Seeing Beyond Risk Canadian Institute of Actuaries Institut canadien des actuaires Voir au-delà du risque

Educational Note

Currency Risk in the Valuation of Policy Liabilities for Life and Health Insurers

Committee on Life Insurance Financial Reporting

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Members should be familiar with educational notes. Educational notes describe but do not recommend practice in illustrative situations. They do not constitute Standards of Practice and are, therefore, not binding. They are, however, intended to illustrate the application (but not necessarily the only application) of the Standards of Practice, so there should be no conflict between them. They are intended to assist actuaries in applying Standards of Practice in respect of specific matters. Responsibility for the manner of application of Standards of Practice in specific circumstances remains that of the members in the life insurance practice area.

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Memorandum

To: All Life Insurance Practitioners

From: Tyrone G. Faulds, Chairperson
Practice Council

B. Dale Mathews, Chairperson
Committee on Life Insurance Financial Reporting

Date: December 2, 2009

Subject: **Educational Note – Currency Risk in the Valuation of Policy Liabilities for Life and Health Insurers**

The purpose of this educational note is to emphasize the importance of providing for currency risk in the valuation to the extent that it is not hedged and to provide additional guidance in doing so.

The note is consistent with the recent changes to the Standards of Practice – Practice-Specific Standards for Insurers, Subsection 2340 – Foreign Exchange (http://www.actuaries.ca/members/publications/2009/209090e.pdf, September 2009).

In accordance with the Institute's Policy on Due Process for the Approval of Guidance Material Other than Standards of Practice, this educational note has been prepared by the Committee on Life Insurance Financial Reporting and has received final approval for distribution by the Practice Council on November 26, 2009.

As outlined in subsection 1220 of the Standards of Practice, "*The actuary should be familiar with relevant Educational Notes and other designated educational material.*" That subsection explains further that a "practice which the Educational Notes describe for a situation is not necessarily the only accepted practice for that situation and is not necessarily accepted actuarial practice for a different situation." As well, "The Educational Notes are intended to illustrate the application (but not necessarily the only application) of the Standards, so there should be no conflict between them."

If you have any questions or comments regarding this educational note, please contact Dale Mathews at her CIA Online Directory address, Dale_Mathews@manulife.com.

TGF, BDM

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RESERVING FOR CURRENCY RISK

1. INTRODUCTION

The purpose of this educational note is to emphasize the importance of providing for currency risk in the valuation to the extent that it is not hedged and to provide additional guidance in doing so.

Currency risk can be defined as the risk of incurring losses resulting from adverse movement in exchange rates.

Because exchange rates can be very volatile in both the short and long terms, often more so than interest rates (see section 4. Examples), they can expose companies to substantial risks of incurring losses when liabilities and assets are denominated in different currencies.

This note would apply to all asset types, although for equities and some other types of investments, judgement would be required to assess whether currency risk is already included in return assumptions. One such example would be where liabilities are backed by the shares of a foreign-listed multinational company that transacts business mostly in the currency of the liabilities.

The wording of the Standards of Practice has been changed to reflect the fact that there may be significant interest rate differentials in countries using different currencies. In such a case, the market is expecting one currency to appreciate (or depreciate) relative to the other currency (otherwise, if the foreign exchange rates were expected to remain fixed at the foreign exchange rates at the balance sheet date, this would provide an arbitrage opportunity to invest in the currency yielding the highest return).

Paragraph 2340.16 of the Standards of Practice states, "The needed assumptions would include foreign exchange rates when policy liabilities and their supporting assets are denominated in different currencies."

Paragraphs 2340.17 through 2340.19 of the Standards of Practice state

.17 "The base scenario used to develop the assumption for foreign exchange rates would be based on currency forwards. If currency forwards are not available, the forward exchange rates would be derived based on risk-free interest rate differentials where available. If neither is available, the actuary would use his or her best judgment to develop an appropriate approach."

.18 "A provision for adverse deviations would be developed from a scenario using adverse movements in the exchange rate. Such movements would reflect the historical volatility in the exchange rate over the applicable period. The provision for adverse deviations would be the excess of the policy liabilities based on this adverse scenario over the policy liabilities calculated using the base scenario."

.19 "A minimum provision for adverse deviations would apply. This would be the excess of the policy liabilities resulting from the application of an adverse five percent margin to the projected exchange rates underlying the base scenario over the policy liabilities calculated using the base scenario."

The remainder of this note will provide guidance on the application of this Standard of Practice.

Some currency risk exposure situations are

Canadian branches of foreign companies where some of the assets supporting the Canadian liabilities are denominated in non-Canadian currency,

Canadian companies operating in countries where the local liabilities are backed by non-local denominated currencies,

universal life index-linked accounts where the credited rate is based on a foreign index but supported by a Canadian denominated asset, and

Canadian companies where the liabilities (other than expenses) and the assets are Canadian denominated, but the expenses are US denominated.

2. BASE SCENARIO

The base scenario assumption would be taken directly from currency forwards, or their equivalent. When currency forwards are not readily available, risk-free interest rate differentials can be used to derive a forward rate, F, as,

$$F = S \times ((1 + i_a)/(1 + i_b))^m$$

where

F is the corresponding forward exchange rate,

S is the spot exchange rate, expressed as the price in currency *a* of a unit of currency *b*,

i_a and i_b are the risk-free interest rates for the respective currencies (if risk-free interest rates are not available, deduct an appropriate amount for C1 risk for each country), and

m is the common maturity in years for the forward rate and the two interest rates.

The underlying theory is that of interest rate parity, which is a relationship that must hold between the spot interest rates of two currencies if there are to be no arbitrage opportunities. However, the empirical evidence for the theory is unconvincing.

In the *IMF Staff Papers* Vol. 51, No. 3 ©2004 International Monetary Fund titled, "Monetary Policy and Long-Horizon Uncovered Interest Parity" by Chinn and Meredith[1], the authors conclude "…that the simple form of the UIP [uncovered interest parity] condition is essentially useless as a predictor of short-term movements in exchange rates… Over longer horizons, however, our results suggest that UIP may significantly outperform naive alternatives such as the random walk hypothesis, although it is still likely to explain only a relatively small proportion of the observed variance in exchange rates."

Nonetheless, in spite of its shortcoming, the theory has the important advantage of putting assets denominated in different currencies on equal footing. Choosing a higher-yielding foreign bond over a local one (in this context, local is meant to be the currency in which the liability is denominated) without an offsetting depreciation of the currency

[1] See http://www.ssc.wisc.edu/~mchinn/chinn_meredith_IMFSP.pdf

would lead to lower policy liabilities. In light of the high volatility of exchange rates, as shown in section 4, this would appear to be both imprudent and difficult to justify.

Let us consider two examples.

First, consider a company that has a choice of investing between two risk-free 10-year strip bonds (for simplicity, C1 risk is assumed to be zero in both cases). The first one denominated in the same currency as the liability, yields 5% risk-free to maturity. The other, denominated in a foreign currency, yields 7% risk-free. Assuming that the current exchange rate is 1.000, the best estimate for the exchange rate in 10 years would be $(1.05/1.07)^{10}$ multiplied by the current rate. The result is 0.828. The foreign currency would, therefore, be expected to depreciate by 17.2% over the 10-year period.

The C1 deduction would include sovereign risk in the case of a bond issued by a sovereign government.

Some developing countries may not have deep or liquid bond markets, making this exercise difficult. In such cases, the actuary is encouraged to seek the input of individuals knowledgeable in techniques or theories available to determine such values. An example would be "International Finance Theory and Policy" by Steven M. Suranovic dealing with the purchasing power parity theory[2].

Second, consider a company that decided to back its 30-year liabilities with a foreign stock index. Its assumed best estimate return over the 30-year period would be reduced by the expected currency depreciation. So, if the best estimate return were 9% and the 30-year interest rates were 7% and 8%, respectively, its currency-adjusted return would become 7.99% where $(1.07/1.08)^{30} \times 1.09^{30} = 1.0799^{30}$.

Note, however, that there can be unusual instances where assets denominated in a different currency than that of the liabilities would not necessarily create a currency risk exposure. Such situation would occur where U.S. liabilities are supported by the shares of Canadian companies that transact a significant percentage of their business in U.S. dollars and who report their financial results in that currency. In such cases, it is expected that movements between the Canadian and U.S. currencies would largely be reflected in the share prices.

This note cannot possibly cover all possible situations and the actuary would apply the spirit of this note to the circumstances of his or her company. If the actuary believes that his or her company's position is such that a full adjustment for currency is not necessary, he or she would document this rationale.

3. PROVISION FOR ADVERSE DEVIATIONS

Paragraph 1740.05 of the Standards of Practice states, "*The margin for adverse deviations in each assumption should reflect the uncertainty of that assumption and of any related data.*"

Historical evidence indicates that currency volatility increases with time but decreases with the degree of integration of the economies of any two countries.

[2] See http://internationalecon.com/v1.0/Finance/ch30/F30-1.html

To establish a provision for adverse deviations, the actuary would develop a scenario reflecting historical volatility of that exchange rate over periods consistent with the length of time over which the currency mismatch is expected to exist.

The provision for adverse deviations would be equal to the excess of the policy liability calculated using this scenario over the corresponding liability calculated using the base scenario. A minimum provision would apply. This would be taken as the increase in the policy liability resulting from the application of an adverse 5% margin to the projected exchange rates underlying the base scenario over the amount calculated using the base scenario.

An acceptable approach to reflecting volatility would be to use one standard deviation of the changes in the exchange rate as the measurement. The actuary would apply the standard deviation in the direction that produces an adverse movement in the exchange rate of this amount over the projection period.

The use of one standard deviation establishes an unbiased measure. In situations where the actuary feels there is strong economic evidence that one currency will appreciate (or depreciate) relative to the other and the mean historical movement over appropriate periods is consistent with this direction, the actuary would consider using the mean plus or minus one standard deviation as the measure of volatility.

In the special case where one currency is pegged to another well established currency such as the US dollar, if the pegging has been present for an extended period of time, and there is only a nominal interest rate differential between the two countries, a margin for adverse deviations of less than 5% may be appropriate. Where the un-pegging of such a currency is deemed to be a remote possibility, the consequences of un-pegging are not necessarily provided for in the policy liability.

The approach to calculating standard deviation illustrated in the examples assumes implicitly that the exchange rate follows a random walk, that is, that the exchange rate does not revert toward a long-term mean. While this assumption might not be critical for relatively short projection periods, it becomes important as the projection period lengthens. The assumption of mean reversion results in smaller confidence intervals for the projected exchange rate compared to the random walk hypothesis. Therefore, the actuary might consider mean reversion for establishing the margin for adverse deviations when this assumption is supported by the data.

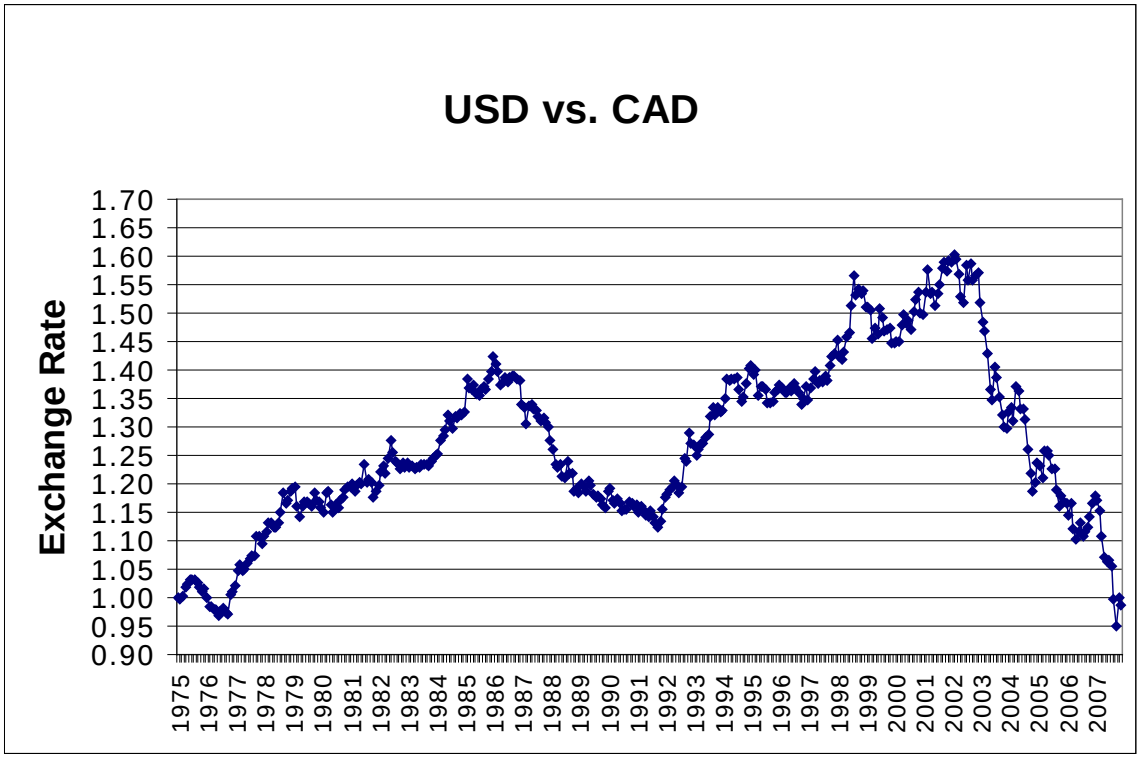
4. EXAMPLES

This section illustrates historical exchange rates for two currency combinations and the development of the base scenario, as well as the additional scenario to determine the provision for adverse deviations.

With regard to practical implementation in a deterministic Canadian Asset Liability Method (CALM) valuation, the base scenario assumptions for foreign exchange rates, along with appropriate margins as developed consistent with this guidance would apply in all interest scenarios being tested.

Example 1 Canada – US exchange rates

The following graph shows the monthly exchange rate between the US dollar (USD) and the Canadian dollar (CAD) for the period of January 1975 to December 2007.



The highest point during that period was $1.6086, which was reached in February, 2002. Conversely, the lowest point of $0.9499 took place in October, 2007. The USD depreciated by 40.9% between the high and low points.

Using the 396 monthly rates, the following statistics result for the change in the exchange rate over monthly, 1-year and 10-year periods.

Statistic	Monthly	1-Year Periods	10-Year Periods
Mean	0.000	.003	.089
Standard Deviation (1)	.015	.056	.176
Standard Deviation (2)		.053	.169

(1) is based on the 1-year and 10-year periods developed from the monthly data.

(2) is equal to the standard deviation over one month periods multiplied by $\sqrt{12}$ for 1-year periods and by $\sqrt{12} \times \sqrt{10}$ for 10-year periods.

Consider a liability of $1,000 denominated in CAD and payable at the end of 10 years. The assets backing this liability are denominated in USD and the currency risk is not hedged.

The following table illustrates the construction of the base scenario exchange rate projection, the adverse scenario based on historical volatility and the scenario reflecting the minimum 5% margin. The scenarios are constructed as of September 30, 2008. At that time, rates were,

Exchange Rate: 1.00 USD buys 1.059 CAD

U.S. 10-year risk-free rate: 3.83%

Canadian 10-year risk-free rate: 3.72%

As the risk-free rates in Canada and the U.S. are fairly close, there is little implied movement in the exchange rates. In the base scenario, the exchange rate moves from 1.059 to 1.048 over 10 years. The base scenario liability in CAD at September 30, 2008 is 694.02, which, because of the reflection of the interest forward rates, is the same as if the assets were denominated in CAD. If exchange rates are assumed to remain unchanged, the liability reserve would be 686.71 CAD.

In the adverse scenario, one standard deviation of .176 is used to project the exchange rate. The projected exchange rate at the end of year t is obtained from the starting rate of 1.059 as $1.059 \times ((1-.176)^{1/10})^{(10-t)}$. The exchange rate at the end of 10 years is .877 and the resulting liability is 833.38 CAD which produces a provision for adverse deviations of 139.36 or 20.1%.

Finally, application of a 5% adverse margin to the projected exchange rates in the base scenario produces a liability of 730.48 CAD.

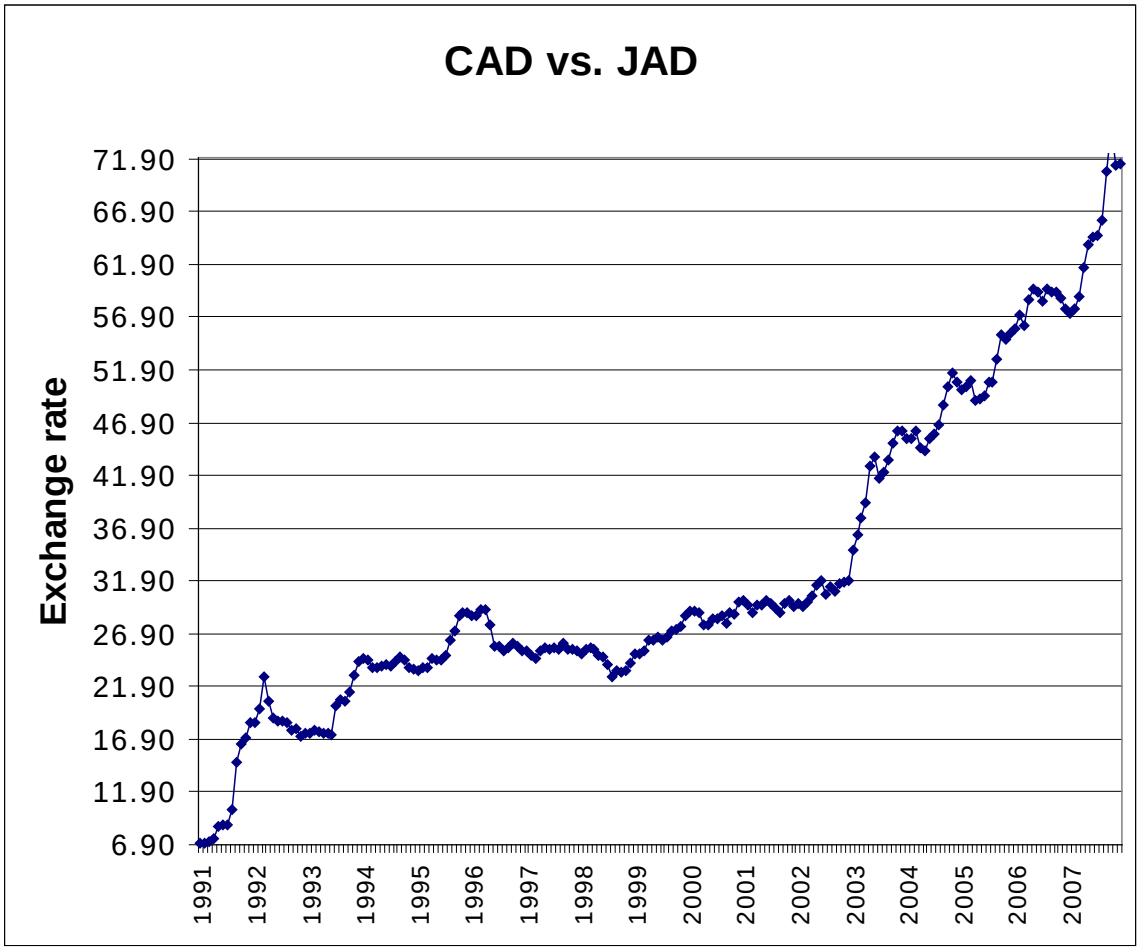
The results are summarized in the table below.

Canada – US Exchange Rates Liabilities in CAD	
Liability assuming no change in exchange rates	686.71
Base Exchange Rate Scenario Liability	694.02
Adverse Exchange Rate Scenario Liability	833.38
Liability based on 5% minimum margin scenario	730.48
Liability Held	833.38
Provision for Adverse Deviations	139.36

Example 1 - Canada / U.S.	Time										
Liability in CAD	0	1	2	3	4	5	6	7	8	9	10
U.S. risk-free interest rate	3.83%	3.83%	3.83%	3.83%	3.83%	3.83%	3.83%	3.83%	3.83%	3.83%	3.83%
Canada risk-free interest rate	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%
Base Scenario											
Projected Exchange Factor {(1.0372/1.0383)^(10-n)}	0.989	0.991	0.992	0.993	0.994	0.995	0.996	0.997	0.998	0.999	1.000
Projected Exchange (1 $US buys X CAD) Sept. 30, 2008	1.059	1.058	1.057	1.056	1.055	1.054	1.052	1.051	1.050	1.049	1.048
Ultimate Exchange (1 $US buys X $CAD)	1.048	1.048	1.048	1.048	1.048	1.048	1.048	1.048	1.048	1.048	1.048
Asset is Purchased on USD											
Value in USD	655.30	680.39	706.45	733.51	761.60	790.77	821.06	852.51	885.16	919.06	954.26
Value in CAD at Projected Rates	694.02	719.84	746.62	774.39	803.20	833.08	864.07	896.22	929.55	964.13	1,000.00
For Comparison											
Value in CAD if invested directly in CAD Bond {1000/(1.0372)^n}	694.02	719.84	746.62	774.39	803.20	833.08	864.07	896.22	929.55	964.13	1,000.00
Value in CAD if invested in USD Bond - assume no change in exchange rates	686.71	713.01	740.32	768.67	798.11	828.68	860.42	893.37	927.59	963.11	1000.00
Adverse Scenario											
Projected Exchange Factor {((.824^1/10))^(10-n)}	0.824	0.840	0.857	0.873	0.890	0.908	0.925	0.944	0.962	0.981	1.000
Projected Exchange (1 USD buys X CAD) Sept. 30, 2008	1.059	1.039	1.019	0.999	0.980	0.961	0.943	0.925	0.907	0.890	0.873
Ultimate Exchange (1 USD buys X CAD)	0.873	0.873	0.873	0.873	0.873	0.873	0.873	0.873	0.873	0.873	0.873
Asset is Purchased in $US											
Value in USD	786.88	817.02	848.31	880.80	914.53	949.56	985.93	1,023.69	1,062.89	1,103.60	1,145.87
Value in CAD at Projected Rates	833.38	848.71	864.32	880.22	896.41	912.90	929.69	946.79	964.20	981.94	1,000.00
Scenario Reflecting 5% Margin											
Projected Exchange (1 USD buys X CAD) Sept. 30, 2008	1.0590	1.0051	1.0040	1.0030	1.0019	1.0008	0.9998	0.9987	0.9976	0.9966	0.9955
Ultimate Exchange (1 USD buys X CAD)	0.9955	0.9955	0.9955	0.9955	0.9955	0.9955	0.9955	0.9955	0.9955	0.9955	0.9955
Asset is Purchased on USD											
Value in USD	689.79	716.20	743.64	772.12	801.69	832.39	864.27	897.38	931.75	967.43	1004.48
Value in CAD at Projected Rates	730.48	719.84	746.62	774.39	803.20	833.08	864.07	896.22	929.55	964.13	1000

Example 2 Canada – Jamaica exchange rates

The following graph shows the monthly exchange rate between the Jamaican dollar (JAD) and the Canadian dollar for the period of January 1991 to December 2007.



The highest point during that period was JAD 74.94, reached in October 2007. Conversely, the lowest point of JAD 6.985 took place in January 1991. The Canadian dollar appreciated by 972.87% in the 202 months separating the high and low points.

Using the 204 monthly rates the following statistics result for the change in the exchange rate over monthly, 1-year and 10-year periods.

Statistic	Monthly	1-Year Periods	10-Year Periods
Mean	.012	.150	1.223
Standard Deviation (1)	.046	.313	.587
Standard Deviation (2)		.160	.506

(1) is based on the 1-year and 10-year periods developed from the monthly data.

(2) is equal to the standard deviation over one month periods multiplied by $\sqrt{12}$ for 1-year periods and by $\sqrt{12} \times \sqrt{10}$ for 10-year periods.

Consider a liability of 1000 denominated in JAD and payable at the end of 10 years. The assets backing this liability are denominated in CAD and the currency risk is not hedged.

The following table illustrates the construction of the base scenario exchange rate projection, the adverse scenario based on historical volatility and the scenario reflecting the minimum 5% margin. The scenarios are being constructed on September 30, 2008. At that time, rates were,

Exchange Rate: 1.00 CAD buys 72.40 JAD

Canadian 10-year risk-free rate: 3.72%

Jamaican 10-year risk-free rates: 13.0% (assumed)

In this example, the risk-free rates in Jamaica are much higher than in Canada and there is, therefore, considerable implied movement in the exchange rates. In the base scenario the exchange rate moves from 72.4 to 170.6 over 10 years. The liability in JAD at September 30, 2008 is 294.59, which, because of the reflection of the interest forward rates, is the same as if the assets were denominated in JAD. If the exchange rates are assumed to remain unchanged, the liability would be 694.02 JAD.

For the adverse scenario, the actuary might feel that there is strong economic evidence that the JAD will continue to depreciate versus the Canadian dollar and this is directionally consistent with the historic mean. Therefore, the mean minus one standard deviation of (1.223 - .587) or 0.636 is used to project the exchange rate.

The projected exchange rate at the end of year t is obtained from the starting rate of 72.40 as $72.40 \times ((1 + 0.636)^{1/10})^{(10-t)}$.

The exchange rate at the end of 10 years is 118.4 and the resulting liability is 424.20 JAD producing a provision for adverse deviations of 129.61 JAD or 44%.

Finally, application of a 5% adverse margin to the projected exchange rates in the base scenario produces a liability of 310.09 JAD.

The results are summarized in the table below.

Canada – Jamaica Exchange Rates **Liabilities in JAD**	
Liability assuming no change in exchange rates	694.02
Base Exchange Rate Scenario Liability	294.59
Adverse Exchange Rate Scenario Liability	424.20
Liability based on 5% minimum margin scenario	310.09
Liability Held	424.20
Provision for Adverse Deviations	129.61

Example 2 - Jamaica / Canada	Time										
Liability in JAD	0	1	2	3	4	5	6	7	8	9	10
Canada risk-free interest rate	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%	3.72%
Jamica risk-free interest rate	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%
Base Scenario											
Projected Exchange Factor {(1.13/1.0372)^(10-n)}	2.356	2.162	1.985	1.822	1.672	1.535	1.409	1.293	1.187	1.089	1.000
Projected Exchange (1 CAD buys X JAD) Sept. 30, 2008	72.400	78.878	85.935	93.624	102.00	111.13	121.07	131.902	143.703	156.560	170.568
Ultimate Exchange (1 CAD buys X JAD)	170.568	170.57	170.57	170.57	170.57	170.57	170.57	170.568	170.568	170.568	170.568
Asset is Purchased on CAD											
Value in CAD	4.07	4.22	4.38	4.54	4.71	4.88	5.07	5.25	5.45	5.65	5.86
Value in JAD at Projected Rates	294.59	332.88	376.16	425.06	480.32	542.76	613.32	693.05	783.15	884.96	1,000.00
For Comparison											
Reserve in JAD if invested directly in JAD Bond {1000/(1.13)^n}	294.59	332.88	376.16	425.06	480.32	542.76	613.32	693.05	783.15	884.96	1,000.00
Reserve in $Jam if invested in $Can Bond - assume no change in exchange rates	694.02	719.84	746.62	774.39	803.20	833.08	864.07	896.22	929.55	964.13	1000.00
Adverse Scenario											
Projected Exchange Factor {((1.636^1/10))^(10-n)}	1.636	1.557	1.483	1.411	1.344	1.279	1.218	1.159	1.103	1.050	1.000
Projected Exchange (1 CAD buys X JAD) Sept. 30, 2008	72.400	76.053	79.891	83.922	88.156	92.604	97.277	102.185	107.341	112.757	118.446
Ultimate Exchange (1 CAD buys X JAD)	118.446	118.446	118.446	118.446	118.446	118.446	118.446	118.446	118.446	118.446	118.446
Asset is Purchased in CAD											
Value in CAD at Projected Rates	5.86	6.08	6.30	6.54	6.78	7.03	7.30	7.57	7.85	8.14	8.44
Value in JAD at Projected Rates	424.22	462.20	503.59	548.67	597.80	651.32	709.64	773.17	842.40	917.82	1,000.00
Scenario Reflecting 5% Margin											
Projected Exchange (1 CAD buys X JAD) Sept. 30, 2008	72.4000	74.934	81.638	88.943	96.900	105.570	115.016	125.307	136.518	148.732	162.040
Ultimate Exchange (1 CAD buys X JAD)	162.040	162.040	162.040	162.040	162.040	162.040	162.040	162.040	162.040	162.040	162.040
Asset is Purchased in CAD											
Value in CAD	4.28	4.44	4.61	4.78	4.96	5.14	5.33	5.53	5.74	5.95	6.17
Value in JAD at Projected Rates	310.09	332.88	376.16	425.06	480.32	542.76	613.32	693.05	783.15	884.96	1000