

The Retrospective Life Insurance Method: A Pedagogic Spreadsheet Application

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Abstract

This paper describes an innovative Excel spreadsheet model, referred to as the Retrospective Method Pedagogic Spreadsheet Application, that has been successfully used in risk management and insurance, and personal finance courses to demonstrate the retrospective life insurance method. The model can also be use in a principles of finance course to illustrate the time value of money. There are numerous pedagogic benefits of modeling life insurance funding in a spreadsheet application, especially when class time is limited. Our method provides an intuitive understanding of the sophisticated mathematical and statistical models common to actuarial science. The model is quite flexible and can be applied to life insurance policies (e.g., interest-sensitive whole life and universal life products) reflecting a variety of fee, expense, surrender charges, guaranteed or projected costs of insurance, current interest rates or interest rate scenarios. Furthermore, interest sensitive policy values may be generated for any age, by gender, and any proposed premium payments. Given the interest rate sensitivity of the spreadsheet application, the paper also includes a discussion of how to utilize Monte Carlo simulation in investigating the impact of interest rate variability on insurance policy performance.

JEL Classification: A20, A23, G30

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Introduction

There are two methods used to calculate life insurance policy cash values: the prospective life insurance method and the retrospective life insurance method. This paper demonstrates the retrospective life insurance method using an Excel spreadsheet application. We refer to our method as the Retrospective Method Pedagogic Spreadsheet Application (RMPSA).

There are pedagogic benefits of modeling life insurance funding in a spreadsheet application, especially when class time is limited. Our RMPSA has been successfully used in risk management and insurance, and personal finance courses and provides students with an intuitive understanding of the sophisticated mathematical and statistical models common to actuarial science.

This model may also be used in a principles of finance course to illustrate the time value of money. Generally speaking, 70 percent of the funding for a cash value life insurance policy is earned interest. For the interest-sensitive whole life and universal life products, interest can represent more than 90 percent of the funding. The importance of the time value of money concept is readily apparent.

Furthermore, the RMPSA is quite flexible. The model can be applied to interest-sensitive whole life and universal life policies reflecting a variety of fee, expense, surrender charges, cost of insurance, and interest rate scenarios. Additionally, insurance policy illustrations may be generated for any age, by gender, for common modal premium payment patterns.

This paper proceeds as follows: Section I highlights the pedagogic justifications and contributions of our model and Section II discusses the spreadsheet specifics by referring to the Excel cells and formulas. Section III and Section IV present applications of our method using interest sensitive whole life insurance and universal life policies, respectively. Section V describes how to analyze the impact of interest rate uncertainty in the model using Monte Carlo simulation. A conclusion is provided in Section VI.

I. Pedagogic Justifications and Contributions

Spreadsheet applications are well suited to and quite prevalent in finance education as evidenced by their early use as a pedagogic tool (see Chaney, 1982, and Tallman, 1983). Steinberg (1991) provides an extensive learning theory argument for computer applications. By 1995, approximately 50 percent of all sample undergraduate intermediate finance and investment courses used spreadsheet applications (see Clinebell and Clinebell, 1995). The immediate and multiple solutions to extensive mathematical problems provided by spreadsheet applications supports higher levels of theoretical, interpretative and conceptual learning (see Alonzi, Lange and Simkins, 2000, Ghani and D'Mello, 1993, and Lange, 1993). Spreadsheets are also well suited for demonstrating life insurance methods because they provide an intuitive understanding of the complex mathematical and statistical models employed.

Four important pedagogic advantages of the RMPSA are as follows. First, our model helps overcome the inherent difficulty of an iterative solution in insurance models. Second, the model simplifies analysis involving the co-determination of the cash value factors. Third, the model provides an immediate solution to computational questions involving thousands of calculations. Fourth and more broadly, the model provides intuition into conceptually and analytically difficult topics.

There is an increased need for insurance education in the finance curriculum because of recent changes in the institutional and legal environment. Banks are now permitted to engage in insurance underwriting directly through operating subsidiaries with the passage of the Gramm-Leach-Bliley Act (Financial Services Modernization Act) of 1999 [S.900]. The Gramm-Leach-Bliley Act repealed several sections of the 1933 Glass-Steagall Act, and made possible the marketing of insurance products by an expanded number of financial intermediaries. Accordingly, we believe our model provides an intuitive way of including insurance in a current finance curriculum as a time value of money application, so that students are better equipped for the changing marketplace.

The retrospective life insurance method would first appear to be rather straightforward (Black and Skipper, 1994). According to the retrospective method, the

Ending period accumulation value is equal to the:
Beginning period accumulation value, Plus premium payments received,
Less the cost of insurance, Less fees and expenses,
Plus interest.

The difficulty is the cost of insurance depends on the beginning period cash value, which in turn impacts the interest credited. Subsequent costs of insurance and interest credits are a function of both the periodic co-determination and previous period cost of insurance deductions and interest credits. That is, a change in either the cost of insurance or interest rates, causes a change in periodic accumulation values leading to changes in both the cost of insurance and interest credits. The retrospective life insurance method requires an iterative solution process involving thousands of calculations.

The time value of money concept may be demonstrated by noting the large impact changes in interest rates or time have on future or present values. The sensitivity of life insurance accumulation values to changes in interest rates and/or cost of insurance is more difficult due to the co-determination problem and iterative solution process noted above. Life insurance computations rely on sophisticated mathematical and statistical models as discussed by Bowers et al (1997), De Vylder (1997), and Jordan (1991). Interestingly, the additional difficulty of life insurance computations adds to the contribution of spreadsheet applications. For example, a universal life funding spreadsheet solution presented in Lange and Simkins (2001) overcomes life insurance formula limitations and iterative convergence problems noted by Cherry (2000).

II. Retrospective Method - Pedagogic Spreadsheet Application

Our spreadsheet program is based on the retrospective life insurance computation method applicable to interest-sensitive whole life (ISWL) and universal life (UL) products (refer to Black and Skipper, 1994, Bowers et al, 1997, and Jordan, 1991). This section describes the pedagogic spreadsheet application in three steps. First, we discuss the Excel data input and output cell references; second, we identify the retrospective method base assumptions; and third we describe the resulting policy values.

A. Cell References

- RMPSA Input and Codes

Exhibit 1 illustrates the data input cells and program settings in Excel (see cell range B1:L6), respective input cell codes (see cell range B9:L12), output values (see cell range

B14:J17) and first four rows of the retrospective method formulas (see B20:L24). The complete retrospective method spreadsheet is over 1200 lines.

Exhibit 1 shows the original data and program settings used to calculate the accumulation values for a life insurance policy. The example used is for a female age 30, with premiums payable to age 95 and assumes a guaranteed rate of interest and guaranteed mortality charges. Next, the Excel input cell reference (Column-Row) is shown first in ALL CAPS, followed by an explanation of the program setting and description of the variables.

- C3 Age = 25. Issue age of the insured.
- C6 Near/Last = 0. Default = 0.

Near/Last is the number of months between the insureds date of birth and the policy issue date. This allows the cost of insurance to be based on the insured age as of the last birthday prior to the policy anniversary date, Default = 0, or insured age nearest birthday, the number of months between the insureds date of birth and the policy issue date.

- D3 Premium = \$679.69.

The beginning premium of \$679.69 may be found by using the Goal Seek Excel Tool, described below. The beginning premium based on the guaranteed cost of insurance and guaranteed interest rate may be interpreted as the premium that would be required on a traditional whole life product for a \$100,000 policy on a female age 25, the current policy example. For example, the traditional whole life premium computed by the prospective premium computation method [Black and Skipper (1994), Bowers et al (1997), Jordan (1991)] or guideline premium under IRS Revenue Code 26 Section 7702 would be \$689.50.

- D6 #Years = 70.

Premiums are payable to age 95 or for 70 years. The spreadsheet permits any number of premium payments from single premium policies, 10 Pay Life, paid up at 65, age 95 or age 100: #Years = 1, 10, 40, 70 and 75 respectively.

- E3 Gender = 2. Male =1, Female =2.
- E6 Payment Mode = 12.

Premiums may be paid monthly, quarterly, semiannually or annually: Pmt Mode = 1, 3, 6, 12 respectively.

- F3 Guaranteed/Current Cost of Insurance = 1.

The base mortality exhibit is the 1980 CSO table which provided separate male and female mortality rates per thousand insureds, interpreted as cost of insurance per thousand dollars of coverage. For example the 1980 CSO rate for a Female age 25 is 1.16 deaths per thousand. Interpreted as the guaranteed maximum cost of \$1.16 per thousand of coverage, results in a monthly cost of insurance of \$.09667 ($\$1.16/12$), cells F22:F24. Changing F3 Guaranteed/Current Cost of Insurance to equal 2, changes the mortality charge to current cost of insurance rates, viewed as a percentage of the guaranteed rate.

- G3 Expense \$ = \$35.

- G6 #Years = 70.

The Expense amount is an annual value, but is assessed on a monthly basis.

- H3 Fee % = 4%.

- H6 #Years = 70.

The policy fee is a percentage of the premium and is assessed when the premium is paid.

Policy fees and expenses for ISWL and UL products vary by insurer. Some policies have both an annual expense often designated as a dollar amount and premium fee calculated as a percentage of premium paid [*A.M. Best's Flitcraft Compend*, 1986-1994]. Gold (1994) found the first year median expenses and fees to be 30% of the premium. Subsequent annual expenses and fees were approximately 7% of premium. The spreadsheet allows any combination of expenses and fees, for any combination of time periods. For example, one could replicate a policy that has a higher first year expense by changing G3, Expenses, to the first year amount and G6, #Years, to 1.

- I3 Guaranteed Interest Rate = 4.50%.

Guaranteed rates during the 1980's and 1990's varied by insurer from 4% to 5% [*A.M. Best's Flitcraft Compend*, 1986-1994]

- I11 Guaranteed Factor = 1.003675.

Interest is credited on insurance policies at effective rates, thus the guaranteed interest factor is equal to 1 plus the guaranteed rate to the one twelfth or $(1.045)^{(1/12)}$.

- J3 Current Interest Rate = 4.50%.
Originally set at the guaranteed rate of 4.50%. Credited interest rates on ISWL and UL policies during the 1980's and 1990's varied from under 6% to over 11% [*A.M. Best's Policy Reports*]. Changing J2 the current interest rate demonstrates the impact interest rates have on life insurance policy accumulation values.
- J11 Current Factor = 1.03675.
Interest is credited on insurance policies at effective rates, thus the current interest factor is equal to 1 plus the current rate to the one twelfth or $(1.045)^{(1/12)}$.
- I4 Projected Interest Rate = 1.
The current, 1, or yearly, 2, code creates policy accumulation values using either the current interest rate for each year or a different interest rate for each year. Changes in interest rates or different interest rate scenarios [Carr and French (1989)] may be explored by setting the I4 Current/Yearly code to 2, and entering the yearly interest rates in Y17:Y41, discussed below.
- L3 Death Benefit = \$100,000.
Any death benefit amount may be entered. The death benefit is automatically increased according to Revenue Code 26 Section 7702 minimum death benefit requirements.
- L6 Type A/B = 1.
Code is applicable to universal life in which a level, type A = 1, or increasing, type B = 2, death benefit may be selected. Under type B, the death benefit is equal to the face amount plus the accumulation value.

- *RMPSA Output*

- C16 Value Age = 65
- C17 Value Age = 95
RMPSA Output values for any desired age may be shown by changing cells C16 or C17. Age 65 is the standard reference year value, while age 95 represents the value at policy maturity.
- D16/17 Accumulation Values @65 = \$41,890, @95 = \$100,000

- E16/17 Death Benefit @65 = \$100,000, @95 = \$100,000
- G16/17 Cumulative Premiums @65 = \$27,188, @95 = \$47,578
- H16/17 Cumulative COI @65 = \$13,410, @95 = \$64,725
- I16/17 Cumulative Expenses @65 = \$2,488, @95 = \$4,353
- J16/17 Cumulative Interest @65 = \$30,600, @95 = \$121,499

The RMPSA Output is a significant pedagogic opportunity. Life insurance funding may be seen in very simplistic valuation terms; specifically premiums paid, expenses paid, cost of insurance purchased, interest earned, and the resulting accumulation values and death benefits. For example, the policy funding by age 65 included \$27,188 in premiums and \$30,600 interest earned, for a total funding amount of \$57,788. The funding paid \$13,410 for the cost of insurance, \$2,488 in expenses and fees, leaving \$41,890 as the accumulation value.

The importance of the time value of money is readily apparent, as interest accounts for over half of the policy funding by age 65 and over 70% by age 95. Further, as demonstrated below, the financial impact on life insurance funding may be immediately analyzed by changing data input values or assumptions.

B. RMPSA Assumptions

Exhibit 2 contains the RMPSA Assumptions for Projected Interest Rates, Cost of Insurance, IRS Code 26 Section 7702 Minimum Death Benefit, and Surrender Charges. The projected interest rates may be changed as discussed below to analyze the impact of various interest rate paths on life insurance funding. Generally, the assumption values would not be changed except for more in depth analyzes appropriate for specific insurance courses. For example, a course on life insurance may wish to view the impact of changing current costs of insurance or surrender charges.

- X17:Y120 Interest Rate Projection

Any yearly interest rate path may be explored by entering yearly interest rates. Interest rates for year 21 and on equal the 20th year interest rate.

- AA17:AE120 Guaranteed Cost of Insurance 1980 CSO
The guaranteed cost of insurance is the 1980 CSO table rates for male and females by age. Exhibit 2 shows both the annual cost per \$1,000 and the respective monthly guaranteed cost of insurance.
- AF17:AG120 Current Cost of Insurance
Gold (1994) found median 1, 5 and 10 year cost of insurance as a percentage of the 1980 CSO table to be 66%, 59% and 55% respectively. The RMPSA assumed current cost of insurance are 60% of the Male/Female 1980 CSO table to age 60, increasing thereafter by age (61% for age 61, 62% for age 62 and so forth). The assumed 60% of the 1980 CSO mortality table simplifies the model. Increasing the percentage of the CSO at age 61 supports the concept of select versus ultimate mortality experience. The rates may be changed to further explore the effects of more or less aggressive pricing assumptions on accumulation values.
- AI17:AJ116 IRS Code 26 Section 7702 Minimum Death Benefits
Also referred to as a cash value corridor, the code requires that the policy death benefit be a greater than or equal to a specified percentage of the accumulation value. The minimum death benefit is 250% of the accumulation value up to age 40, declining to 100% by age 95.
- AL17:AM35 Surrender Charges
Surrender charges are stated as a percentage of the accumulation value for the first 15 years of the policy.

C. *RMPSA Policy Values*

The Retrospective Method Pedagogic Spreadsheet Application is quite flexible. Life insurance policies reflecting a variety of ISWL and UL fee, expense, surrender charges, current interest rates or interest rate scenarios, and current cost of insurance assumptions may be generated for any age, by gender, and for any proposed premium payments. The flexibility of this model is necessary as actual interest rates, mortality charges, expenses and fees vary widely across policies [Black and Skipper (1994), Gold (1994), *A.M. Best's Flitcraft Compend* 1986-

1994]. For instance, Chung and Skipper (1987) find a considerable dispersion of accumulation values by and between stated interest rates.

As was shown in Exhibit 1, the computations beginning in row 22 are performed monthly regardless of the premium payment mode. Most of the columns require little or no explanation and parallel the retrospective method repeated below:

Ending period accumulation value is equal to the,
Beginning period accumulation value,
Plus premium payments received,
Less the cost of insurance,
Less fees and expenses,
Plus interest.

For example, Policy Year, Month, Age and Premium are self-explanatory. The Mortality Charge, column E, is the 1980 CSO cost of insurance rate discussed above, or $1/12^{\text{th}}$ of the age 25 rate of \$1.16. The Cost of Insurance, column F, is the mortality charge per thousand times the dollar amount of insurance purchased divided by 1000. The dollar amount of insurance purchased, referred to as amount at risk, is the present value at the guaranteed rate of interest, of the death benefit less the previous period ending accumulation value. Expenses, Fees and the Total are listed in columns G, H and I respectively. The credited interest rate is shown in Column J, followed by the end of month accumulation value in column L. Columns M through S (not shown) calculate the surrender charge, surrender value, death benefit and cumulative values for the RMPSA Output.

Though there is a pedagogic benefit in demonstrating the Excel RMPSA formulas, a greater understanding and clearer financial analysis is provided by viewing the annual output Policy Values worksheet, Exhibit 3. Again, the columns are arranged in order of the retrospective method, beginning with the premium paid (see Column C), less cost of insurance (see Column E), less fees and expenses (see columns F and G), plus interest (see Column J). The increasing cost of insurance and contribution to funding by interest is quite clear. Also shown in Exhibit 3 is the actual financial cost of the percentage surrender charge (column L).

In summary, Exhibit 1 shows the original values of a life insurance policy with premiums payable to age 95, for a female age 25, given a 4.5% guaranteed rate of interest, and guaranteed mortality charges. Exhibit 3 provides the annual Policy Values allowing a clearer view of the

insurance policy funding assumptions versus Exhibit 1 which contains the monthly RMPSA calculations.

III. Interest Sensitive Whole Life Policy Computation

As noted above, the accumulation value at age 65 is \$41,890 and \$100,000 at age 95, based on the guaranteed interest rate and guaranteed cost of insurance. However, the basis for the name - Interest Sensitive Whole Life - is the current interest rate is credited, with the guaranteed rate serving solely as a minimum interest rate. Further, the cost of insurance is determined by current mortality experience, with the guaranteed mortality charges representing the maximum charge possible. We next illustrate the solution to three ISWL computational questions to demonstrate the flexibility and pedagogic value of the RMPSA model

Exhibit 4 illustrates the solution to the first ISWL computation question: What are the RMPSA policy values based on the current interest rate? The solution is immediately available by entering a Current Interest Rate into cell J3, 8% for example. As shown in Exhibit 4, and clearly supportive of the importance of the time value of money, the accumulation value at age 65 increased to \$126,799 and at age 95 to \$1,199,726. The Death Benefit at age 65 has risen to \$152,159 representing the 120% IRS Code 26 Section 7702 minimum death benefit requirement. Total premiums and expenses remained unchanged from Exhibit 1, and there is a substantial increase in interest earned reflecting the increase in accumulation values.

An important pedagogic observation from Exhibit 4 is the cumulative cost of insurance at age 65 has declined from \$13,410 (see Exhibit 1) to \$8,973, and at age 95 increased from \$64,725 (see Exhibit 1) to \$78,467. The decline at age 65 is explained by the increased accumulation values reducing the amount of insurance actually purchased, the death benefits minus the accumulation value. Slightly more difficult to see, the increase at age 95 is also due to the increased accumulation values. However, now the IRS Code 26 Section 7702 minimum death benefit requires an increased amount of insurance purchased, increasing the cumulative cost of insurance. The minimum death benefit effect is contained in column N on the Policy Values worksheet.

Exhibit 5 illustrates the solution to the second ISWL computation question: What are the RMPSA policy values based on the current interest rate and current cost of insurance? Setting the F3 Guaranteed/Current COI code to 2 changes the mortality charge to 60% of the guaranteed

rate, increasing by age starting at age 61 according to the spreadsheet design. The accumulation values increase to \$145,799 at age 65 and to \$1,398,225 at age 95.

It is important to note that the last increase in accumulation values is due to two reasons: (1) the reduction in the cost of insurance, and (2) an increase in interest given the lower cost of insurance. The cost of insurance impact is in Exhibits 3 and 5 as the mortality charge (see column E) declines from \$0.09667 to \$0.058. There are corresponding decreases in the total cost of insurance, column F. The marginal increased interest credit may be seen in column K and the related increases in accumulation values, column L. The interaction or co-determination of cost of insurance and interest credits was discussed above.

Exhibit 6 illustrates the solution to the final ISWL computation question: Instead of making 70 payments to age 95, how many payments would be necessary to have the policy perform as compared to the guaranteed values? This computation question is the basis for the retrospective method. Can the life insurance policy be funded with fewer insured out-of-pocket dollars assuming current cost of insurance and current interest rates?

The solution is an iterative exercise, changing the number of payments, D6, until the accumulation value at age 95 is equal to or greater than the original \$100,000. The iterative process offers significant pedagogic insight into the time value of money as the result is generally found quite surprising. Exhibit 6 contains the results of the iterative solution process - seven premium payments. Six payments are not sufficient to fund the policy to maturity; that is, the policy lapses prior to maturity, evidenced by the accumulation value at age 95 equal to zero. Additional applications shows 8 payments are required to provide an accumulation value at age 65 comparable to the originally guaranteed values, \$45,211 versus original \$41,890.

IV. Universal Life Policy Computation

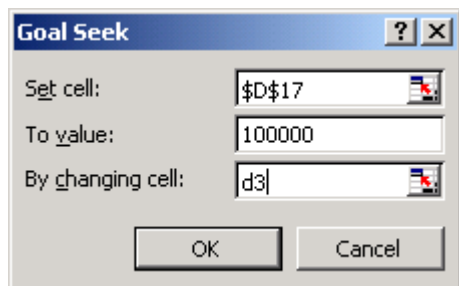
The overall question for UL is the same as for ISWL: Can the life insurance policy be funded with fewer insured out-of-pocket dollars assuming current cost of insurance and current interest rates? The application of the retrospective method for UL policies however differs from ISWL policies in that it is not the number of premiums, but the premium itself that is reduced. The process can be viewed as a discounted premium based on the assumed higher credited interest rates and/or lower mortality charges.

Exhibit 7 illustrates the solution to the UL spreadsheet application question is: What would the UL premium be with a goal of \$100,000 accumulation value at age 95. In other words, what premium is necessary to achieve a policy value of \$100,000 at age 95 assuming a 8% interest rate and current cost of insurance? The Excel Tools/Goal Seek function can be used to calculate the required premium by selecting “Tools”, “Goal Seek”, and inputting:

Set cell = D17

To value = 100000

By changing cell = D3.



As shown in Exhibit 7, the UL minimum premium solution is \$264.57. This is a reduction from the beginning premium of \$679.69 shown in Exhibit 1. Comparing RMPSA Data Output for Exhibits 1 and 7, reveal the savings in premium dollars with cumulative premiums declining at age 65 from \$27,188 to \$10,583.

V. The Impact of Interest Rate Uncertainty Using Monte Carlo Simulation

As shown in the prior examples, life insurance premiums and accumulation values are highly sensitive to interest rates. It is therefore important to analyze the effect of interest rate changes on life insurance funding. One useful technique is Monte Carlo simulation using Crystal Ball[®].¹ The three important benefits of Monte Carlo simulation risk analysis are: (1) help end “analysis paralysis” and contribute to better decision-making by quickly examining all possible scenarios, (2) quickly identify which variables most affect the forecast, and (3) uncover the uncertainty in a model, leading to a better communication of risk. This type of analysis can be incorporated into the RMPSA spreadsheet model to analyze the effects of varying inputs (such as interest rates) on outputs (such as premium required or accumulation value).

¹ Crystal Ball[®] is a registered trademark of Decisioneering, Inc. Monte Carlo simulation can also be conducted using @Risk[®], among other methods.

Exhibit 8 illustrates and describes the steps for using Crystal Ball together with Monte Carlo simulation to analyze interest rate uncertainty. For illustration purposes, it is assumed that mean annual interest rates will decline from 8 percent to 5.75 percent over the life of the insurance policy. Other input values are as discussed for Exhibit 7. Step 1 illustrates the selection of the probability distribution for each interest rate variable over the policy life. In this example, a lognormal probability distribution is assumed and the standard deviation of interest rates is estimated to be 10 percent of the current rate. Of course, different assumptions for the distributions and interest rate volatility can be used and will produce different simulation results. For example, other commonly used distributions in simulation analysis are normal, triangular, and uniform.

Step 2 of Exhibit 8 describes how to select the forecast variable (i.e. the age 65 accumulation value in Cell D16) for the simulation results. Step 3 presents the frequency chart generated by 1000 simulation runs in Crystal Ball. This chart displays the range of possible outcomes for accumulation values in Cell D16. As shown in Exhibit 8, the age 65 accumulation value declines from the Exhibit 7 value of \$25,540 to a range of \$8,977 to \$11,476. By entering \$10,000 in the lower-left field of the frequency chart, the likelihood of achieving a \$10,000 accumulation value can be determined. As shown, the probability of achieving an accumulation value of \$10,000 is forecast to be 66.4 percent. It is important to note that finding the certainty of achieving a particular results is often the goal of a model analysis. It is insightful to note that the age 95 accumulation value lapse prior to maturity in all simulation runs (see Cell L3). Although not illustrated in this exhibit, an increase in cost of insurance or greater decline in interest rates would cause the policy to lapse prior to age 65.

It is important to understand how much a given assumption, such as interest rate forecasts, affects the insurance policy results. As shown in Step 4 of Exhibit 8, by selecting Crystal Ball's "Sensitivity Chart" feature, it is possible to analyze the contribution of each interest rate forecast variable to the age 65 accumulation value. The output below displays the sensitivity rankings of the assumptions in the simulation based on contribution to the variance of the output variable (i.e. accumulation value at age 65). The assumptions are listed on the left side, starting with the assumption with the highest sensitivity. The top 10 assumptions are displayed in this chart for illustration purposes. As shown, the age 65 accumulation value is most sensitive to interest rate forecast Cells Y41, Y55, Y46, among other cells.

Exhibit 9 contains the summary and statistics for Exhibit 8 analysis. The report is generated by the Crystal Ball report option and is based on the above 1000 trials. As shown, the mean accumulation value at age 65 is forecast to be \$10,201 with a range of \$8,904 to \$11,616. This report also lists the median, standard deviation, variance, among other statistical output. In summary, the results in Exhibits 8 and 9 are meant to be illustrative. If class time allows, students are encouraged to investigate the sensitivity of other model output values by varying other input assumptions in the model.

VI. Conclusion

This paper describes an innovative Excel model used to analyze life insurance policies. This model, referred to as the Retrospective Method Pedagogic Spreadsheet Application, has been successfully used in risk management and insurance, and personal finance courses to demonstrate the retrospective life insurance method. Also, our model provides a useful way of including insurance topics in basic finance courses to illustrate the time value of money. Because of recent changes in the institutional and legal environment, there is an increased need for insurance education in the mainstream finance curriculum, so that students are better equipped for the changing marketplace.

This spreadsheet application provides an intuitive understanding of the sophisticated mathematical and statistical models common to actuarial science. The model has been designed to be very flexible, allowing the user to apply the model to both interest-sensitive whole life and universal insurance policies. The model can be used for a variety of fee, expense, surrender charges, current interest rates or interest rate scenarios. Additionally, current cost of insurance assumptions may be generated for any age, by gender, and for any proposed premium payment. It is also easy to illustrate the impact of interest rate uncertainty by employing Monte Carlo simulation using software such as Crystal Ball.

The important pedagogic advantages of are model are as follows. First, our model helps overcome the inherent difficulty of an iterative solution in insurance models. Second, the model simplifies analysis involving the co-determination of the cash value factors. Third, the model provides an immediate solution to computational questions involving thousands of calculations. Fourth and more broadly, the model provides intuition into conceptually and analytically difficult topics.

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United States Internal Revenue Code, Title 26: Section 7702.

Exhibit 1 Retrospective Method Pedagogic Spreadsheet Application (RMPSA): Data Input, Codes and Output

This exhibit illustrates the data input cells and program setting in Excel (see cell range B1:L6), respective input cell codes (see cell range B9:L12), and first four rows of the retrospective method formulas (see B20:L24). The complete retrospective method spreadsheet is over 1200 lines.

	B	C	D	E	F	G	H	I	J	K	L
1	RMPSA DATA INPUT										
2		Age	Premium	Gender	Guaranteed / Current COI	Expense \$	Fee %	Guaranteed Interest Rate	Current Interest Rate	Projected Interest Rate	Death Benefit
3		25	\$ 679.69	2	1	\$ 35.00	4%	4.50%	4.50%	1	\$ 100,000
4											
5		Near / Last	# Years Payable	Payment Mode		# Years Payable	# Years Payable				Type A/B
6		0	70	12		70	70				1
7											
8											
9	RMPSA DATA CODES										
10		Payment Mode		Gender	Cost of Insurance			Guranteed Rate Factor	Current Rate Factor	Projected Interest Rate	Type A/B
11		Mthly=1	Semi=6	Male = 1	Guar. = 1			1.00367	1.00367	Current = 1	A = 1 Level
12		Qtrly =3	Annual=12	Female =2	Current = 2					Yearly = 2	B = 2 Inceas.
13											
14	RMPSA DATA OUTPUT										
15		Age	Accumulation Value	Death Benefit		Cumulative Premiums	Cumulative COI	Cumulative Expenses	Cumulative Interest		
16		65	\$ 41,890	\$ 100,000		\$ 27,188	\$ 13,410	\$ 2,488	\$ 30,600		
17		95	\$ 100,000	\$ 100,000		\$ 47,578	\$ 64,725	\$ 4,353	\$ 121,499		
18											
19											
20	Month	Age	Premium	Mortality Charge	Cost of Insurance	Expense	Fee	Total Expenses	Interest Rate	Interest Earned	Accumulation Value
21	0	25									\$ -
22	1	25	\$ 679.69	\$ 0.09667	\$9.57	\$ 2.92	\$ 27.19	\$ 30.10	4.50%	\$ 2.35	\$642.37
23	2	25	\$ -	\$ 0.09667	\$9.57	\$ 2.92	\$ -	\$ 2.92	4.50%	\$ 2.31	\$632.20
24	3	25	\$ -	\$ 0.09667	\$9.57	\$ 2.92	\$ -	\$ 2.92	4.50%	\$ 2.28	\$621.99

Exhibit 2 RMPSA Assumptions

This exhibit contains the RMPSA assumptions for projected interest rates (see cell range X17:Y41), cost of insurance (see cell range AA17:AE120), IRS Code 26 Section 7702 minimum death benefit (see cell range AI17:AJ116) and surrender charges (see cell range AL17:AM35).

Microsoft Excel - Retro Model FMA AFS02															
File Edit View Insert Format Tools Data Window Help Acrobat															
X41 = 20															
X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
15	RMPSA ASSUMPTIONS														
16															
17	Interest Rate		Cost of Insurance		1980 CSO	Source NAIC					Minimum		Surrender Charges		
18	Projection										Death Benefit				
19											IRS 26 Sect. 7702				
20	Policy Year	Interest Rate	Age	Guaranteed Male Annual	Guaranteed Female Annual	Guaranteed Male Monthly	Guaranteed Female Monthly	Current Male %COI	Current Female %COI	Age	Factor	Policy Year	Surrender Charge		
21			0	\$ 4.18	\$ 2.89	\$ 0.34833	\$ 0.24083	60.0%	60.0%	0	250%	1	100%		
22	1	8.00%	1	\$ 1.07	\$ 0.87	\$ 0.08917	\$ 0.07250	60.0%	60.0%	1	250%	2	95%		
23	2	7.75%	2	\$ 0.99	\$ 0.81	\$ 0.08250	\$ 0.06750	60.0%	60.0%	2	250%	3	90%		
24	3	7.50%	3	\$ 0.98	\$ 0.79	\$ 0.08167	\$ 0.06583	60.0%	60.0%	3	250%	4	85%		
25	4	7.25%	4	\$ 0.95	\$ 0.77	\$ 0.07917	\$ 0.06417	60.0%	60.0%	4	250%	5	80%		
26	5	7.00%	5	\$ 0.90	\$ 0.76	\$ 0.07500	\$ 0.06333	60.0%	60.0%	5	250%	6	75%		
27	6	6.75%	6	\$ 0.86	\$ 0.73	\$ 0.07167	\$ 0.06083	60.0%	60.0%	6	250%	7	70%		
28	7	6.50%	7	\$ 0.80	\$ 0.72	\$ 0.06667	\$ 0.06000	60.0%	60.0%	7	250%	8	65%		
29	8	6.25%	8	\$ 0.76	\$ 0.70	\$ 0.06333	\$ 0.05833	60.0%	60.0%	8	250%	9	60%		
30	9	6.00%	9	\$ 0.74	\$ 0.69	\$ 0.06167	\$ 0.05750	60.0%	60.0%	9	250%	10	50%		
31	10	5.75%	10	\$ 0.73	\$ 0.68	\$ 0.06083	\$ 0.05667	60.0%	60.0%	10	250%	11	40%		
32	11	5.75%	11	\$ 0.77	\$ 0.69	\$ 0.06417	\$ 0.05750	60.0%	60.0%	11	250%	12	30%		
33	12	5.75%	12	\$ 0.85	\$ 0.72	\$ 0.07083	\$ 0.06000	60.0%	60.0%	12	250%	13	20%		
34	13	5.75%	13	\$ 0.99	\$ 0.75	\$ 0.08250	\$ 0.06250	60.0%	60.0%	13	250%	14	10%		
35	14	5.75%	14	\$ 1.15	\$ 0.80	\$ 0.09583	\$ 0.06667	60.0%	60.0%	14	250%	15	0%		
36	15	5.75%	15	\$ 1.33	\$ 0.85	\$ 0.11083	\$ 0.07083	60.0%	60.0%	15	250%				
37	16	5.75%	16	\$ 1.51	\$ 0.90	\$ 0.12583	\$ 0.07500	60.0%	60.0%	16	250%				
38	17	5.75%	17	\$ 1.67	\$ 0.95	\$ 0.13917	\$ 0.07917	60.0%	60.0%	17	250%				
39	18	5.75%	18	\$ 1.78	\$ 0.98	\$ 0.14833	\$ 0.08167	60.0%	60.0%	18	250%				
40	19	5.75%	19	\$ 1.86	\$ 1.02	\$ 0.15500	\$ 0.08500	60.0%	60.0%	19	250%				
41	20	5.75%	20	\$ 1.90	\$ 1.05	\$ 0.15833	\$ 0.08750	60.0%	60.0%	20	250%				
42	21	5.75%	21	\$ 1.91	\$ 1.07	\$ 0.15917	\$ 0.08917	60.0%	60.0%	21	250%				
43	22	5.75%	22	\$ 1.89	\$ 1.09	\$ 0.15750	\$ 0.09083	60.0%	60.0%	22	250%				
44	23	5.75%	23	\$ 1.86	\$ 1.11	\$ 0.15500	\$ 0.09250	60.0%	60.0%	23	250%				
45	24	5.75%	24	\$ 1.82	\$ 1.14	\$ 0.15167	\$ 0.09500	60.0%	60.0%	24	250%				
46	25	5.75%	25	\$ 1.77	\$ 1.16	\$ 0.14750	\$ 0.09667	60.0%	60.0%	25	250%				
47	26	5.75%	26	\$ 1.73	\$ 1.19	\$ 0.14417	\$ 0.09917	60.0%	60.0%	26	250%				
48	27	5.75%	27	\$ 1.71	\$ 1.22	\$ 0.14250	\$ 0.10167	60.0%	60.0%	27	250%				

Exhibit 3 RMPSA Policy Values

This exhibit shows the annual output policy values worksheet generated by the RMPSA Excel model. The columns are arranged in order of the retrospective method, beginning with the premium paid (Column C), less cost of insurance (Column E), less fees and expenses (Columns F and G), plus interest (Column J). Column L shows the actual financial cost of the percentage surrender charge.

Microsoft Excel - Retro Model FMA AFS02														
File Edit View Insert Format Tools Data Window Help Acrobat														
L10 = Surrender Charge														
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
5	POLICY VALUES													
6			Insured	Tobe Insured										
7														
8			Age	25		Amount	\$ 100,000							
9														
10	Policy Year	Age	Premium	Mortality Charge	Cost of Insurance	Expense	Fee	Total Expenses	Interest Rate	Interest Earned	Accumulation Value	Surrender Charge	Cash Value Surrender	Death Benefit
11	1	26	\$ 679.69	\$ 1.16	\$ 114.89	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 25.73	\$ 528.35	\$ 528.35	\$ -	\$ 100,000
12	2	27	\$ 679.69	\$ 1.19	\$ 117.22	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 49.45	\$ 1,078.09	\$ 1,024.18	\$ 53.90	\$ 100,000
13	3	28	\$ 679.69	\$ 1.22	\$ 119.49	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 74.14	\$ 1,650.24	\$ 1,485.21	\$ 165.02	\$ 100,000
14	4	29	\$ 679.69	\$ 1.26	\$ 122.67	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 99.81	\$ 2,244.87	\$ 1,908.14	\$ 336.73	\$ 100,000
15	5	30	\$ 679.69	\$ 1.30	\$ 125.78	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 126.49	\$ 2,863.08	\$ 2,290.46	\$ 572.62	\$ 100,000
16	6	31	\$ 679.69	\$ 1.35	\$ 129.77	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 154.21	\$ 3,505.03	\$ 2,628.77	\$ 876.26	\$ 100,000
17	7	32	\$ 679.69	\$ 1.40	\$ 133.66	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 183.01	\$ 4,171.87	\$ 2,920.31	\$ 1,251.56	\$ 100,000
18	8	33	\$ 679.69	\$ 1.45	\$ 137.45	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 212.92	\$ 4,864.84	\$ 3,162.15	\$ 1,702.70	\$ 100,000
19	9	34	\$ 679.69	\$ 1.50	\$ 141.13	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 244.02	\$ 5,585.23	\$ 3,351.14	\$ 2,234.09	\$ 100,000
20	10	35	\$ 679.69	\$ 1.58	\$ 147.50	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 276.28	\$ 6,331.51	\$ 3,165.75	\$ 3,165.75	\$ 100,000
21	11	36	\$ 679.69	\$ 1.65	\$ 152.79	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 309.73	\$ 7,105.96	\$ 2,842.38	\$ 4,263.57	\$ 100,000
22	12	37	\$ 679.69	\$ 1.76	\$ 161.59	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 344.37	\$ 7,906.24	\$ 2,371.87	\$ 5,534.37	\$ 100,000
23	13	38	\$ 679.69	\$ 1.89	\$ 171.99	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 380.13	\$ 8,731.89	\$ 1,746.38	\$ 6,985.51	\$ 100,000
24	14	39	\$ 679.69	\$ 2.04	\$ 183.93	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 417.00	\$ 9,582.45	\$ 958.25	\$ 8,624.21	\$ 100,000
25	15	40	\$ 679.69	\$ 2.22	\$ 198.25	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 454.92	\$ 10,456.63	\$ -	\$ 10,456.63	\$ 100,000
26	16	41	\$ 679.69	\$ 2.42	\$ 213.97	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 493.88	\$ 11,354.05	\$ -	\$ 11,354.05	\$ 100,000
27	17	42	\$ 679.69	\$ 2.64	\$ 231.02	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 533.85	\$ 12,274.38	\$ -	\$ 12,274.38	\$ 100,000
28	18	43	\$ 679.69	\$ 2.87	\$ 248.48	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 574.84	\$ 13,218.25	\$ -	\$ 13,218.25	\$ 100,000
29	19	44	\$ 679.69	\$ 3.09	\$ 264.57	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 616.93	\$ 14,188.11	\$ -	\$ 14,188.11	\$ 100,000
30	20	45	\$ 679.69	\$ 3.32	\$ 281.00	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 660.17	\$ 15,184.78	\$ -	\$ 15,184.78	\$ 100,000
31	21	46	\$ 679.69	\$ 3.56	\$ 297.72	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 704.62	\$ 16,209.17	\$ -	\$ 16,209.17	\$ 100,000
32	22	47	\$ 679.69	\$ 3.80	\$ 313.85	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 750.32	\$ 17,263.15	\$ -	\$ 17,263.15	\$ 100,000
33	23	48	\$ 679.69	\$ 4.05	\$ 330.18	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 797.36	\$ 18,347.83	\$ -	\$ 18,347.83	\$ 100,000
34	24	49	\$ 679.69	\$ 4.33	\$ 348.25	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 845.73	\$ 19,462.81	\$ -	\$ 19,462.81	\$ 100,000
35	25	50	\$ 679.69	\$ 4.63	\$ 367.15	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 895.44	\$ 20,608.61	\$ -	\$ 20,608.61	\$ 100,000
36	26	51	\$ 679.69	\$ 4.96	\$ 387.56	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 946.51	\$ 21,785.06	\$ -	\$ 21,785.06	\$ 100,000
37	27	52	\$ 679.69	\$ 5.31	\$ 408.59	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 998.94	\$ 22,992.92	\$ -	\$ 22,992.92	\$ 100,000
38	28	53	\$ 679.69	\$ 5.70	\$ 431.63	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 1,052.73	\$ 24,231.52	\$ -	\$ 24,231.52	\$ 100,000
39	29	54	\$ 679.69	\$ 6.15	\$ 458.01	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 1,107.83	\$ 25,498.84	\$ -	\$ 25,498.84	\$ 100,000
40	30	55	\$ 679.69	\$ 6.61	\$ 483.80	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 1,164.23	\$ 26,796.78	\$ -	\$ 26,796.78	\$ 100,000
41	31	56	\$ 679.69	\$ 7.09	\$ 509.63	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 1,222.01	\$ 28,126.66	\$ -	\$ 28,126.66	\$ 100,000
42	32	57	\$ 679.69	\$ 7.57	\$ 533.94	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 1,281.27	\$ 29,491.49	\$ -	\$ 29,491.49	\$ 100,000
43	33	58	\$ 679.69	\$ 8.03	\$ 555.29	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 1,342.17	\$ 30,895.87	\$ -	\$ 30,895.87	\$ 100,000
44	34	59	\$ 679.69	\$ 8.47	\$ 573.65	\$ 35.00	\$ 27.19	\$ 62.19	4.50%	\$ 1,404.92	\$ 32,344.64	\$ -	\$ 32,344.64	\$ 100,000

Exhibit 4 Interest Sensitive Whole Life Policy Computation

This exhibit illustrates the solution for finding the RMPSA policy values based on the current interest rate. The current interest rate is entered into Cell J3 and the output is listed in cells B14:J17.

RMPSA DATA INPUT											
	Age	Premium	Gender	Guaranteed / Current COI	Expense \$	Fee %	Guaranteed Interest Rate	Current Interest Rate	Projected Interest Rate	Death Benefit	
3	25	\$ 679.89	2	1	\$ 35.00	4%	4.50%	8.00%	1	\$ 100,000	
RMPSA DATA CODES											
	Payment Mode	Gender	Cost of Insurance	Guaranteed Rate Factor	Current Rate Factor	Projected Interest Rate	Type A/B				
11	Mthly=1	Semi=6	Male = 1	Guar. = 1	1.00367	1.00643	Current = 1	A = 1 Level			
12	Qtrly =3	Annual=12	Female =2	Current = 2			Yearly = 2	B = 2 Increas.			
RMPSA DATA OUTPUT											
	Age	Accumulation Value	Death Benefit	Cumulative Premiums	Cumulative COI	Cumulative Expenses	Cumulative Interest				
16	65	\$ 128,799	\$ 152,159	\$ 27,188	\$ 8,973	\$ 2,488	\$ 111,072				
17	95	\$ 1,199,726	\$ 1,199,726	\$ 47,578	\$ 78,467	\$ 4,353	\$ 1,234,968				
Month	Age	Premium	Mortality Charge	Cost of Insurance	Expense	Fee	Total Expenses	Interest Rate	Interest Earned	Accumulation Value	
21	0	25								\$ -	
22	1	25 \$ 679.89	\$ 0.09667	\$9.57	\$ 2.92	\$ 27.19	\$ 30.10	8.00%	\$ 4.12	\$644.14	
23	2	25 \$ -	\$ 0.09667	\$9.57	\$ 2.92	\$ -	\$ 2.92	8.00%	\$ 4.06	\$635.71	
24	3	25 \$ -	\$ 0.09667	\$9.57	\$ 2.92	\$ -	\$ 2.92	8.00%	\$ 4.01	\$627.24	

Exhibit 5

Interest Sensitive Whole Life Policy Computation Using Current Interest Rates and Current Mortality Charges

This exhibit illustrates the solution to the ISWL computation question: What are the RMPSA policy values based on the current interest rate (see Cell J3) and current cost of insurance (see Cell D3)? If Cell F3, Guaranteed/Current COI, is set to 2, this changes the mortality charge to 60 percent of the guaranteed rates.

Microsoft Excel - Retro Model FMA AFS02											
File Edit View Insert Format Tools Data Window Help Acrobat											
F3 = 2											
	B	C	D	E	F	G	H	I	J	K	L
1	RMPSA DATA INPUT										
2		Age	Premium	Gender	Guaranteed / Current COI	Expense \$	Fee %	Guaranteed Interest Rate	Current Interest Rate	Projected Interest Rate	Death Benefit
3		25	\$ 679.69	2	2	\$ 35.00	4%	4.50%	8.00%	1	\$ 100,000
4											
5		Near / Last	# Years Payable	Payment Mode		# Years Payable	# Years Payable				Type A/B
6		0	70	12		70	70				1
7											
8											
9	RMPSA DATA CODES										
10		Payment Mode		Gender	Cost of Insurance			Guaranteed Rate Factor	Current Rate Factor	Projected Interest Rate	Type A/B
11		Mthly=1	Semi=6	Male = 1	Guar. = 1			1.00367	1.00643	Current = 1	A = 1 Level
12		Qtrly =3	Annual=12	Female =2	Current = 2					Yearly = 2	B = 2 Inceas.
13											
14	RMPSA DATA OUTPUT										
15		Age	Accumulation Value	Death Benefit		Cumulative Premiums	Cumulative COI	Cumulative Expenses	Cumulative Interest		
16		65	\$ 145,779	\$ 174,935		\$ 27,188	\$ 5,375	\$ 2,488	\$ 126,454		
17		95	\$ 1,398,225	\$ 1,398,225		\$ 47,578	\$ 75,068	\$ 4,353	\$ 1,430,069		
18											
19											
20	Month	Age	Premium	Mortality Charge	Cost of Insurance	Expense	Fee	Total Expenses	Interest Rate	Interest Earned	Accumulation Value
21	0	25									\$ -
22	1	25	\$ 679.69	\$ 0.05800	\$ 5.74	\$ 2.92	\$ 27.19	\$ 30.10	8.00%	\$ 4.14	\$ 647.99
23	2	25	\$ -	\$ 0.05800	\$ 5.74	\$ 2.92	\$ -	\$ 2.92	8.00%	\$ 4.11	\$ 643.44
24	3	25	\$ -	\$ 0.05800	\$ 5.74	\$ 2.92	\$ -	\$ 2.92	8.00%	\$ 4.08	\$ 638.87

Exhibit 6 Interest Sensitive Whole Life Policy Computation – Minimum Number of Premiums

This exhibit illustrates the solution to the ISWL computation question: Instead of making 70 payments to age 95, how many payments would be necessary to have the policy perform as compared to the guaranteed values? The solution is an iterative exercise and involves changing the number of payments, D6, until the accumulation value at age 95 (Cell D17) is equal to or greater than the original \$100,000.

Microsoft Excel - Retro Model FMA AFS02											
File Edit View Insert Format Tools Data Window Help Acrobat											
D6 = 7											
B	C	D	E	F	G	H	I	J	K	L	
1	RMPSA DATA INPUT										
2		Age	Premium	Gender	Guaranteed / Current COI	Expense \$	Fee %	Guaranteed Interest Rate	Current Interest Rate	Projected Interest Rate	Death Benefit
3		25	\$ 679.69	2	2	\$ 35.00	4%	4.50%	8.00%	1	\$ 100,000
4											
5		Near / Last	# Years Payable	Payment Mode		# Years Payable	# Years Payable				Type A/B
6		0	7	12		70	70				1
7											
8											
9	RMPSA DATA CODES										
10		Payment Mode		Gender		Cost of Insurance		Guaranteed Rate Factor	Current Rate Factor	Projected Interest Rate	Type A/B
11		Mthly=1	Semi=6	Male = 1		Guar. = 1		1.00367	1.00643	Current = 1	A = 1 Level
12		Qtrly =3	Annual=12	Female =2		Current = 2				Yearly = 2	B = 2 Increas.
13											
14	RMPSA DATA OUTPUT										
15		Age	Accumulation Value	Death Benefit		Cumulative Premiums	Cumulative COI	Cumulative Expenses	Cumulative Interest		
16		65	\$ 36,022	\$ 100,000		\$ 4,758	\$ 8,765	\$ 1,590	\$ 41,619		
17		95	\$ 271,656	\$ 271,656		\$ 4,758	\$ 32,243	\$ 2,640	\$ 301,782		
18											
19											
20	Month	Age	Premium	Mortality Charge	Cost of Insurance	Expense	Fee	Total Expenses	Interest Rate	Interest Earned	Accumulation Value
21	0	25									\$ -
22	1	25	\$ 679.69	\$ 0.05800	\$5.74	\$ 2.92	\$ 27.19	\$ 30.10	8.00%	\$ 4.14	\$647.99
23	2	25	\$ -	\$ 0.05800	\$5.74	\$ 2.92	\$ -	\$ 2.92	8.00%	\$ 4.11	\$643.44
24	3	25	\$ -	\$ 0.05800	\$5.74	\$ 2.92	\$ -	\$ 2.92	8.00%	\$ 4.08	\$638.87

Exhibit 7 Universal Life Policy Computation – Reduced Premium

This spreadsheet shows the solution to the UL spreadsheet application question: What would the UL premium be with a goal of \$100,000 accumulation value at age 95? The UL premium is listed in Cell D3 and the accumulation value at age 95 is listed in Cell D17. The interest rate is assumed to be 8.00 percent (Cell J3). The solution is obtained using the Excel Tools/Goal Seek function.

RMPDSA DATA INPUT											
	Age	Premium	Gender	Guaranteed / Current COI	Expense \$	Fee %	Guaranteed Interest Rate	Current Interest Rate	Projected Interest Rate	Death Benefit	
3	25	\$ 264.57	2	2	\$ 35.00	4%	4.50%	8.00%	1	\$ 100,000	
RMPDSA DATA CODES											
	Payment Mode	Gender	Cost of Insurance	Guranteed Rate Factor	Current Rate Factor	Projected Interest Rate	Type A/B				
10	Mthly=1	Semi=6	Male = 1	Guar. = 1	1.00367	1.00843	Current = 1	A = 1 Level			
12	Qtrly =3	Annual=12	Female =2	Current = 2			Yearly = 2	B = 2 Increases.			
RMPDSA DATA OUTPUT											
	Age	Accumulation Value	Death Benefit	Cumulative Premiums	Cumulative COI	Cumulative Expenses	Cumulative Interest				
16	65	\$ 25,540	\$ 100,000	\$ 10,583	\$ 9,487	\$ 1,823	\$ 26,268				
17	95	\$ 100,000	\$ 100,000	\$ 18,520	\$ 71,639	\$ 3,191	\$ 156,310				
Month	Age	Premium	Mortality Charge	Cost of Insurance	Expense	Fee	Total Expenses	Interest Rate	Interest Earned	Accumulation Value	
21	0	25								\$ -	
22	1	25 \$	\$ 0.05800	\$5.76	\$ 2.92	\$ 10.58	\$ 13.50	8.00%	\$ 1.58	\$246.88	
23	2	25 \$	\$ 0.05800	\$5.76	\$ 2.92	\$ -	\$ 2.92	8.00%	\$ 1.53	\$239.73	
24	3	25 \$	\$ 0.05800	\$5.77	\$ 2.92	\$ -	\$ 2.92	8.00%	\$ 1.49	\$232.54	

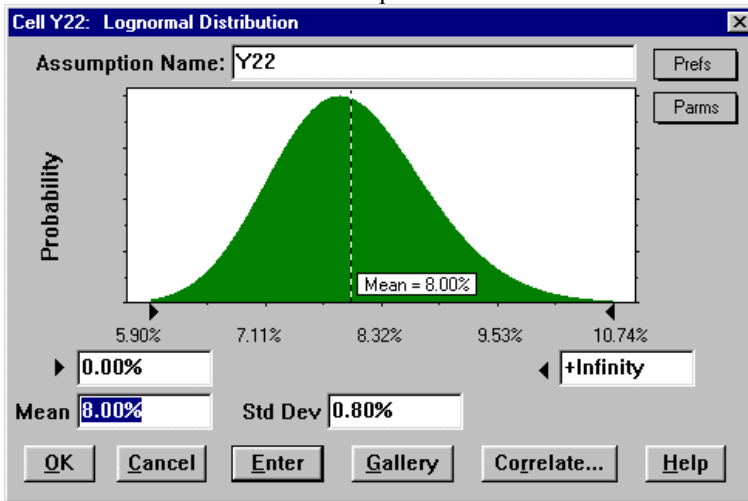
Exhibit 8

The Impact of Interest Rate Uncertainty Using Monte Carlo Simulation and Crystal Ball®

This exhibit illustrates how to analyze the impact of interest rate uncertainty using Monte Carlo simulation and Crystal Ball. The following steps show how to analyze the impact on accumulation values assuming an annual interest rate volatility equal to 10 percent of the forecast rate. The forecast values represent an overall decline in interest rates from 8 percent to 5.75 percent over a 10-year period.

Steps Using Crystal Ball (CB):

Step 1. Set up the probability distribution for each interest rate variable. For example, a lognormal probability distribution is chosen for the interest rates in each policy year (see Exhibit 2 for input cells discussed earlier). The illustration below shows the input information for Cell Y22.

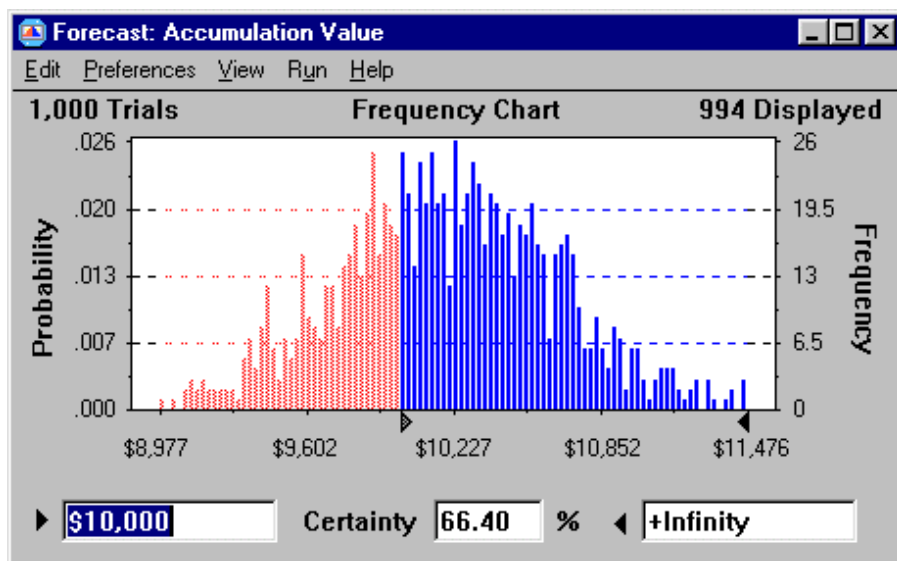


Step 2. Once the distributions are defined for all variables, it is necessary to identify which output variable(s) will be examined. In the RMPSA model, we want to analyze the impact of interest rates on accumulation value at age 65 (see Cell D16 below). By selecting the “Define Forecast” icon in Crystal Ball, the following input cell appears. Cell D16 (also named accumulation value) is entered in the forecast name input cell.

Age	Premium	Accumulation Value	Death Benefit
65	\$ 264.57	\$ 10,173	\$ 100,000
95	\$ -	\$ -	\$ -

Exhibit 8 Continued

Step 3. Now, the simulation can be run in Crystal Ball. As the simulation generates output values in Crystal Ball, the frequency chart can be viewed as it is constructed. The frequency chart below displays the simulation output for 1000 runs. Using this frequency chart, it is possible to determine not only the range of possible outcomes for accumulation values, but also the likelihood of their occurrence. For example, by entering \$10,000 in the lower-left field of the frequency chart output, the likelihood, or certainty, of achieving a \$10,000 accumulation value can be determined. As shown below, the chance of achieving this accumulation value is forecast to be 66.40%.



Step 4: It is important to understand how much a given assumption, such as interest rate forecasts, affects the insurance policy results. By selecting Crystal Ball's "Sensitivity Chart" feature, it is possible to analyze the contribution of each interest rate forecast variable to the age 65 accumulation value. As shown below, the age 65 accumulation value is most sensitive to the Cells Y41, Y55, Y46, Y42, Y50, Y48, Y44, Y56, Y52, and Y40. The sensitivities are displayed as a percentage of the contribution to the variance of the forecast. Other display options are available in Crystal Ball.

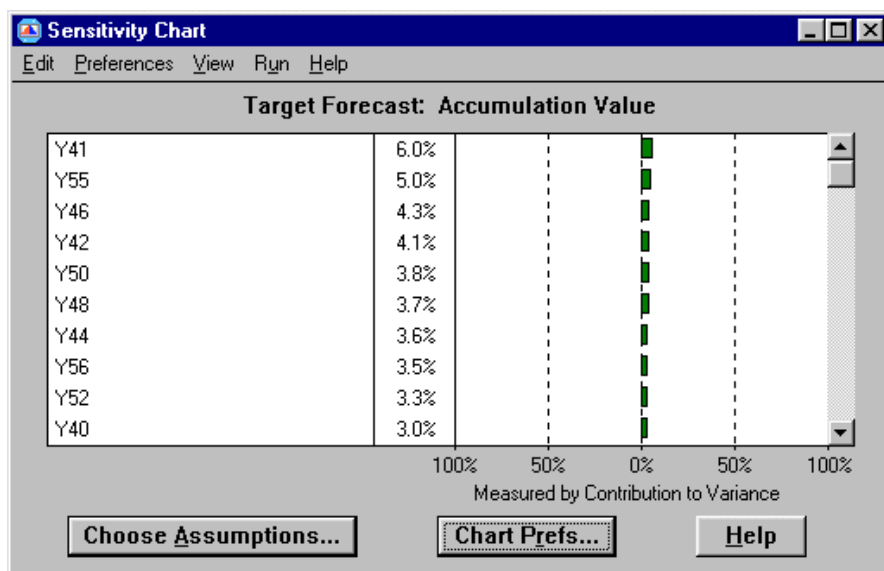


Exhibit 9

This exhibit contains the summary and statistics for the Monte Carlo simulation. The report is generated by the Crystal Ball report option and is based on a total of 1000 trials.

Crystal Ball Report

Simulation started on 5/29/02 at 1:09:24

Simulation stopped on 5/29/02 at 1:41:29

Forecast: Accumulation Value

Cell: D16

Summary:

Certainty Level is 66.40%

Certainty Range is from \$10,000 to +Infinity

Display Range is from \$8,977 to \$11,476

Entire Range is from \$8,904 to \$11,616

After 1,000 Trials, the Std. Error of the Mean is \$15

Statistics:

	<u>Value</u>
Trials	1000
Mean	\$10,201
Median	\$10,194
Mode	---
Standard Deviation	\$467
Variance	\$218,517
Skewness	0.04
Kurtosis	2.90
Coeff. of Variability	0.05
Range Minimum	\$8,904
Range Maximum	\$11,616
Range Width	\$2,712
Mean Std. Error	\$14.78