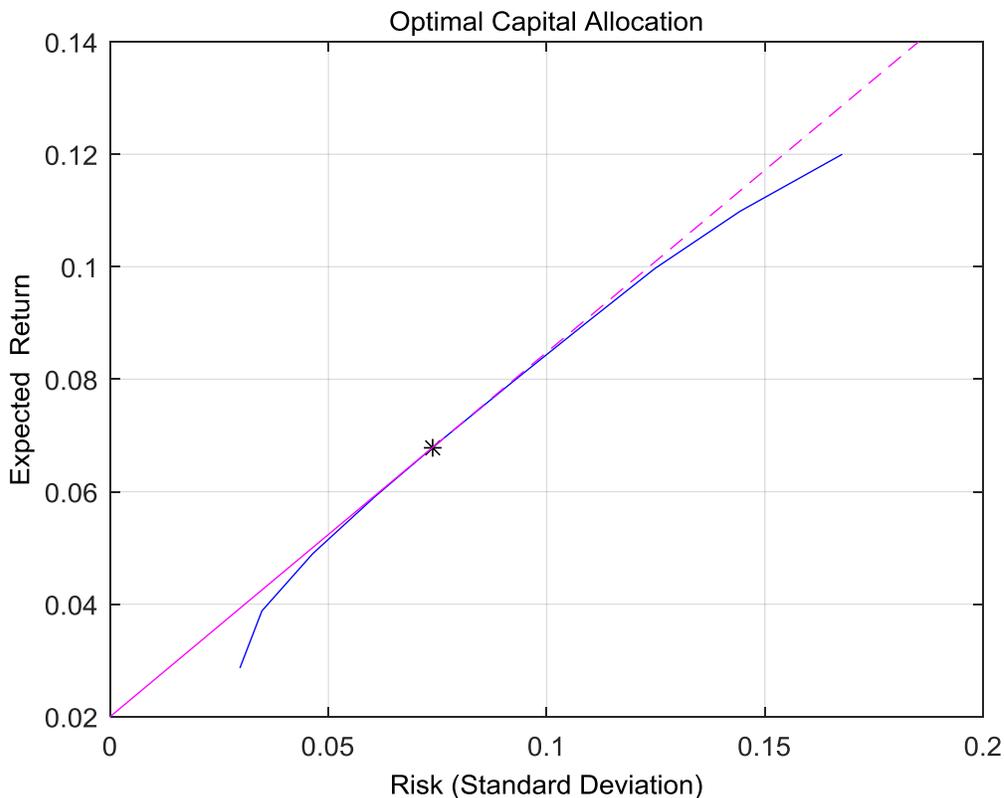
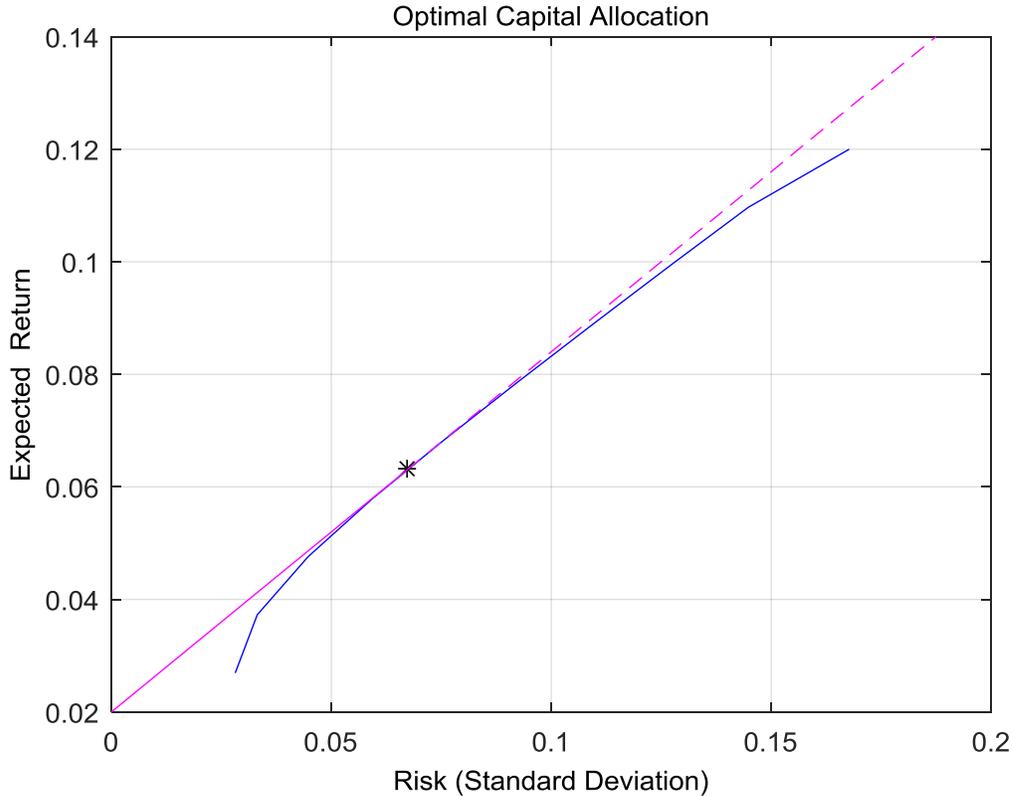Portfolio Optimization Results with GSCI as Inflation Hedge Asset:

Having discussed the allocation of Gold to the basic portfolio, we now want to check whether other commodities can provide a better inflation-hedge than the most well-known precious metal. S&P GSCI Index, which includes Energy, Agriculture, Livestock, Industrial and Precious Metals commodities, is the next asset added to the basic portfolio. S&P GSCI Index has the biggest allocation to Energy and Agriculture commodities, which have low correlation with Precious metals (detailed in Appendix 1). By adding S&P GSCI Index to the basic portfolio, optimization results show that assumed return of 6% for the S&P GSCI Index is not sufficient to have a non-zero weight for this asset in the new portfolio. Basic portfolio allocates 2.17% to Corporate Bonds, 45.37% to Treasuries, 15.64% to Equity Ex-US and 36.83% to Equity US. The risk-adjusted returns of Gold and S&P GSCI Index support this point, as Information Ratios are 0.34 and 0.26 correspondingly. The result is supported by Dempster and Artigas (2010) findings.

Exhibit 9 – Average Annual Returns, Volatility, and Risk-adjusted Returns for Various Commodities and S&P GSCI

1997-2009					
	Gold	Silver	Platinum	Oil	S&P GSCI
Return	5.9%	6.7%	7.0%	3.9%	-0.2%
St.Deviation	16.0%	28.4%	23.6%	36.5%	25.0%
Risk-adjusted returns	0.37	0.24	0.30	0.11	-0.01
2009-2016					
	Gold	Silver	Platinum	Oil	S&P GSCI
Return	1.4%	-2.9%	-4.8%	-7.5%	-9.9%
St.Deviation	18.5%	34.9%	21.4%	30.3%	20.5%
Risk-adjusted returns	0.08	-0.08	-0.23	-0.25	-0.48

The breakeven return of S&P GSCI, which makes the optimizer to allocate any non-zero weight is 9%. Exhibit 10 shows the optimal portfolio allocation for the basic portfolio case.

Exhibit 10 – Portfolio Optimization Chart with GSCI

Optimal Capital Allocation

Portfolio Optimization Results with REITs as Inflation Hedge Asset:

The third asset added to the basic portfolio of MSCI U.S., MSCI ex-U.S., U.S. Treasuries and Corporates is REIT Index. The interest in adding REITs to the portfolio lies in the fact that REITs products provide investors with the opportunity to make an investment, which has a feature of both equity and fixed-income securities. However, portfolio optimization results suggest that adding REITs Index to the basic portfolio will not provide any change, as the REITs Index allocation is 0% in this case. The corresponding weights of all basic portfolio are the same as for S&P GSCI

Index case. The return of REITs Index which makes optimizer allocate any non-zero weight is 15%.

Portfolio Optimization Results with TIPS as Inflation Hedge Asset:

Last type of asset, which was used as a potential inflation-hedge was TIPS. Treasury Inflation Protected Securities (TIPS) have same characteristics as Treasuries, however, TIPS returns are protected from inflation. Nevertheless, the assumed return of 0.5% does not give any non-zero allocation to TIPS and basic portfolio results are the same as for S&P GSCI Index case. Interestingly, allocations start to occur if the expected returns increase to 2.5% which means that based on our assumptions for expected returns for basic portfolio assets, we should have deflationary expectations.

In conclusion to the US Case, we would like to summarize our optimization results. We constructed Basic Portfolio, which includes Equity US, Equity ex-US, U.S. Treasuries and Corporate Bonds. Alternatively, we added four potential inflation-hedge assets to the Basic Portfolio, which are Gold, Commodities Index, REIT Index and TIPS. The results show that the only inflation-hedge asset that can be used as a proper diversifier is Gold. The results of final allocation are presented under Exhibit 11.

Exhibit 11 – Optimized Portfolio Weights, Return, Volatility and Information Ratio

Asset	Weights
MSCI U.S.	41.09%
MSCI ex-U.S.	13.19%
U.S. Treasuries	33.61%
Corporates	5.31%
Gold	6.80%
Portfolio Return	6.78%
Portfolio Volatility	7.38%
Information Ratio	0.92

Canada Case:

Having discussed four options of adding inflation-hedge assets for the US case, we now want to extend our analysis and present the case for a Canadian Investor. For this section, we considered a six-asset problem by looking at a five-asset basic portfolio. The Canadian basic portfolio includes Equity US, Equity CAN, Equity EAFE, Canadian Corporate bonds and Canadian Treasuries. Inflation hedges for Canadian Investor represent US equivalents. It should be also mentioned that all returns in this case are denominated in the Canadian dollar. Expected return projections and volatility of returns for the basic portfolio assets as well as for the four inflation-hedge assets are presented under Exhibit 12.

Exhibit 12 - Annualized Market Forecasts

Asset	Real Return Projection	Std. Dev	Information Ratio
MSCI Canada	8.00%	11.10%	0.72
MSCI U.S.	8.00%	9.93%	0.81
MSCI EAFE	10.00%	12.52%	0.80
Treasuries	1.90%	4.12%	0.46
Corporates	2.50%	3.55%	0.70
RRB	0.90%	7.95%	0.11
Gold	4.00%	17.73%	0.23
GSCI	4.00%	15.71%	0.25
REITS	6.00%	12.07%	0.50

Portfolio Optimization Results with Gold as Inflation Hedge Asset:

The first inflation hedge asset added to the Basic Portfolio is Gold. The results show the diversified allocation of 25.81% to Corporate Bonds, 1.69% to Treasuries, 13% to Equity EAFE, 28.63% to

Equity US, 21.91% to Equity CAN and 8.96% to Gold. Compared to the US case, allocation to

Gold increased from 6.8% to 8.96%. Results of this portfolio optimization can be seen in Exhibit

13 below.

Exhibit 13 – Portfolio Optimization Chart with Gold
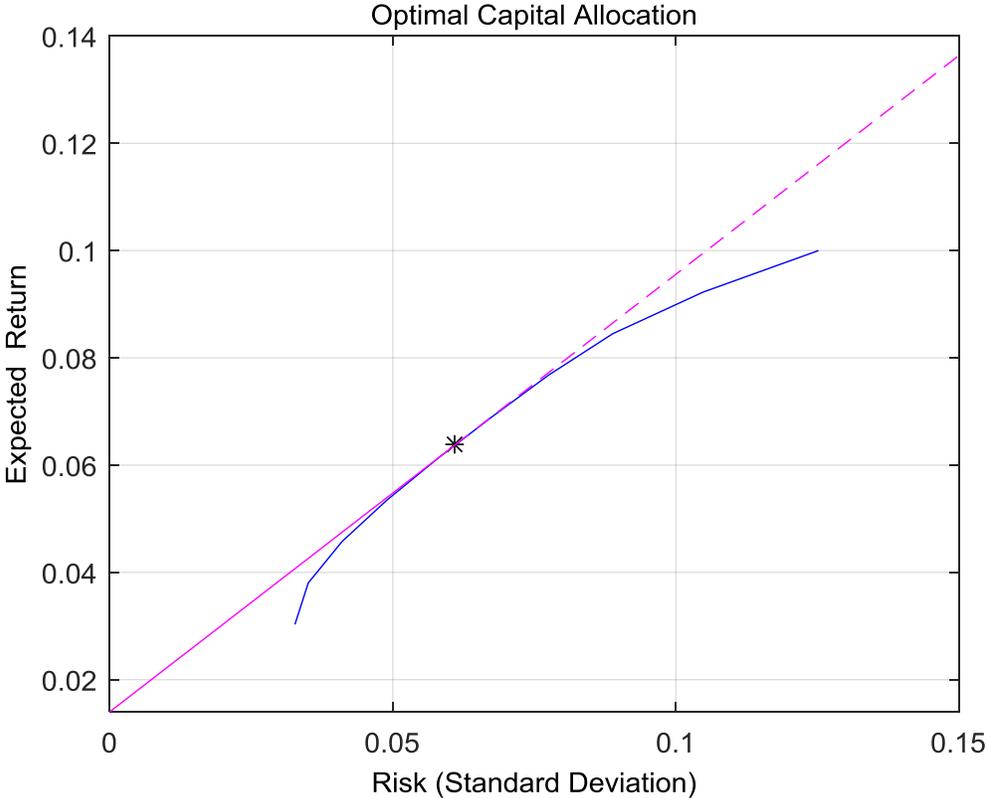
Portfolio Optimization Results with GSCI as Inflation Hedge Asset:

Next, to comprehend other commodities as long term strategic assets, we used S&P GSCI Index.

The optimization results show different composition between Corporate Bonds and Treasuries,

where 13.79% is allocated to Corporate Bonds, 28.52% to Treasuries, 8.63% to Equity EAFE,

23.49% to Equity US, 22.43% to Equity CAN and 3.14% to S&P GSCI Index.

Exhibit 14 – Portfolio Optimization Chart with GSCI

Optimal Capital Allocation
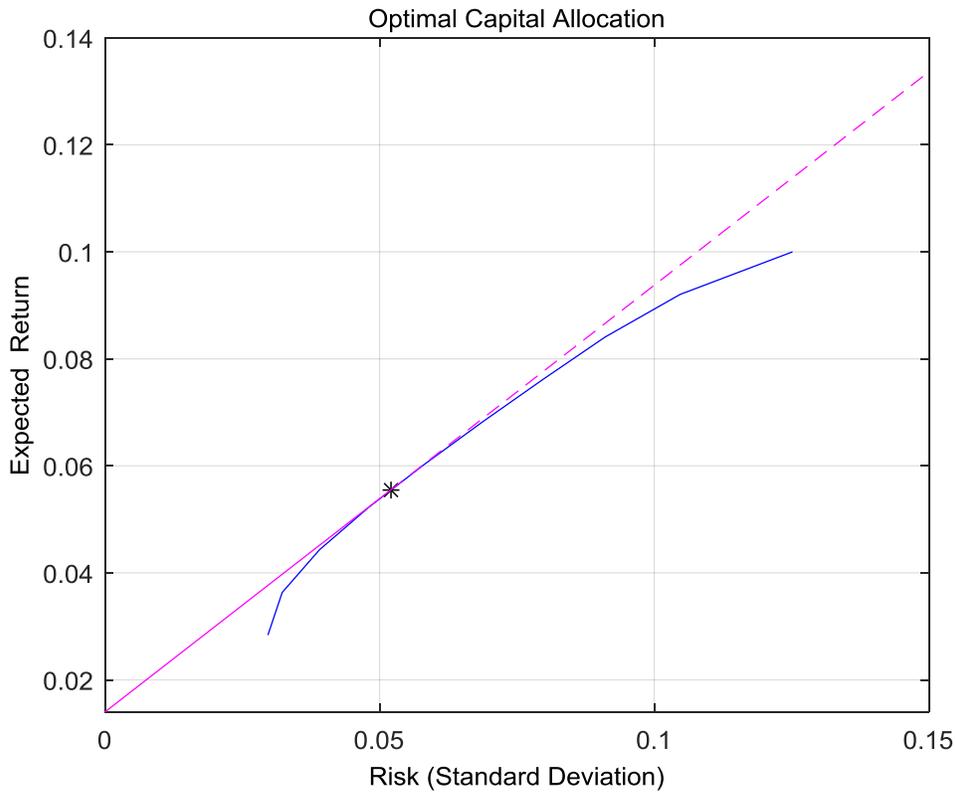
Portfolio Optimization Results with REITs as Inflation Hedge Asset:

Another asset, which also represents Alternative Investments group, is REITs Index. As it was mentioned before, analogous to the US REIT Index, Canadian REITs were used. This time, the allocation shows 11.29% weight for Corporate Bonds, 24.11% for Treasuries, 9.32% for Equity EAFE, 27.23% for Equity US, 22.98% for Equity CAN and 5.07% for REITs Index. (See more details in Sensitivity of Results)

Exhibit 15 – Portfolio Optimization Chart with REITs

Optimal Capital Allocation
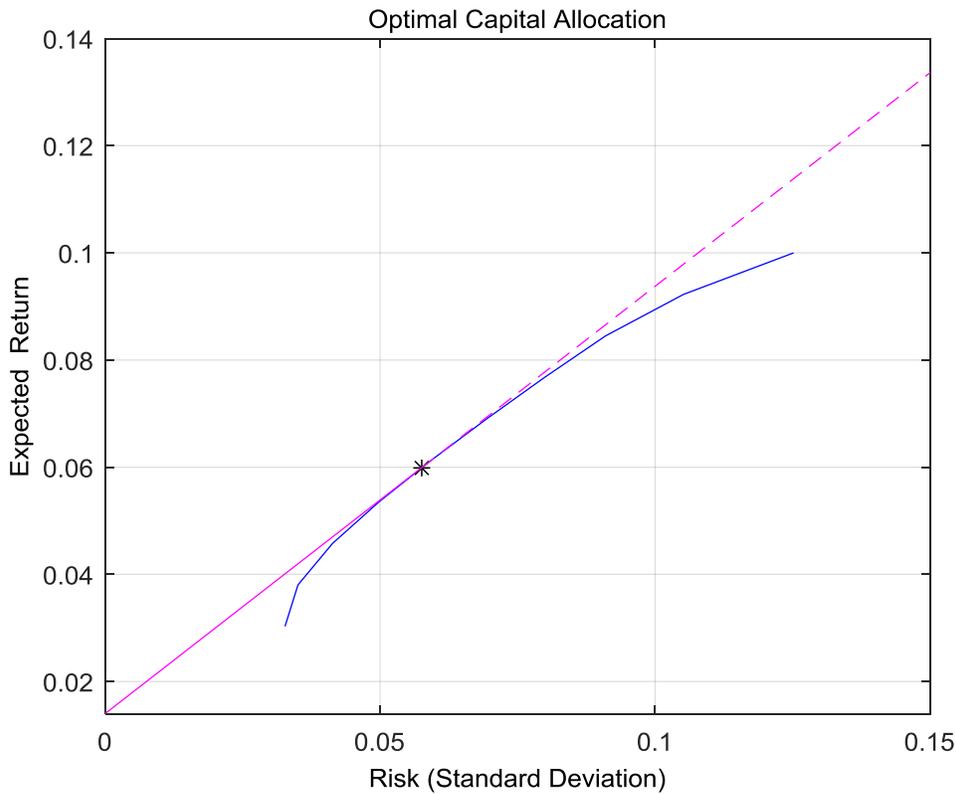
Portfolio Optimization Results with Real Return Bonds as Inflation Hedge Asset:

The last asset that was independently added to the Basic Portfolio is Real Return Bond, which is the equivalent of TIPS. The assumed return of 0.9% is not sufficient for the optimizer to allocate any non-zero weight resulting in optimized weights, 15.82% for Corporate Bonds, 24.83% for Treasuries, 10.21% for Equity EAFE, 24.43% for Equity US and 24.7% for Equity CAN, which are the same as the basic portfolio.

Exhibit 16 – Portfolio Optimization Chart with Real Return Bonds


Optimal Capital Allocation
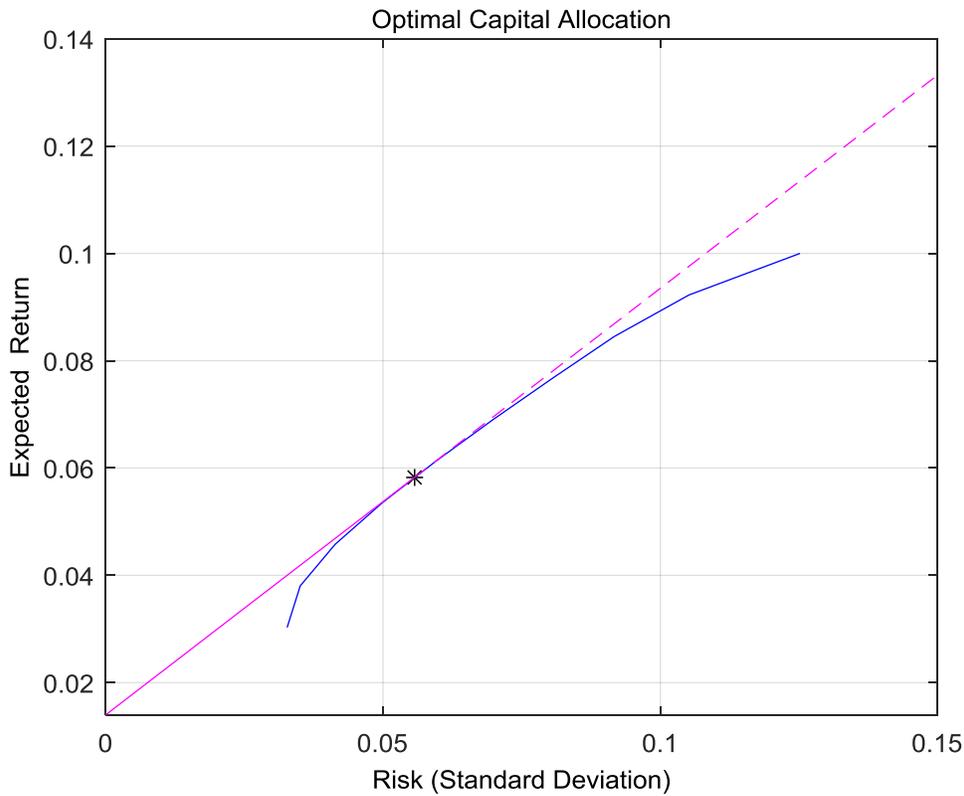
In conclusion to the Canada Case, we would like to summarize our optimization results. The Basic Portfolio constructed for the US Case was slightly changed for the Canadian investor. Alternatively, we added similar to the US Case inflation hedges to the Basic Portfolio to test, whether from the Canadian investor perspective the allocation would be different. Our results show that Gold, S&P GSCI Index and REITs Index can be considered as potential inflation hedges for the Canadian investor. The final allocations are presented under Exhibit 17.

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Exhibit 17 – Summary of Portfolio Optimization Results from the perspective of Canadian investor

Gold		GSCI		REIT		RRB	
Asset	Wts.	Asset	Wts.	Asset	Wts.	Asset	Wts.
MSCI U.S.	28.63%	MSCI U.S.	23.49%	MSCI U.S.	27.23%	MSCI U.S.	24.43%
MSCI Canada	21.91%	MSCI Canada	22.43%	MSCI Canada	22.98%	MSCI Canada	24.70%
MSCI EAFE	13.00%	MSCI EAFE	8.63%	MSCI EAFE	9.32%	MSCI EAFE	10.21%
U.S. Treasuries	1.69%	U.S. Treasuries	28.52%	U.S. Treasuries	24.11%	U.S. Treasuries	24.83%
Corporates	25.81%	Corporates	13.79%	Corporates	11.29%	Corporates	15.82%
Gold	8.96%	GSCI	3.14%	REIT	5.07%	RRB	0.00%
Portfolio Return	6.38%	Portfolio Return	5.55%	Portfolio Return	5.99%	Portfolio Return	5.82%
Portfolio Volatility	6.10%	Portfolio Volatility	5.20%	Portfolio Volatility	5.76%	Portfolio Volatility	5.56%
Information Ratio	1.05	Information Ratio	1.07	Information Ratio	1.04	Information Ratio	1.05

Exhibit 18 – Risk and Return Expectation of the four Canadian portfolios
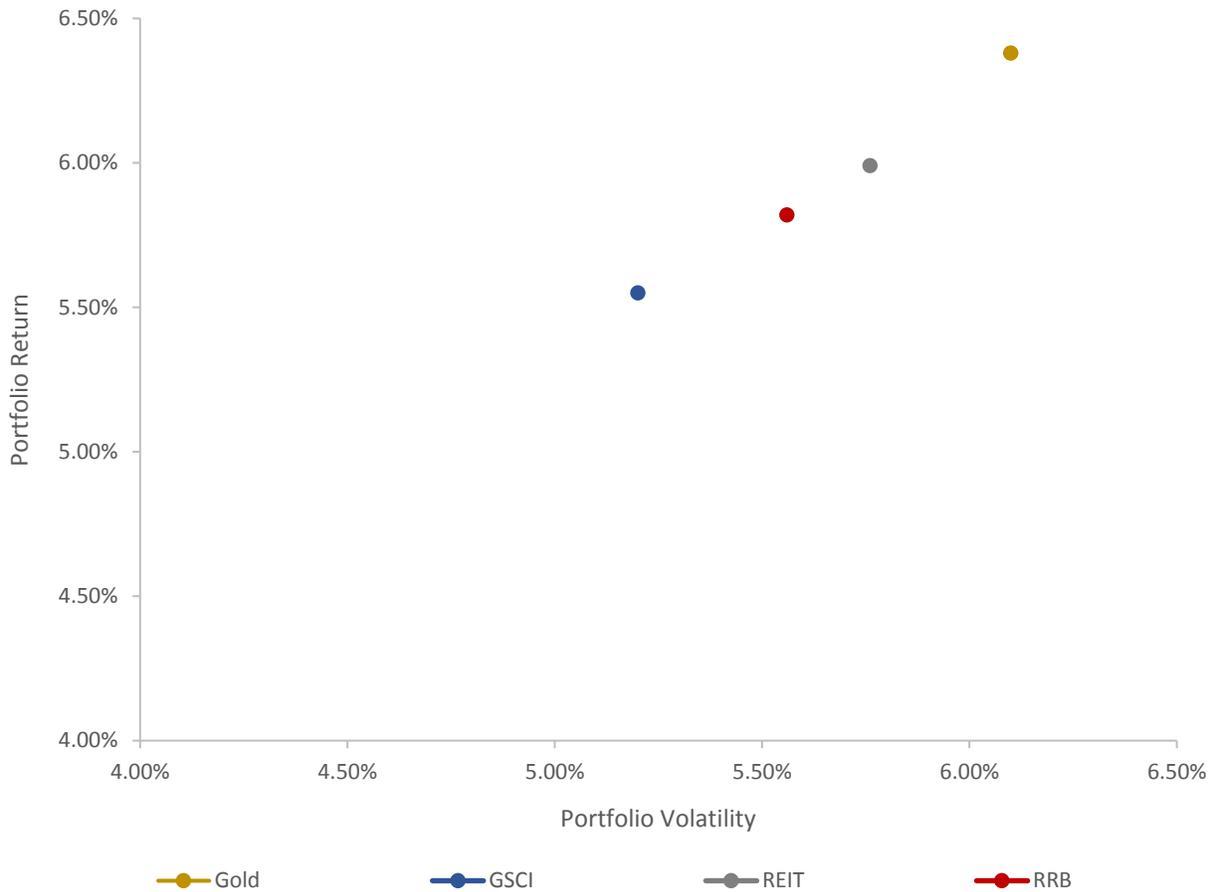
Sensitivity of Results:

As optimizations are extremely sensitive to asset return assumptions, it is important to test the results against a set of different assumptions to gauge the robustness of the results. Exhibits 19, 20, 21, and 22 show results for sensitivity analysis for US case whereas Exhibits 23, 24, 25, and 26 show sensitivity analysis for Canadian case. In all cases, except US TIPS and Canada RRB, the base case return assumption has been tested against a shock of 1% decrease and increase in return assumptions. The results of the sensitivity analysis, drawn by comparing the central panel (base case assumptions) against the right and left panel, reflect that most of the results are robust against

1% change in return assumptions. The only case in which the results appear to be weak is the Canadian REITs, where a decrease of 1% in return assumptions results in complete exclusion of REITs from the optimal allocation. In all the cases in which original results did not favor any allocation to inflation hedge asset, sensitivity results show that changing return assumptions by 1% does not make any difference. On the other hand, except for Canadian REITs all other cases reflect that changing return assumption by 1% results in a smaller allocation to inflation hedge asset but the allocation is not eliminated. Lastly, our result is in line with the correlation of basic portfolio with each individual inflation hedge assets (provided in Appendix 2) where Gold and GSCI have the lowest correlation of -0.01 and 0.14 with the basic portfolio.
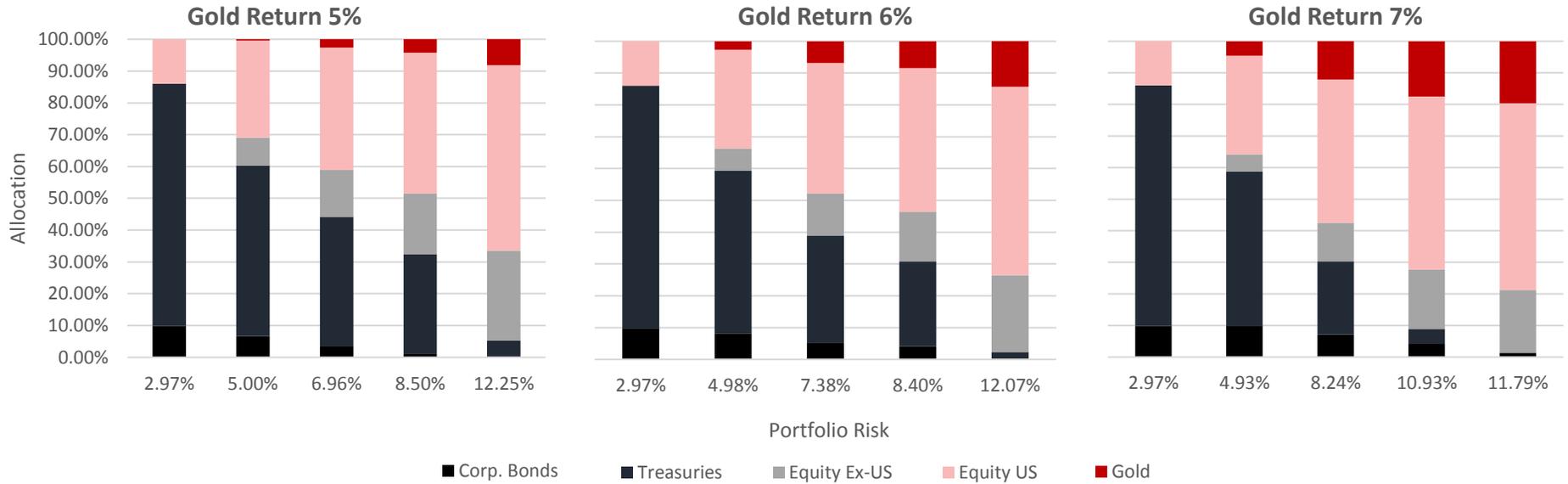
Exhibit 19: US Gold Sensitivity

Gold Return 5% | Gold Return 6% | Gold Return 7%

Legend: ■ Corp. Bonds ■ Treasuries ■ Equity Ex-US ■ Equity US ■ Gold

Exhibit 20: US GSCI Sensitivity

GSCI Return 5% | GSCI Return 6% | GSCI Return 7%

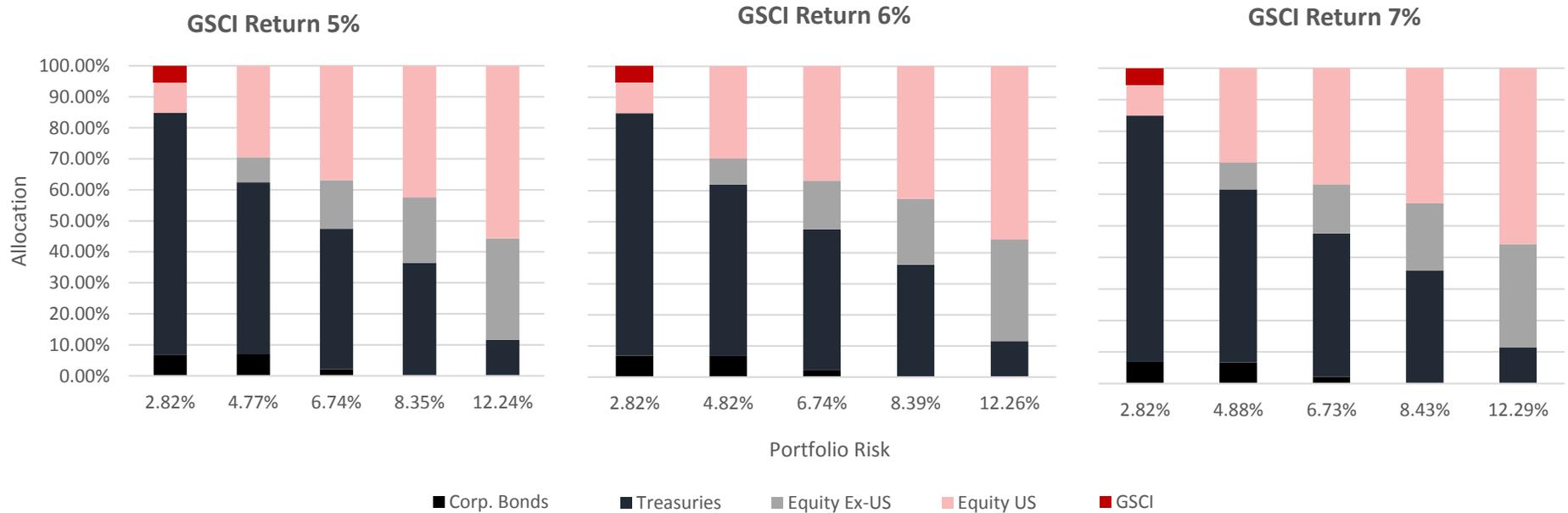Legend: ■ Corp. Bonds ■ Treasuries ■ Equity Ex-US ■ Equity US ■ GSCI
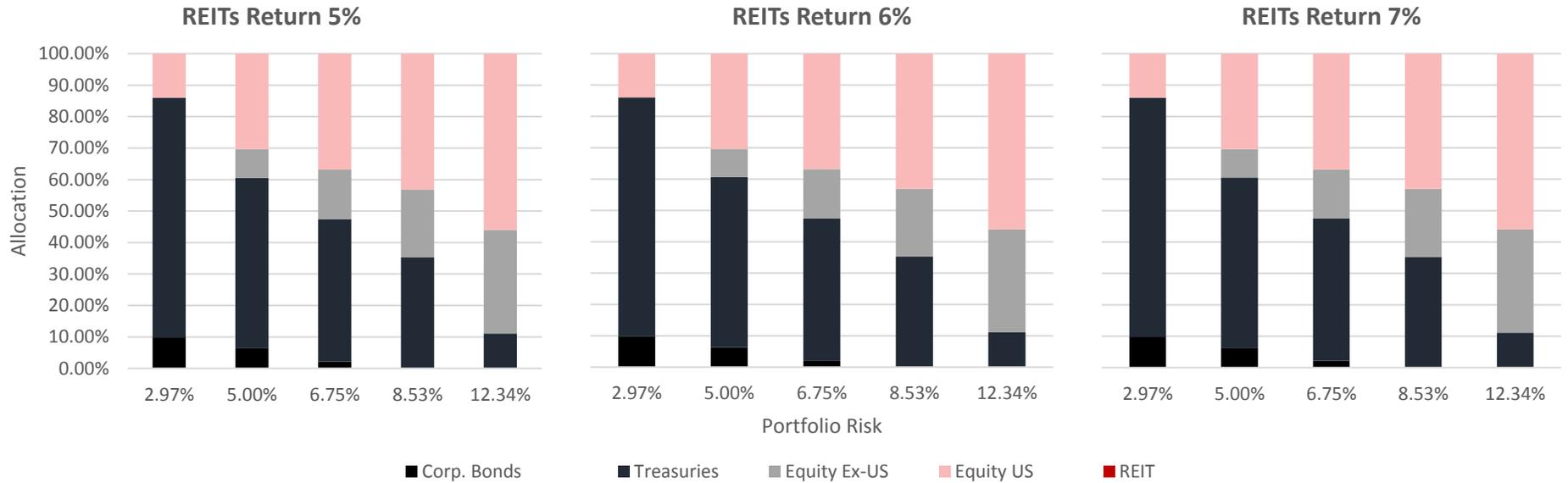
Exhibit 21: US REITs Sensitivity

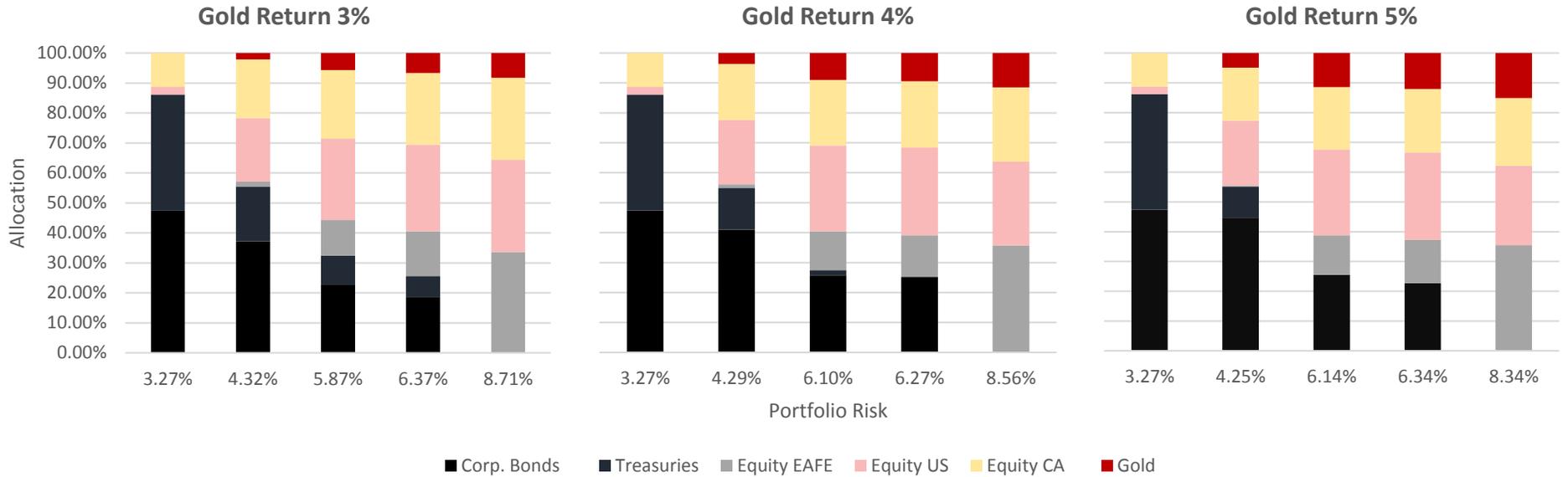**Exhibit 22: US TIPS Sensitivity**
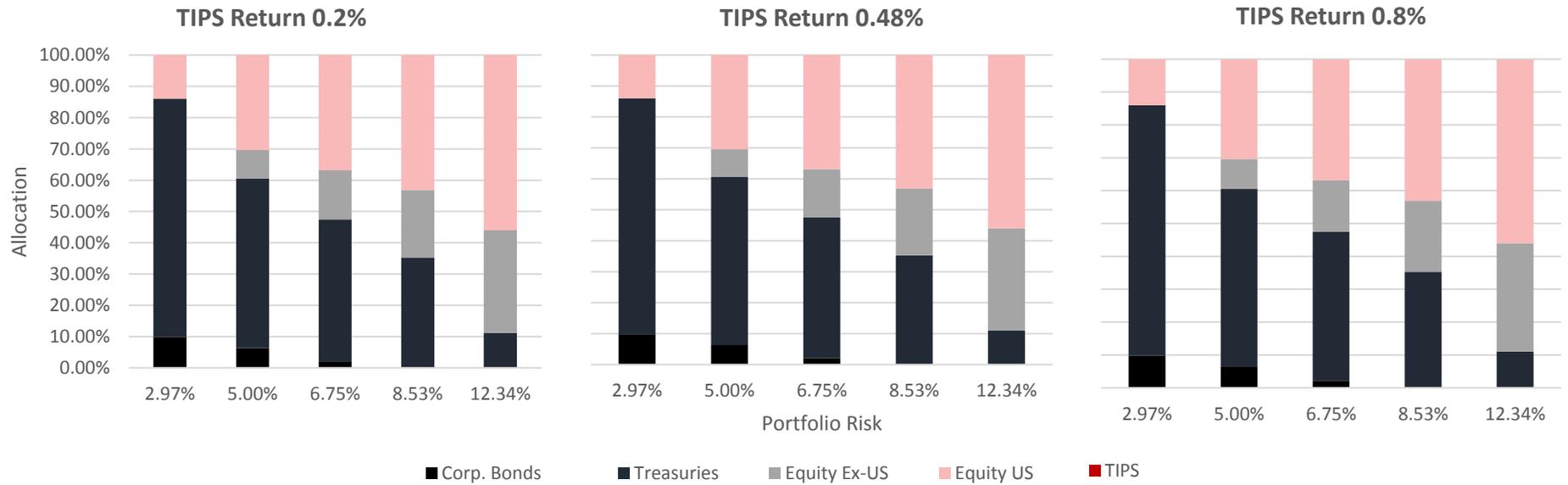
Exhibit 23: Canada Gold Sensitivity
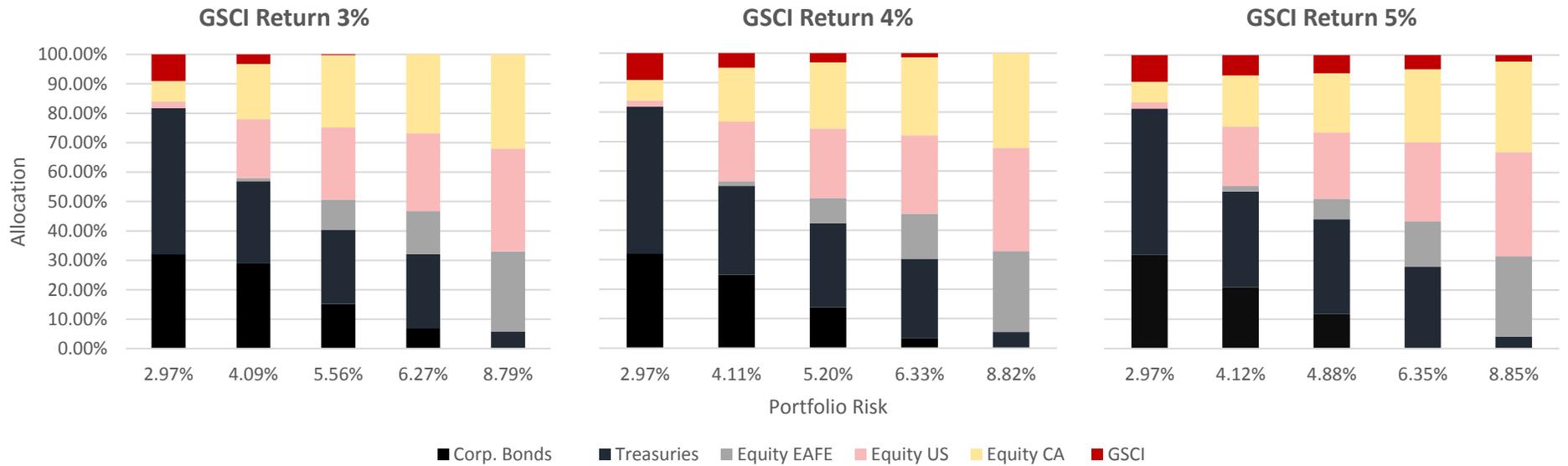

Exhibit 24: Canada GSCI Sensitivity

Exhibit 25: Canada REITs Sensitivity
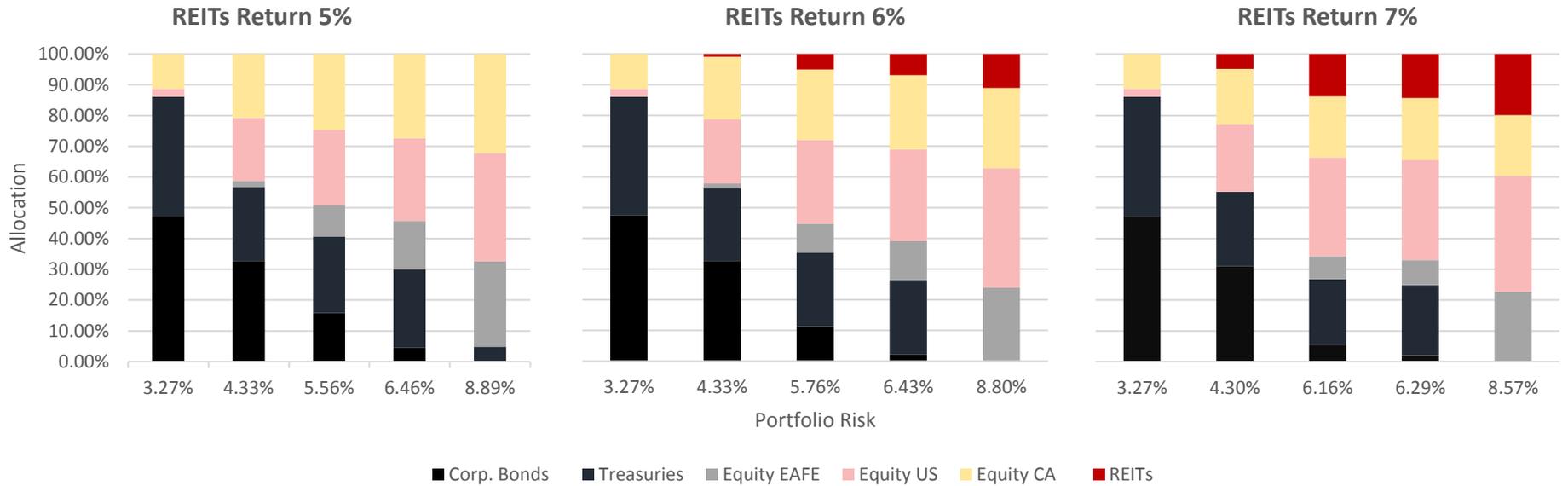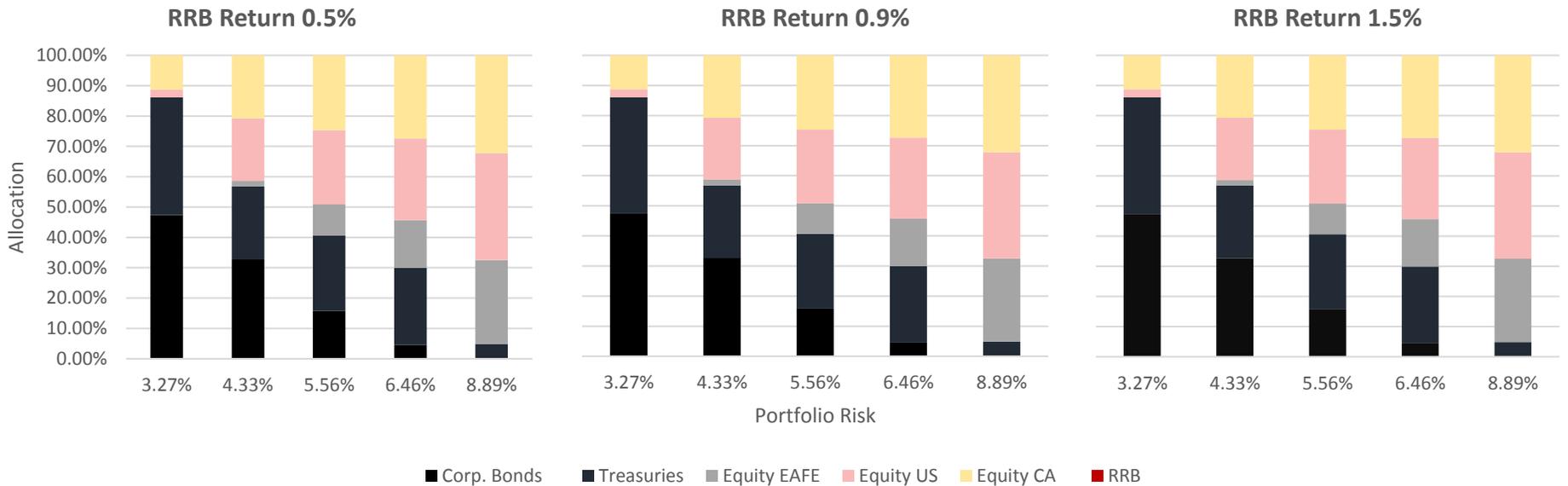

Exhibit 26: Canada RRB Sensitivity

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Conclusion

In conclusion to our analysis, we see that Gold is a strong long term strategic asset as our portfolio optimizations allocated 6.80% and 8.96% to Gold for the US and Canadian portfolios, respectively. Similarly, inflation protected securities are equally unattractive for both investors as our portfolio optimizations allocated zero weights to inflation protected securities in both cases. The results were different for Commodities and REITs as our results indicate that these two assets are not appropriate hedges for the US investor. However, it appears that there is some usefulness of these assets in a Canadian investor's portfolio as our portfolio optimizations allocated 3.14% and 5.07% weights to GSCI Commodities Index and REITs in the Canadian case. The results for GSCI Commodities in the Canadian case are more robust as compared to REITs as following our sensitivity analysis, we can conclude that a decrease of 1% in return assumption for REITs results in zero allocation in the optimal allocation. Furthermore, our results for rejection of Commodities Index, REITs, and TIPS in the US case are robust to input returns variability of 3%, 9%, and 2.25% respectively. Similarly, the result for Real Return Bonds in the Canadian case is robust to input returns variability of 2%.

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Appendix

Appendix 1

GSCI Index. Sector Weights (2016)

Sector	2016 Weights
Energy	56.96%
Agriculture	19.64%
Livestock	9.09%
Industrial Metals	9.51%
Precious Metals	4.81%

Appendix 2

Correlation of Canadian Basic Portfolio with Inflation Hedge Assets

Inflation Hedge Asset	Correlation with Basic Portoflio
Gold	-0.01
GSCI	0.14
REITs	0.41
RRB	0.23