Universal Life Insurance Duration Measures

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Abstract

In August 2010, Lincoln Financial Group introduced a "New Hybrid Life Product – Lincoln DurationGuarantee (SM) Universal Life (UL)" with shorter coverage durations for ages not typically covered by term insurance. This latest UL product follows the development of 'No Lapse Universal Life Insurance' in the mid 1990's in response to policyholder concerns about lapsing original UL policies.

This paper considers alternative interpretations of 'Duration' as a length of time, average life of cash flows and interest rate sensitivity as applied to UL policy cash values. The interest rate sensitivity of UL policy cash values, amplified by the corresponding cost of insurance sensitivity with declining interest income, suggests UL has always been a simple question of Duration. The Lincoln DurationGuarantee (SM) Universal Life (UL) directly, and perhaps finally, acknowledges the Duration concept, but in what sense?

Introduction

The concept of Duration has several interpretations. The insurance industry refers to a life insurance policy's number of years of being in force or length of time as its duration of existence or horizon to when it matures, as in 'for the duration' or 'to maturity' (Lincoln Financial DurationGuarantee PR NewsWire, 2010). This view of duration differs from that generally held by financial economists. For them duration is still may be a length of time, that of the average life of cash flows, a time weighted measure of a financial instrument's cash flows (Macaulay, 1938; Bierwag, 1987). An additional financial economic interpretation of duration is as an elasticity, the marginal change in a financial instrument's current price given a change in yield (Macaulay, 1938; Bierwag, 1987).

Created during the early 1980's, the original UL Life Insurance product calculated premiums based on reduced current mortality rate assumptions and historically high current interest rates. This resulted in significantly lower premiums relative to Traditional Cash Value Insurance.

Figures 1a and 1b, Commissioners Standard Ordinary (CSO) Mortality Tables include the 1958 CSO, and separate Male, Female 1980 and 2001 CSO Tables. The decline in mortality rates over time, which could be passed on to the insured in the form of lower premiums is readily apparent. Note, the cost of insurance rates in Figures 1a and 1b are maximum guaranteed rates, not the current mortality rate UL policy assumptions which were generally 60% or less of the guaranteed cost of insurance rates.

The UL Median Credited Interest Rate was 11% in 1985 (Best's Policy Reports – 2000). The 11% then current rate reflected the early 1980's interest rate experience as shown in Figure 2: Life Insurance Industry 1985 Median UL Illustrated Rate and Historical AAA Bond Yields 1919-1984 & 1985-2007. Including a 1.5% spread on investments returns required an actuarial projection of 12.5% for the policy to perform as illustrated to maturity, up to 95 years.

When interest rates fell back to long-term historical averages, the original reduced UL premium was financially insufficient to pay the increasing cost of insurance associated with decreasing policy cash values, causing the polices to lapse prior to maturity.

It is important to distinguish between the increasing cost of insurance rate by age which could result in increasing the policy cost of insurance, and the increasing cost of insurance due to policy accumulated cash value reductions. This later effect is actually a secondary cost of insurance effect, amplifying the interest rate sensitivity of interest sensitive life insurance products such Universal Life. The retrospective financial method for life insurance policy valuations is the amount of insurance at risk is equal to the death benefit minus the policy accumulated cash value. If interest rates decrease, less interest is earned and the accumulated cash value is less. This requires a greater amount of insurance to be purchased and thus a higher cost of insurance, leading to reduced accumulated cash values, further decreasing interest earnings and so on. The increasing cost of insurance rate by age is a third amplification of the interest rate sensitivity as the increasing amount at risk due to reduced accumulated policy cash values is subject to an increasing cost of insurance rate.

The combined cost of insurance with increased amount of insurance at risk, and the increasing cost of insurance rates by age are reflected in the policy mortality charge – the reported policy deduction for insurance. The mortality charge amplified interest rate sensitivity is important since annual insurance premium payments are expected future cash flows, thus traditional interest rate immunization strategies are not available.

The Applied Life Insurance Illustrator (APLII) Excel[1] spreadsheet is the underlying model for considering different interpretations of Duration. The APLII spreadsheet simultaneously creates life insurance policy values for Traditional, Participating, Interest-Sensitive Whole Life, and Universal Life insurance policies (Jones, Lange and Simkins, 2003). The APLII provides comparative life insurance policy value determination methods, policy

[1] Excel is a registered trademark of the Microsoft Corporation.

premium strategies, impact of cash value factors, and insurer policy designs. The spreadsheet requires minimal data input, yet accommodates interest rate scenario pricing, different fees and expenses; current and guaranteed cost of insurance; multiple CSO tables; modal premiums; and premium contingent valuations including reduced or vanishing premium strategies (Lange, Himes and Jones, 2003).

The APLII has been extensively described and applied in prior research. Pedagogic applications for the prospective (Lange, D. and S. Jones, 2004) and retrospective premium determination models (Lange, D. and B. Simkins, 2003, 2001) demonstrate the APLII spreadsheets' features. Additional examples of the APLII include creating UL Illustrations (Jones, S., D. Lange and B. Simkins, 2003) and considering UL's No-Lapse Guarantee (Graham L. and D. Lange, 2010).

The following sections demonstrate and consider the alternative interpretations of Duration as applied to UL, specifically the Mortality Charge Amplified Interest Rate Sensitivity and the Average Life of the Policy Cash Value.

DURATION: MORTALITY CHARGE AMPLIFIED INTEREST RATE SENSITIVITY

As noted above, as interest rates decline and policy cash values fail to grow as projected, the insurance purchased within a policy, death benefit minus policy cash value, increases. This increases the mortality charge in the policy leading to a secondary decrease in projected policy cash values. As also noted, the marginal mortality rate itself has an increasing impact by age as shown in Figures 1a and 1b, CSO Tables. Referring to the solid line representing the 1958 CSO Mortality Table in Figure 1a, the cost of insurance for a male age 60 is approximately $20, and by age 79 increases to $100 per $1,000. Figure 1b shows the cost of insurance increasing to over $300 per $1,000 by age 95. Thus the increased amount of insurance purchased is done so at every increasing cost of insurance per $1,000. Again, even though the cost of insurance still increases with age, the marginal increase has declined with the 1980 CSO and again with the 2001 CSO Mortality Tables.

To further demonstrate the cost of insurance effect, a sample UL policy is provided in Table 1: APLII – Applied Life Insurance Illustrator for a male [C2] age 35 [D2], $100,000 [B2] UL policy, designed to mature at age 95 with a $100,000 [P40] policy cash value. The Guideline, maximum annual, premium based on the 1980 CSO [C5] is $1,294.60 [P2], allowing a UL

Planned Premium of $536.53 [M2] assuming a 9% [J5] current interest rate. The interest income for age 50 is $711 [R22] with an associated Mortality Charge of $340 [S22]. By age 75, interest income increases to $3,892 [R32] and the morality charge to $2,344 [S32]. For age 90, the respective values are $6,476 and $4,498, and for age 95, $8,286 and $1,048.

The question is what happens to interest income and mortality charges as interest rates decrease? To demonstrate the sensitivity of the policy cash values to a change in interest rates, a marginal decrease of .03%, 3 basis points, is assumed, a decline from 9% to 8.97%. Table 2: Mortality Charge Amplified Interest Rate Sensitivity Example includes the annual interest income, mortality charge and Policy Cash Value for ages 45 to 95. The 9% columns in Table 2 duplicate the interest, mortality and policy cash values from Table 1. The final three columns of Table 2 show comparable values at the assumed interest rate of 8.97%.

Referring to Table 2, note the policy cash value at age 95 declines from $100,000 to $12,494, or by $87,506. Also observe the annual decrease in interest income is greater than the increase in cost of insurance up to age 80, but the reverse is true after age 80. For example, at age 80, interest income declines by $177 ($4,739 to $4,562), while the cost of insurance increases by $134 ($3,206 to $3,340). At age 85, interest income declines by $415 ($5,588 to $5,163), while the mortality charge increases by $551 ($4,086 to $4,637). Most notably, at age 95, interest income falls by $6,409 ($8,286 to $1,877), and the mortality charge increases by $20,117 ($1,048 to $21,165). The spiked impact at the older ages is evident from Figure 1b – CSO Tables.

Overall, the intent of Tables 1 and 2 is to demonstrate the first interpretation of duration as the marginal change in a financial instruments current price given a change in interest rates, or in life insurance terms, the change in the policy cash value. Perhaps more importantly, the example shows how the policy cash value interest rate sensitivity is amplified by the mortality charge effect, expanding the interpretation of duration to a combined elasticity.

DURATION: REDUCED MATURITY in # of YEARS and LAPSE AGE

Duration as a length of time, as in ‘for the duration’ as used by Lincoln Financial DurationGuarantee (PR NewsWire, 2010) effectively refers to policy maturity in the context of a life insurance policy or to age 95 in the above example. An alternative view of duration from that of a maturity time period, but still a length of time, is that of the average life of cash flows, a

time weighted measure of financial instrument cash flows (Macaulay, 1938; Bierwag, 1987). In the context of a life insurance policy, the change in the length of time given a change in interest rates can be viewed frfom two different but mutually consistent perspectives. And so we can state the same thing in two alternate ways: [1] the number of years the policy's maturity is reduced and [2] the policyholder age at which the policy cash value becomes zero - the policy lapses.

Table 3: Duration – Reduced Maturity in # of Years and Lapse Age, Male and Table 4: Female contain the results of APLII simulations in which current interest rates decline to either the guarantee rate of 4.5% or a 2% decline from the current, at issue, rate. The decline in interest rates to the guaranteed rate approximates the actual experience of UL median rates since the 1980's during which median UL rates fell from 11% towards 4.5% (Bests Policy Reports, 2000). The 2% decline is applied proportionally during the first ten year years of the policy and maintains the 2% reduction for the remaining life of the policy.

Simulation values are provided for a male, issue ages 25, 35, and 45, for the 1980 and 2001 CSO Tables, assuming current at issue interest rates of 11%, 9% and 7% corresponding to actual experience of UL median rates during the 1980's and 1990's. Results include Guideline and Planned Premiums, Reduced Maturity in # of Years and Lapse Age, across the eighteen above scenarios by age, 36 scenarios in total. Planned premiums are calculated assuming a $100,000 cash value at age 75 - actuarially projecting a paid-up policy by age 75 based on the UL premium determination assumptions of higher current interest rates and lower current mortality charges.

For example, referring to Table 3, the Guideline Premium based on the 1980 CSO for a male age 25 is $847. However given the UL premium determination assumption of an 11% current interest rate, the required Planned Premium is $275, or $357 at 9%, and $504 at 7%. Assuming the current interest rate continues, the respective premiums would provide $100,000 policy cash value at age 75, and maintain the policy in-force for 70 years or to age 95.

Referring to the 11% example, if interest rates declined to the Guaranteed Rate of 4.5%, the policy maturity would be reduced by 32 years and so the policy lapses at age 63. Instead of an in-force policy to age 95, the policy lapses 32 years early as the policy cash value goes to zero, due to decreasing interest income amplified by increasing mortality charges discussed

above. A 2% decline, from 11% to 9%, causes the policy maturity to be reduced by 19 years and lapse at the age of 76.

There are several observations provided from Tables 3 and 4.

First: the interest income impact on UL policy funding is apparent in the planned premiums relative to age. The Guideline Premium for a 25 year old, 1980 CSO, is $847, while the Planned Premium is only 275 at 11%, increasing to $504 at 7%. Comparable Planned Premium reductions are associated with the 2001 CSO for age 25. Referring to age 34 and 45, Guideline Premiums are increasing and the proportional decrease in Planned Premiums is declining, both a function of the time value of money, interest income.

Second: the mortality charge effect across CSO Tables as shown in Figures 1a and 1b: CSO Tables are represented by the decreasing Guideline Premiums and subsequent Planned Premiums by age. The Guideline Premium of $847 for the 1980 CSO declines to $683 on the 2001 CSO. A similar pattern of decreasing Guideline Premiums and dependent Planned Premiums is present for age 35 and 45.

Third: all of the 18 scenario policies for a 25 year old male and female lapse prior to age 95, policy maturity. All but two policies lapse prior to maturity for a 35 year old male. Only five lapse prior to maturity for a female age 45. Finally, only 4 (3) of the 18 lapse prior to maturity for at issue 45 year old male (female).

The decreasing lapse rates is a function of the decreasing period over which interest income declines is realized and the higher Planned Premium creating increased policy cash values and reduced required insurance purchases.

Fourth: the magnitude of the interest rate sensitivity amplified by the mortality charge may be seen by examining Table 3: Duration – Reduced Maturity in # of Years and lapse Age. A 25 year old male at issue policyholder with the 1980 CSO generation of UL policies with an 11% current interest rate had a policy lapse at age 63, rather than have a paid-up policy by age 75. This early lapsing was delayed until the insured's 70's with a 9% current interest rate. However, even with the most recent 2001 CSO and a more conservative current interest rate of 7%, the policy lapses prior to maturity for a 25 year old by age 86.

Perhaps most interesting in the results, is the additional reduced premiums for a female age 25 results in a greater interest rate sensitivity.

Summary

This paper considers alternative interpretations of 'Duration' as a length of time, average life of cash flows and interest rate sensitivity as applied to UL policy cash values. UL policy simulations demonstrate the interest income impact on UL policy funding, the mortality charge effect across CSO Tables, policies lapse prior to maturity, and the magnitude of the interest rate sensitivity amplified by the mortality charge. Overall, the paper suggests UL has always been a simple question of Duration. The Lincoln DurationGuarantee (SM) Universal Life (UL) directly, and perhaps finally, acknowledges the Duration concept.

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Figure 1a: CSO Tables

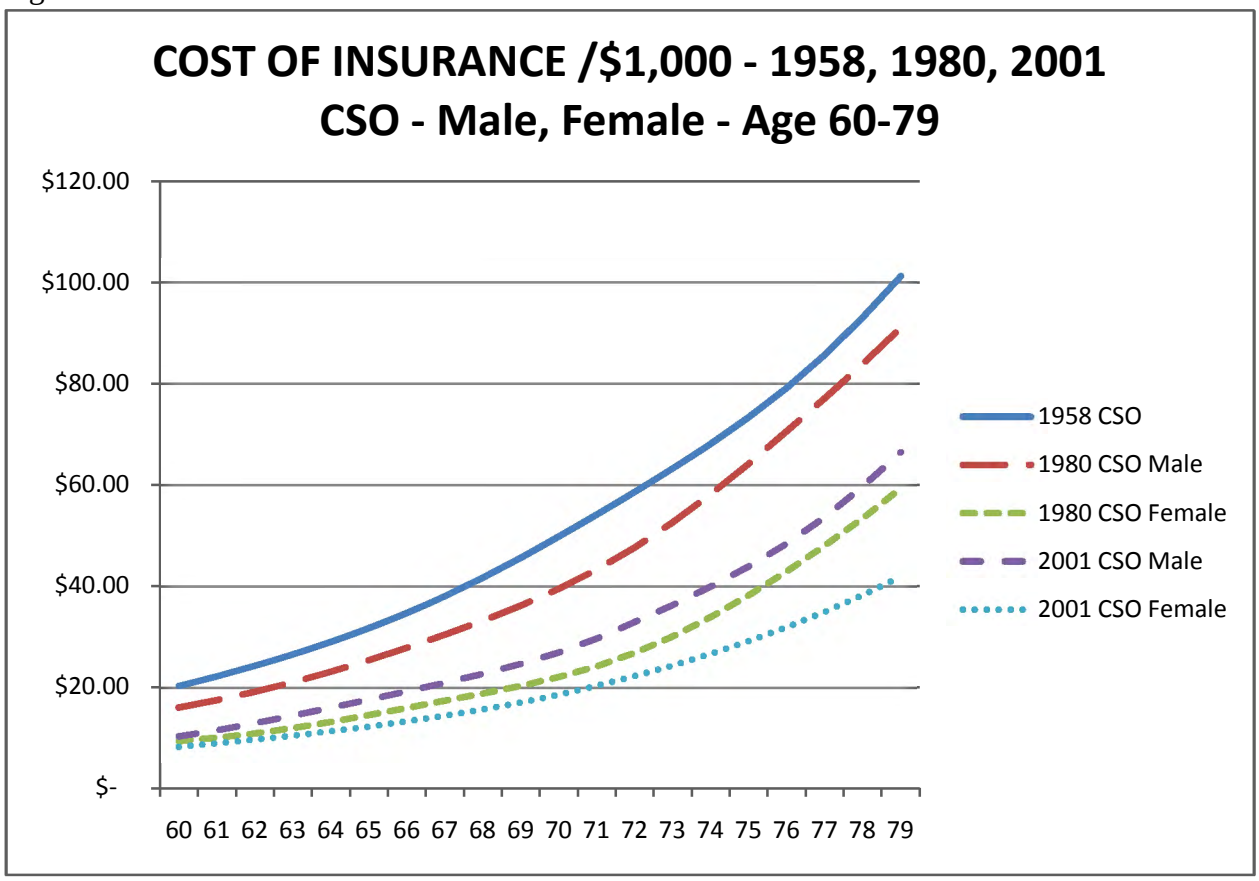


Figure 1b – CSO Tables

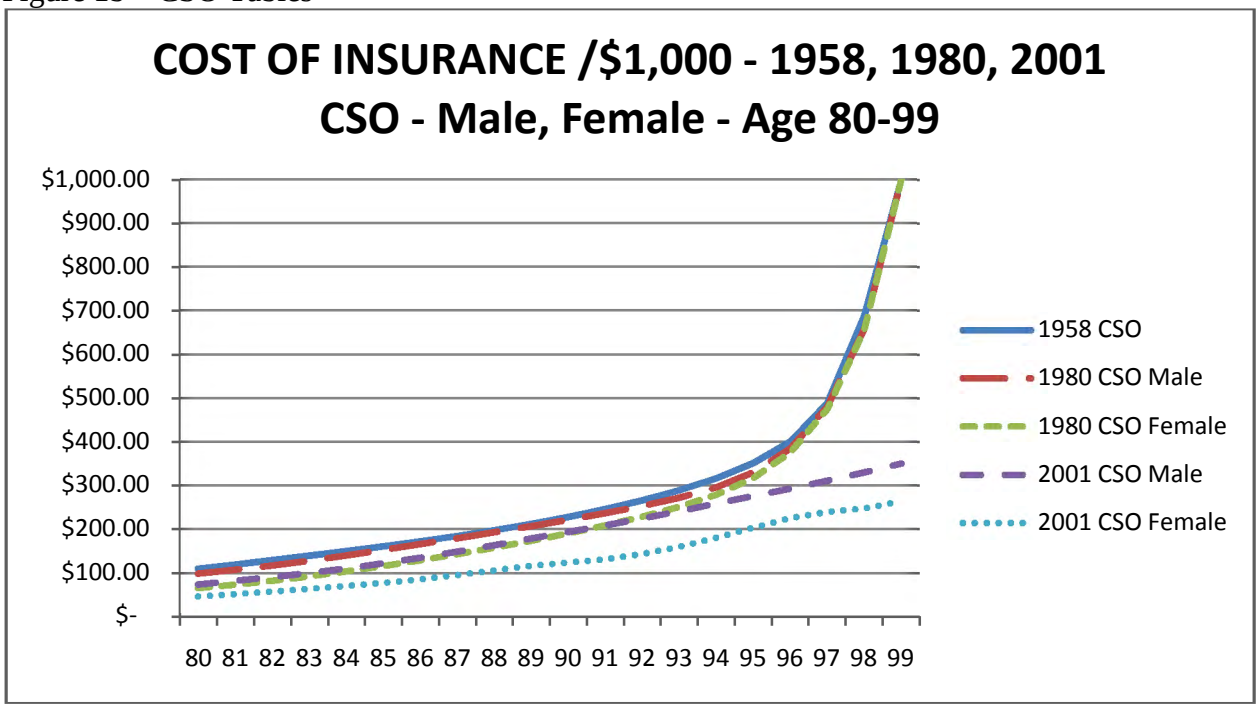


Figure 2: Life Insurance Industry 1985 Median UL Illustrated Rate And Historical AAA Bond Yields 1919-1984 & 1985-2007

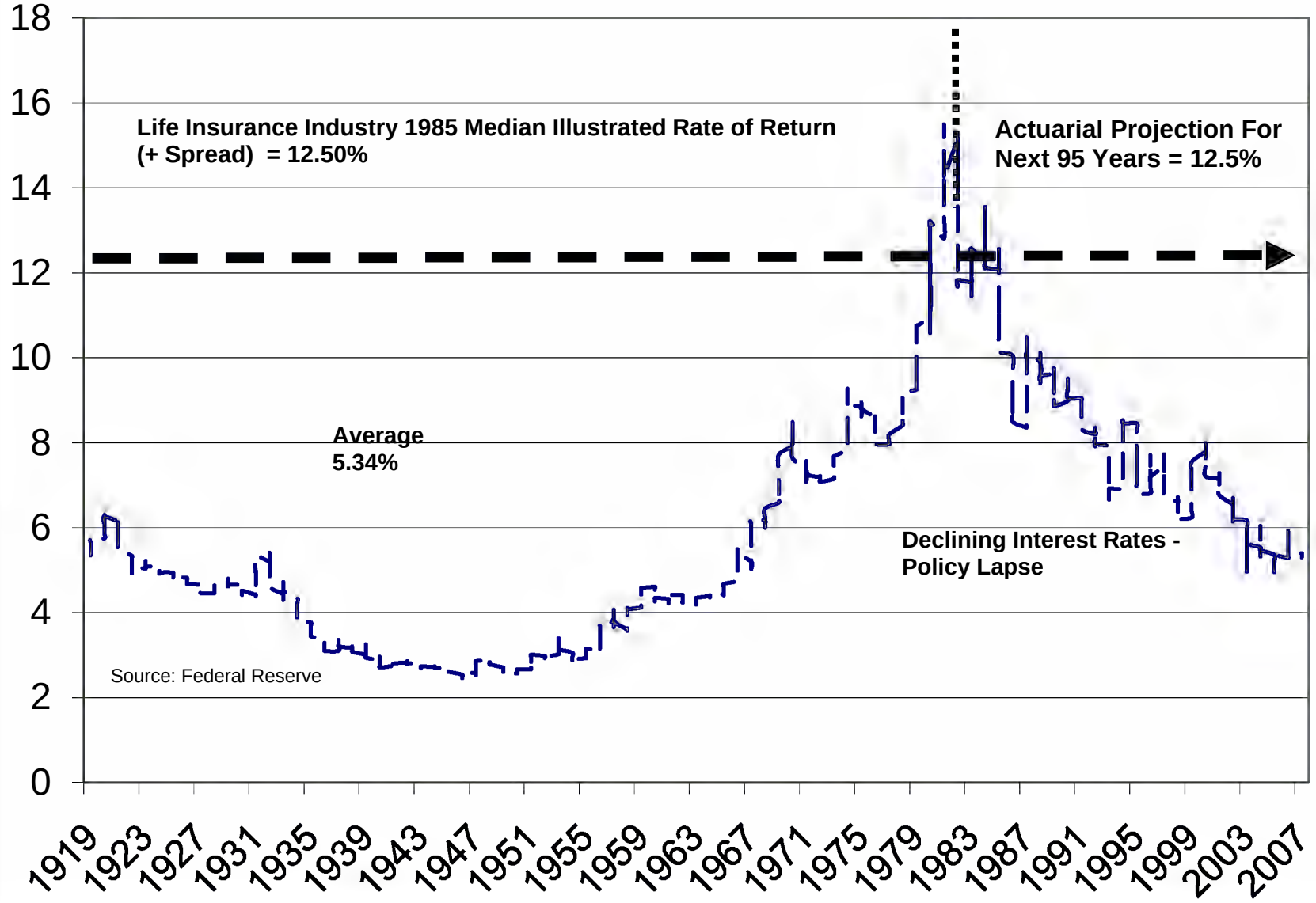
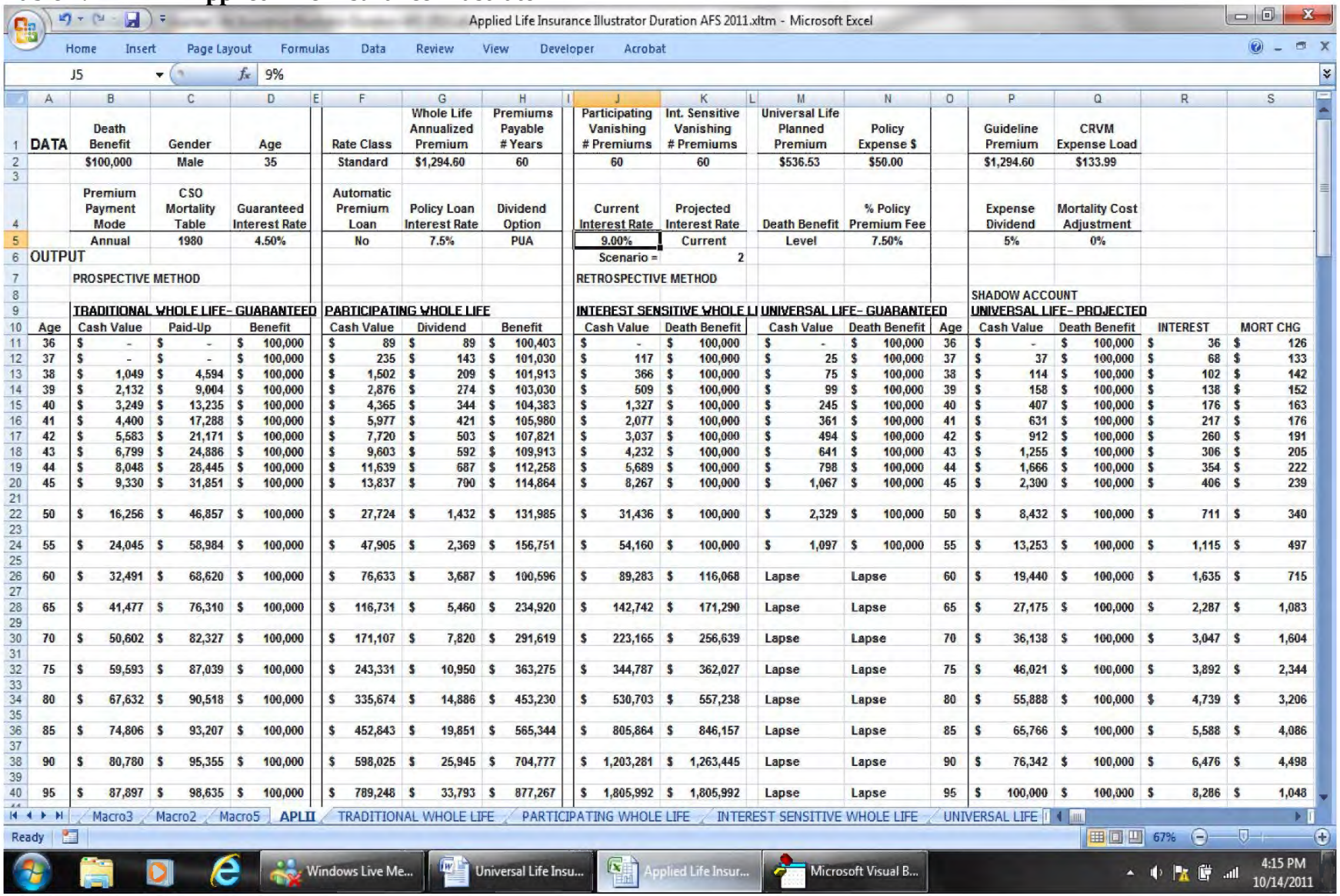


Table 1: APLII – Applied Life Insurance Illustrator



Applied Life Insurance Illustrator Duration AFS 2011.xltm - Microsoft Excel

DATA	Death Benefit	Gender	Age	Rate Class	Whole Life Annualized Premium	Premiums Payable # Years	Participating Vanishing # Premiums	Int. Sensitive Vanishing # Premiums	Universal Life Planned Premium	Policy Expense $	Guideline Premium	CRVM Expense Load
	$100,000	Male	35	Standard	$1,294.60	60	60	60	$536.53	$50.00	$1,294.60	$133.99

Premium Payment Mode	CSO Mortality Table	Guaranteed Interest Rate	Automatic Premium Loan	Policy Loan Interest Rate	Dividend Option	Current Interest Rate	Projected Interest Rate	Death Benefit	% Policy Premium Fee	Expense Dividend	Mortality Cost Adjustment
Annual	1980	4.50%	No	7.5%	PUA	9.00%	Current	Level	7.50%	5%	0%

OUTPUT — Scenario = 2

PROSPECTIVE METHOD — RETROSPECTIVE METHOD

	TRADITIONAL WHOLE LIFE- GUARANTEED			PARTICIPATING WHOLE LIFE			INTEREST SENSITIVE WHOLE LI		UNIVERSAL LIFE- GUARANTEED			SHADOW ACCOUNT UNIVERSAL LIFE- PROJECTED			
Age	Cash Value	Paid-Up	Benefit	Cash Value	Dividend	Benefit	Cash Value	Death Benefit	Cash Value	Death Benefit	Age	Cash Value	Death Benefit	INTEREST	MORT CHG
36	$ -	$ -	$ 100,000	$ 89	$ 89	$ 100,403	$ -	$ 100,000	$ -	$ 100,000	36	$ -	$ 100,000	$ 36	$ 126
37	$ -	$ -	$ 100,000	$ 235	$ 143	$ 101,030	$ 117	$ 100,000	$ 25	$ 100,000	37	$ 37	$ 100,000	$ 68	$ 133
38	$ 1,049	$ 4,594	$ 100,000	$ 1,502	$ 209	$ 101,913	$ 366	$ 100,000	$ 75	$ 100,000	38	$ 114	$ 100,000	$ 102	$ 142
39	$ 2,132	$ 9,004	$ 100,000	$ 2,876	$ 274	$ 103,030	$ 509	$ 100,000	$ 99	$ 100,000	39	$ 158	$ 100,000	$ 138	$ 152
40	$ 3,249	$ 13,235	$ 100,000	$ 4,365	$ 344	$ 104,383	$ 1,327	$ 100,000	$ 245	$ 100,000	40	$ 407	$ 100,000	$ 176	$ 163
41	$ 4,400	$ 17,288	$ 100,000	$ 5,977	$ 421	$ 105,980	$ 2,077	$ 100,000	$ 361	$ 100,000	41	$ 631	$ 100,000	$ 217	$ 176
42	$ 5,583	$ 21,171	$ 100,000	$ 7,720	$ 503	$ 107,821	$ 3,037	$ 100,000	$ 494	$ 100,000	42	$ 912	$ 100,000	$ 260	$ 191
43	$ 6,799	$ 24,886	$ 100,000	$ 9,603	$ 592	$ 109,913	$ 4,232	$ 100,000	$ 641	$ 100,000	43	$ 1,255	$ 100,000	$ 306	$ 205
44	$ 8,048	$ 28,445	$ 100,000	$ 11,639	$ 687	$ 112,258	$ 5,689	$ 100,000	$ 798	$ 100,000	44	$ 1,666	$ 100,000	$ 354	$ 222
45	$ 9,330	$ 31,851	$ 100,000	$ 13,837	$ 790	$ 114,864	$ 8,267	$ 100,000	$ 1,067	$ 100,000	45	$ 2,300	$ 100,000	$ 406	$ 239
50	$ 16,256	$ 46,857	$ 100,000	$ 27,724	$ 1,432	$ 131,985	$ 31,436	$ 100,000	$ 2,329	$ 100,000	50	$ 8,432	$ 100,000	$ 711	$ 340
55	$ 24,045	$ 58,984	$ 100,000	$ 47,905	$ 2,369	$ 156,751	$ 54,160	$ 100,000	$ 1,097	$ 100,000	55	$ 13,253	$ 100,000	$ 1,115	$ 497
60	$ 32,491	$ 68,620	$ 100,000	$ 76,633	$ 3,687	$ 190,596	$ 89,283	$ 116,068	Lapse	Lapse	60	$ 19,440	$ 100,000	$ 1,635	$ 715
65	$ 41,477	$ 76,310	$ 100,000	$ 116,731	$ 5,460	$ 234,920	$ 142,742	$ 171,290	Lapse	Lapse	65	$ 27,175	$ 100,000	$ 2,287	$ 1,083
70	$ 50,602	$ 82,327	$ 100,000	$ 171,107	$ 7,820	$ 291,619	$ 223,165	$ 256,639	Lapse	Lapse	70	$ 36,138	$ 100,000	$ 3,047	$ 1,604
75	$ 59,593	$ 87,039	$ 100,000	$ 243,331	$ 10,950	$ 363,275	$ 344,787	$ 362,027	Lapse	Lapse	75	$ 46,021	$ 100,000	$ 3,892	$ 2,344
80	$ 67,632	$ 90,518	$ 100,000	$ 335,674	$ 14,886	$ 453,230	$ 530,703	$ 557,238	Lapse	Lapse	80	$ 55,888	$ 100,000	$ 4,739	$ 3,206
85	$ 74,806	$ 93,207	$ 100,000	$ 452,843	$ 19,851	$ 565,344	$ 805,864	$ 846,157	Lapse	Lapse	85	$ 65,766	$ 100,000	$ 5,588	$ 4,086
90	$ 80,780	$ 95,355	$ 100,000	$ 598,025	$ 25,945	$ 704,777	$ 1,203,281	$ 1,263,445	Lapse	Lapse	90	$ 76,342	$ 100,000	$ 6,476	$ 4,498
95	$ 87,897	$ 98,635	$ 100,000	$ 789,248	$ 33,793	$ 877,267	$ 1,805,992	$ 1,805,992	Lapse	Lapse	95	$ 100,000	$ 100,000	$ 8,286	$ 1,048

Macro3 | Macro2 | Macro5 | APLII | TRADITIONAL WHOLE LIFE | PARTICIPATING WHOLE LIFE | INTEREST SENSITIVE WHOLE LIFE | UNIVERSAL LIFE

Ready — 67% — Windows Live Me... | Universal Life Insu... | Applied Life Insur... | Microsoft Visual B... — 4:15 PM 10/14/2011

Table 2: MORTALITY CHARGE AMPLIFIED INTEREST RATE SENSITIVITY EXAMPLE

AGE	9.00% INTEREST	9.00% MORT CHG	9.00% CASH VALUE	8.97% INTEREST	8.97% MORT CHG	8.97% CASH VALUE
45	$406	$239	$2,390	$404	$239	$2,385
50	$711	$340	$8,432	$707	$341	$8,407
55	$1,115	$497	$13,253	$1,107	$498	$13,194
60	$1,635	$715	$19,440	$1,619	$716	$19,317
65	$2,287	$1,083	$27,175	$2,260	$1,086	$26,934
70	$3,047	$1,604	$36,138	$3,000	$1,615	$35,670
75	$3,892	$2,344	$46,021	$3,804	$2,382	$45,087
80	$4,739	$3,206	$55,888	$4,562	$3,340	$53,851
85	$5,588	$4,086	$65,766	$5,163	$4,637	$60,548
90	$6,476	$4,498	$76,342	$5,116	$7,320	$58,688
95	$8,286	$1,048	$100,000	$1,877	$21,165	$12,494

Table 3:Duration – Reduced Maturity in # of Years and Lapse Age, Male

Issue Age		25			35			45		
CSO / Issue Rate	Rate Decline	Premium	Reduced Maturity # Years	Lapse Age	Premium	Reduced Maturity # Years	Lapse Age	Premium	Reduced Maturity # Years	Lapse Age
1980 CSO	Guideline	$847			$1,295			$2,081		
11%	Guarantee%	$275	32	63	$496	24	71	$1,046	16	79
	2% Decline		19	76		10	85		0	95
9%	Guarantee%	$357	25	70	$643	18	77	$1,294	10	85
	2% Decline		16	79		9	86		0	95
7%	Guarantee%	$504	16	79	$873	10	85	$1,637	0	95
	2% Decline		14	81		8	87		0	95
2001 CSO	Guideline	$683			$1,041			$1,675		
11%	Guarantee%	$214	28	67	$390	21	74	$862	12	83
	2% Decline		12	83		0	95		0	95
9%	Guarantee%	$290	21	74	$530	14	81	$1,108	5	90
	2% Decline		10	85		0	95		0	95
7%	Guarantee%	$430	11	84	$756	5	90	$1,453	0	95
	2% Decline		9	86		1	94		0	95

Table 4:Duration – Reduced Maturity in # of Years and Lapse Age, Female

Issue Age		25			35			45		
CSO / Issue Rate	Rate Decline	Premium	Reduced Maturity # Years	Lapse Age	Premium	Reduced Maturity # Years	Lapse Age	Premium	Reduced Maturity # Years	Lapse Age
1980 CSO	Guideline	$695			$1,050			$1,640		
11%	Guarantee%	$231	38	57	$420	19	76	$883	10	85
	2% Decline		20	75		0	95		0	95
9%	Guarantee%	$307	29	66	$559	12	83	$1,124	3	92
	2% Decline		18	77		0	95		0	95
7%	Guarantee%	$446	19	76	$780	3	92	$1,463	0	95
	2% Decline		16	79		0	95		0	95
2001 CSO	Guideline	$579			$888			$1,410		
11%	Guarantee%	$182	36	59	$352	18	77	$790	6	89
	2% Decline		12	83		0	95		0	95
9%	Guarantee%	$256	17	78	$489	9	86	$1,034	0	95
	2% Decline		1	94		0	95		0	95
7%	Guarantee%	$394	5	90	$711	0	95	$1,377	0	95
	2% Decline		2	93		0	95		0	95