Diversified Equity Fund
Modeling

INTRODUCTION

The goal of this analysis is to measure the impact of potential asset mix changes on the performance of the Diversified Equity Fund. The analysis will use both historical returns and prospective market parameters (expected returns, volatility and correlation coefficients).

The analysis will have three components:

1) Impact of potential changes on the Diversified Equity Fund by using expected returns, volatility and correlation coefficients for the next 10 years and the next 20 years.
2) Impact of potential changes on the Diversified Equity Fund by using the actual historical returns achieved by the underlying managers of the fund. Market indexes will be used for the new asset classes. The period under consideration will range from January 2007 to September 2011.
3) Impact of potential changes on the Diversified Equity Fund by using historical index returns for each asset class. The period under consideration will range from January 2000 to September 2011.

The proposed changes are similar to the one described in the plan for the review of the Diversified Equity Fund, which was presented at the October 13, 2011 Joint Pension Board meeting. Proposed changes to the portfolio will seek to capture sources of additional return and add diversifiers to lower the risk of the portfolio.

Due to constraints on data, the asset classes that are expected to capture sources of additional return will include the following:

- Canadian small cap equity (for historical returns only, Russell doesn't maintain prospective return for that asset class)
- Emerging markets
- Private equity

The asset classes that are expected to lower the risk of the portfolio will include the following:

- Real estate
- Infrastructure
- Commodities
- Market neutral strategies

The following portfolios will be created for each of the three components:

Portfolio	**Characteristics**[1]
Existing portfolio	Use the existing asset mix
Portfolio 1	3% allocation to Canadian small cap equity, 5% to emerging market equity, 5% to private equity and 5% to commodities
Portfolio 2	3% allocation to Canadian small cap equity, 5% to emerging market equity, 5% to private equity and 5% to global REITs
Portfolio 3	3% allocation to Canadian small cap equity, 5% to emerging market equity, 5% to private equity and 5% to listed infrastructure
Portfolio 4	3% allocation to Canadian small cap equity, 5% to emerging market equity, 5% to private equity and 5% to market neutral strategies
Portfolio 5	3% allocation to Canadian small cap equity and 3.75% each to commodities, global REITs, listed infrastructure and market neutral strategies
Portfolio 6	5% allocation to emerging markets equity and 2.50% each to commodities, global REITs, listed infrastructure and market neutral strategies
Portfolio 7	5% allocation to private equity and 2.50% each to commodities, global REITs, listed infrastructure and market neutral strategies

[1] In order to fund the new mandates, assets were taken away from EAFE and U.S. equities. After changes, the asset mix is 30% Canadian equities, 20% U.S. equities, 20% global equities, 15% EAFE equities and 15% new mandates.

DATA

1) **Prospective Market Parameters**
   a. **20-Year Horizon**

Expected Returns and Volatility

	Canada Equity	US Equity	EAFE Equity	Emerging Markets Equity	Global Equity	Private Equity	Global Commodities	Global REITs	Global Listed Infrastructure	Market Neutral Strategy
Expected Return	7.40%	7.80%	7.80%	9.00%	8.00%	9.60%	5.10%	7.50%	6.50%	4.30%
Volatility	19.40%	22.90%	20.60%	30.00%	20.90%	24.30%	20.20%	22.70%	17.70%	9.50%

Correlation Matrix

	Canada Equity	US Equity	EAFE Equity	Emerging Markets Equity	Global Equity	Private Equity	Global Commodities	Global REITs	Global Listed Infrastructure	Market Neutral Strategy
Canada Equity	1.00									
US Equity	0.59	1.00								
EAFE Equity	0.71	0.74	1.00							
Emerging Markets Equity	0.61	0.73	0.74	1.00						
Global Equity	0.72	0.93	0.91	0.86	1.00					
Private Equity	0.65	0.85	0.84	0.79	0.91	1.00				
Global Commodities	0.32	0.52	0.39	0.49	0.51	0.47	1.00			
Global REITs	0.63	0.77	0.79	0.71	0.84	0.77	0.54	1.00		
Global Listed Infrastructure	0.58	0.55	0.60	0.54	0.62	0.55	0.38	0.68	1.00	
Market Neutral Strategy	0.46	0.39	0.42	0.38	0.45	0.38	0.36	0.40	0.44	1.00

b. 10-Year Horizon

Expected Returns and Volatility

	Canada Equity	US Equity	EAFE Equity	Emerging Markets Equity	Global Equity	Private Equity	Global Commodities	Global REITs	Global Listed Infrastructure	Market Neutral Strategy
Expected Return	6.70%	7.10%	7.10%	8.40%	7.30%	8.90%	4.40%	6.80%	5.70%	3.60%
Volatility	18.90%	22.90%	20.40%	30.20%	20.70%	21.40%	19.60%	22.50%	17.00%	8.00%

Correlation Matrix

	Canada Equity	US Equity	EAFE Equity	Emerging Markets Equity	Global Equity	Private Equity	Global Commodities	Global REITs	Global Listed Infrastructure	Market Neutral Strategy
Canada Equity	1.00									
US Equity	0.59	1.00								
EAFE Equity	0.71	0.74	1.00							
Emerging Markets Equity	0.61	0.73	0.74	1.00						
Global Equity	0.72	0.93	0.91	0.86	1.00					
Private Equity	0.65	0.85	0.84	0.79	0.91	1.00				
Global Commodities	0.32	0.52	0.39	0.49	0.51	0.47	1.00			
Global REITs	0.63	0.77	0.79	0.71	0.84	0.77	0.54	1.00		
Global Listed Infrastructure	0.58	0.55	0.60	0.54	0.62	0.55	0.38	0.68	1.00	
Market Neutral Strategy	0.46	0.39	0.42	0.38	0.45	0.38	0.36	0.40	0.44	1.00

RESULTS

1) **Prospective Market Parameters**
   a. **Portfolio Composition**

Portfolio Composition

Portfolio	Canada Equity	US Equity	EAFE Equity	Emerging Markets Equity	Global Equity	Private Equity	Global Commodities	Global REITs	Global Listed Infrastructure	Market Neutral Strategy
Existing Portfolio	30.00%	22.50%	30.00%	0.00%	17.50%	0.00%	0.00%	0.00%	0.00%	0.00%
Portfolio 1	30.00%	20.00%	15.00%	5.00%	20.00%	5.00%	5.00%	0.00%	0.00%	0.00%
Portfolio 2	30.00%	20.00%	15.00%	5.00%	20.00%	5.00%	0.00%	5.00%	0.00%	0.00%
Portfolio 3	30.00%	20.00%	15.00%	5.00%	20.00%	5.00%	0.00%	0.00%	5.00%	0.00%
Portfolio 4	30.00%	20.00%	15.00%	5.00%	20.00%	5.00%	0.00%	0.00%	0.00%	5.00%
Portfolio 5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Portfolio 6	30.00%	20.00%	15.00%	5.00%	20.00%	0.00%	2.50%	2.50%	2.50%	2.50%
Portfolio 7	30.00%	20.00%	15.00%	0.00%	20.00%	5.00%	2.50%	2.50%	2.50%	2.50%

   b. **20-Year Horizon**

Market Parameters
20-Year Investment Horizon

Portfolio	Expected Return	Volatility	Sharpe Ratio
Existing Portfolio	7.72%	15.24%	0.283
Portfolio 1	7.74%	14.81%	0.293
Portfolio 2	7.86%	15.09%	0.295
Portfolio 3	7.81%	14.96%	0.294
Portfolio 4	7.70%	14.82%	0.290
Portfolio 5	N/A	N/A	N/A
Portfolio 6	7.59%	14.64%	0.286
Portfolio 7	7.62%	14.53%	0.290

The previous table shows the impact of the various proposed changes on the expected return and volatility of the Diversified Equity Fund. Portfolios 1 to 4 show the impact of adding emerging markets equity, private equity and a diversifying strategy (either commodities, global REITs, listed infrastructure or market neutral strategies) to the Diversified Equity Fund. In each case the expected return is higher and the volatility is lower, which obviously leads to a higher Sharpe ratio.

Portfolios 6 and 7 show the impact of combining the four diversifying strategies to either emerging markets equity or private equity. Although it causes the expected return of the Diversified Equity Fund to go down for both scenarios, the volatility is also lower in both cases to such an extent that the Sharpe ratio is higher than for the existing portfolio.

c. 10-Year Horizon

Market Parameters
10-Year Investment Horizon

Portfolio	Expected Return	Volatility	Sharpe Ratio
Existing Portfolio	7.02%	15.06%	0.293
Portfolio 1	7.04%	14.56%	0.305
Portfolio 2	7.16%	14.85%	0.307
Portfolio 3	7.11%	14.71%	0.306
Portfolio 4	7.00%	14.57%	0.302
Portfolio 5	N/A	N/A	N/A
Portfolio 6	6.89%	14.47%	0.296
Portfolio 7	6.91%	14.27%	0.302

Very similar conclusions can be reached if we use the 10-year investment horizon. The only difference is that the expected return is lower for portfolio 4, but volatility is lower for all portfolios and Sharpe ratios are also higher.

2) Actual Historical Returns of Investment Managers (2007 Q1 – 2011 Q3)

a. Portfolio Composition

Portfolio Composition (as of 2011 Q3)

Manager	Existing Portfolio	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5	Portfolio 6	Portfolio 7
Beutel, Goodman	10.00%	9.00%	9.00%	9.00%	9.00%	9.00%	10.00%	10.00%
CC&L	10.00%	9.00%	9.00%	9.00%	9.00%	9.00%	10.00%	10.00%
Greystone	10.00%	9.00%	9.00%	9.00%	9.00%	9.00%	10.00%	10.00%
Highstreet	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Small Cap	0.00%	3.00%	3.00%	3.00%	3.00%	3.00%	0.00%	0.00%
S&P 500 Hedged	17.50%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%
S&P 500 Unhedged	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
S&P Midcap 400	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
PanAgora	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Fidelity	15.00%	7.50%	7.50%	7.50%	7.50%	7.50%	7.50%	7.50%
Alliance Bernstein	15.00%	7.50%	7.50%	7.50%	7.50%	7.50%	7.50%	7.50%
Emerging Markets	0.00%	5.00%	5.00%	5.00%	5.00%	0.00%	5.00%	0.00%
T. Rowe Price	8.75%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Harris Associates	8.75%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Private Equity	0.00%	5.00%	5.00%	5.00%	5.00%	0.00%	0.00%	5.00%
Global Commodities	0.00%	5.00%	0.00%	0.00%	0.00%	3.75%	2.50%	2.50%
Global REITs	0.00%	0.00%	5.00%	0.00%	0.00%	3.75%	2.50%	2.50%
Global Listed Infrastructure	0.00%	0.00%	0.00%	5.00%	0.00%	3.75%	2.50%	2.50%
Market Neutral Strategy	0.00%	0.00%	0.00%	0.00%	5.00%	3.75%	2.50%	2.50%

b. Results

Historical Returns
2007 Q1 – 2011 Q3

Portfolio	Expected Return	Volatility
Existing Portfolio	-4.85%	18.14%
Portfolio 1	-3.67%	17.95%
Portfolio 2	-3.94%	18.37%
Portfolio 3	-3.68%	18.00%
Portfolio 4	-3.58%	17.25%
Portfolio 5	-4.00%	17.18%
Portfolio 6	-3.82%	17.48%
Portfolio 7	-3.93%	17.15%

The previous table shows the impact that making the proposed changes would have had on the Diversified Equity over the period ranging from 2007 Q1 to 2011 Q3. All proposed portfolios would have achieved a higher rate of return and volatility would have been lower for each portfolio except one (Portfolio 2, which has a 3% allocation to Canadian small cap equity, 5% to emerging markets equity, 5% to private equity and 5% to global REITs). Sharpe ratios are not calculated because they're meaningless when the portfolio return is lower than the risk-free rate.

3) Historical Index Returns (2000 Q1 – 2011 Q3)

a. Portfolio Composition

Portfolio Composition

Index	Existing Portfolio	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5	Portfolio 6	Portfolio 7
S&P/TSX	30.00%	27.00%	27.00%	27.00%	27.00%	27.00%	30.00%	30.00%
Small Cap	0.00%	3.00%	3.00%	3.00%	3.00%	3.00%	0.00%	0.00%
S&P 500 Hedged	17.50%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%
S&P 500 Unhedged	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
S&P Midcap 400	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Russell 2000	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
EAFE	30.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%
Emerging Markets	0.00%	5.00%	5.00%	5.00%	5.00%	0.00%	5.00%	0.00%
MSCI World	17.50%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%
Private Equity	0.00%	5.00%	5.00%	5.00%	5.00%	0.00%	0.00%	5.00%
Global Commodities	0.00%	5.00%	0.00%	0.00%	0.00%	3.75%	2.50%	2.50%
Global REITs	0.00%	0.00%	5.00%	0.00%	0.00%	3.75%	2.50%	2.50%
Global Listed Infrastructure	0.00%	0.00%	0.00%	5.00%	0.00%	3.75%	2.50%	2.50%
Market Neutral Strategy	0.00%	0.00%	0.00%	0.00%	5.00%	3.75%	2.50%	2.50%

b. Results

Historical Returns
2000 Q1 – 2011 Q3

Portfolio	Expected Return	Volatility
Existing Portfolio	0.68%	15.99%
Portfolio 1	1.51%	15.67%
Portfolio 2	1.56%	16.11%
Portfolio 3	1.51%	15.94%
Portfolio 4	1.35%	15.36%
Portfolio 5	1.60%	14.80%
Portfolio 6	1.65%	15.37%
Portfolio 7	1.42%	15.06%

The previous table shows the impact of having various mixes for the Diversified Equity over the period ranging from 2000 Q1 to 2011 Q3, using index returns. The proposed mixes would have significantly improved the return of the portfolio and volatility would have been lower most of the time (again except for portfolio 2).

CONCLUSION

The above modeling demonstrates that adding select asset classes to the Diversified Equity Fund would have improved the efficiency of the portfolio (either increasing the return for a given level of risk or reducing risk for a given level of return). The results are consistent whether historical or prospective returns are used.