**Society of Actuaries and
Casualty Actuarial Society Symposium**

Washington, DC

CS-3—How ERM is Consistent with Embedded Value Reporting

Stochastic EV modeling - an approach that _distinguishes a company from its competitors_ in terms of enterprise risk management

**S. Michael McLaughlin
July 30, 2003**

ΞIJ ERNST & YOUNG

Quality In Everything We Do

Contents

- Deterministic and stochastic embedded value (EV)

- Ernst & Young stochastic EV case study for ACLI

- EV@Risk^{TM}

- Stochastic EV and EV@Risk^{TM} used as enterprise risk measurement tools

ERNST & YOUNG

Quality In Everything We Do

Deterministic EV

- Best estimate assumptions

- Reflects overall risks in the discount rate – higher discount rate for riskier products

- Easy to implement and understand

- However,
  - Focused primarily on interest-rate risk
  - Does not reflect tail exposure
  - Unable to measure the interaction of risks

ERNST & YOUNG

Quality In Everything We Do

Stochastic EV

- Enables companies to capture the interaction of risks

- Quantifies risks (total enterprise basis & by line of business)

- Helps management to determine a comfortable level of risk and to optimize the risk/reward relationships

- An approach that _distinguishes a company from its competitors_ in terms of enterprise risk measurement and management

What is Stochastic EV?

- Examples of simple application
  - "New York 7" interest rate scenarios used in asset adequacy testing
  - Sensitivity testing (e.g., interest lapse rate, lower mortality rate)

- Formal stochastic approach
  - Identify risk elements (e.g., interest, mortality, and default)
  - Use a stochastic process to define a range of selected risk elements (e.g., Monte Carlo, NAIC economic scenario generator)
  - Run EV model over a range for selected risk elements
    - Start with a deterministic model
    - Stochastic Assumption = deterministic assumption x
                                stochastically generated factor

ERNST & YOUNG

Quality In Everything We Do

# Ernst & Young Stochastic EV Case Study for ACLI

- UL product from the Ernst & Young deterministic EV case study developed for the 2002 ACLI Financial Roundtable

- UL risk elements selected
  - Interest
  - Mortality
  - Asset Default

- Used 100 iterations for each of the risk elements
  - Too many = long run time
  - Too few = reduce accuracy
  - Experience and testing will help identify optimal number of runs

EY ERNST & YOUNG

Quality In Everything We Do

Generating UL Stochastic Risk Assumptions

- The stochastic assumptions are generated for each risk element as follows:
  - Stochastic Assumption = Deterministic Assumption x Stochastic Generated Factor
  - Distribution Assumption = Normal Distribution

- Stochastic Interest
  - Economic Interest Rate scenarios were generated using Ernst & Young Economic Scenario Engine (ESE)

- Stochastic Mortality
  - Mean =1, Standard Deviation = 5%,
  - Max = 2, Min = 0.5
  - Mean reversion speed of 100%

- Stochastic Asset Default
  - Mean =1, Standard Deviation = 100%,
  - Max = 4, Min = 0
  - Mean reversion speed of 15%

ERNST & YOUNG

Quality In Everything We Do

Mean Reversion

Definition: A process by which variables such as prices, rates, and volatilities tend to return to a mean or average value (e.g., if a stock is under performing, its price will move towards an average value).
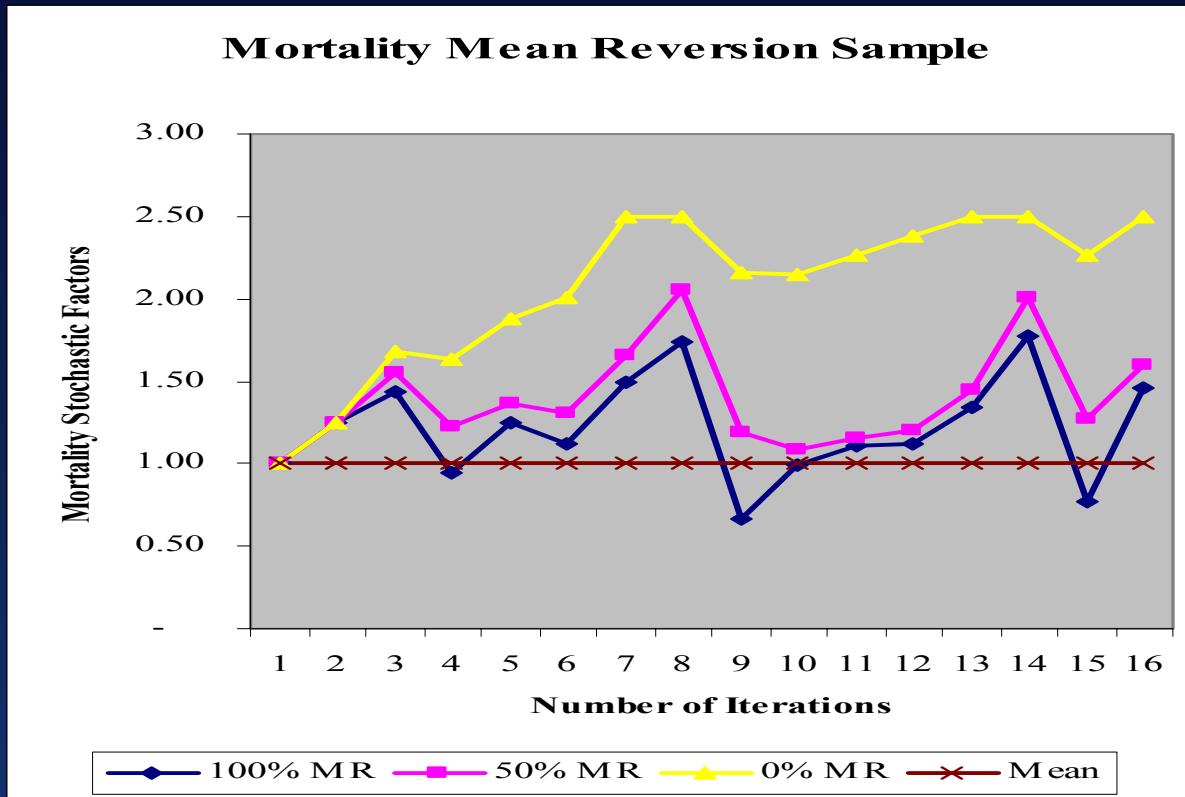
Results of Ernst & Young Universal Life Model

Deterministic Financial Results

- GAAP Earnings for 2002 $ 179,232
- GAAP Earnings 2002-2005 $ 778,388*
- Embedded Value 12/31/2002 $ 1,324,758*
- Embedded Value without Target Surplus $ 561,872*

* Discounted @ 9.00%

ERNST & YOUNG

Quality In Everything We Do

Embedded Value at Risk Concept

- EV@Risk ^{TM} : Difference between the mean EV value and the fifth percentile EV for each risk element (other levels of EV@Risk ^{TM} could also be used)

- Shows variance in EV over a range of economic and non-economic scenarios
  - Quantifies impact to EV for each individual risk elements
  - Demonstrates the **correlation effect** between different risk elements (i.e., sum of individual risk components is greater than when all the risks are run together)

- Allows management to determine a comfortable level of risk

- Requires stochastic EV modeling in order to determine different levels of EV@Risk ^{TM}

ERNST & YOUNG

Quality In Everything We Do

Results of Ernst & Young Universal Life Model

Stochastic Mortality Results

Universal Life Results - Stochastic Mortality				Percentile				
	Deterministic	Mean	EaRisk	5th	25th	50th	75th	95th
GAAP Eanings 2002	$ 179,232	$ 178,764	$ 4,112	$ 174,652	$ 177,198	$ 178,679	$ 180,672	$ 182,711
GAAP Earnings 2002-2005	$ 778,388	$ 777,142	$ 8,756	$ 768,387	$ 773,511	$ 777,888	$ 780,208	$ 785,330
Embedded Value	$ 1,324,758	$ 1,321,195	$ 56,637	$1,264,557	$1,298,890	$1,319,582	$1,344,527	$1,377,207
Embedded Value w/o TS	$ 561,872	$ 558,309	$ 56,637	$ 501,672	$ 536,004	$ 556,696	$ 581,641	$ 614,321

Observations:

- 2002 GAAP earnings at risk is about 2.3% versus the deterministic results while EV@Risk [TM] is about 4.3%

- EV@Risk [TM] is 10.1% when calculated without target surplus

ERNST & YOUNG

Quality In Everything We Do

Results of Ernst & Young Universal Life Model

Stochastic Mortality Results

Universal Life - Stochastic Mortality
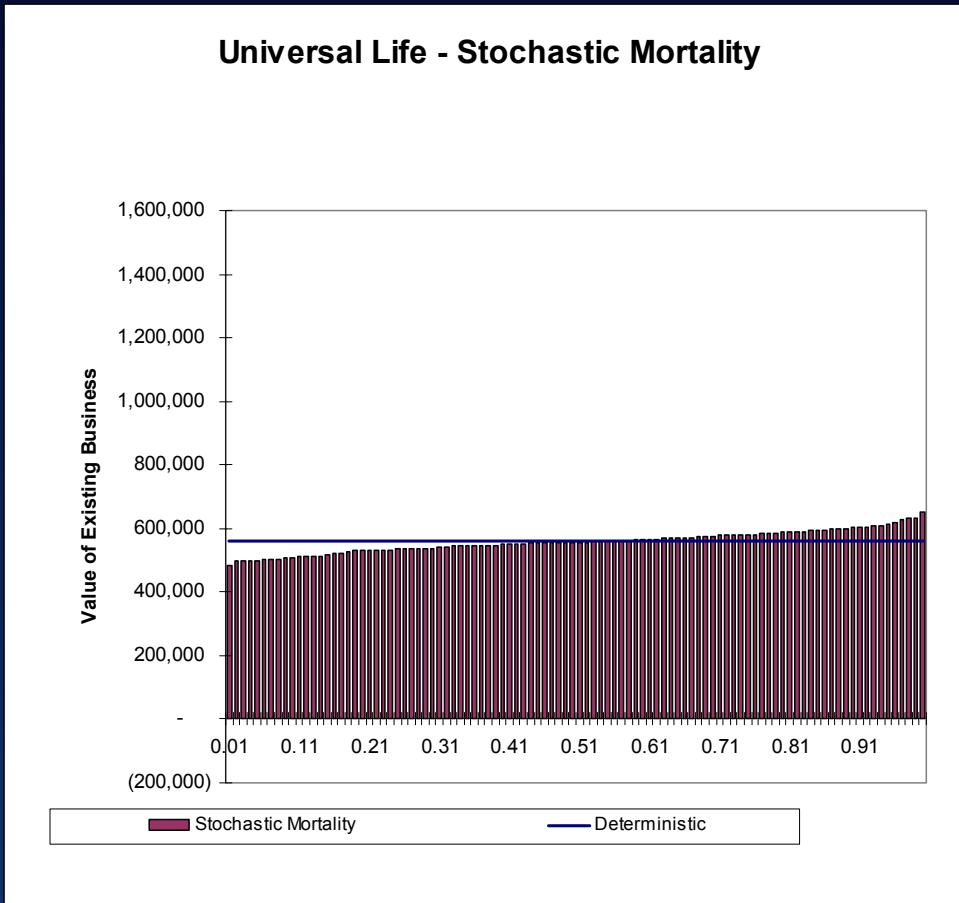
Statistics		
	Result	**% of Mean**
Mean	558,309	100.00%
Median	556,696	99.71%
Minimum	484,634	86.80%
Maximum	653,832	117.11%
Deterministic	561,872	100.64%

Percentile		
	Result	**% of Mean**
5th	501,672	89.86%
25th	536,004	96.00%
50th	556,696	99.71%
75th	581,641	104.18%
95th	614,321	110.03%

ERNST & YOUNG

Quality In Everything We Do

Results of Ernst & Young Universal Life Model

Stochastic Interest Results

Universal Life Results - Stochastic Interest								
				Percentile				
	Deterministic	Mean	EaRisk	5th	25th	50th	75th	95th
GAAP Eanings 2002	$ 179,232	$ 179,014	$ 56	$ 178,958	$ 178,996	$ 179,018	$ 179,034	$ 179,077
GAAP Earnings 2002-2005	$ 778,388	$ 777,616	$ 1,362	$ 776,254	$ 777,206	$ 777,605	$ 778,256	$ 779,014
Embedded Value	$ 1,324,758	$ 1,324,485	$ 398,295	$ 926,190	$1,226,844	$1,384,108	$1,463,875	$1,538,830
Embedded Value w/o TS	$ 561,872	$ 561,599	$ 398,295	$ 163,304	$ 463,958	$ 621,222	$ 700,990	$ 775,944

Observations:

- 2002 GAAP earnings at risk is about 0.0% versus the mean results while EV@Risk [TM] is about 30.1%.

- EV@Risk [TM] is 70.9% when calculated without target surplus

ERNST & YOUNG

Quality In Everything We Do

Results of Ernst & Young Universal Life Model

Stochastic Interest Results

Universal Life - Stochastic Interest
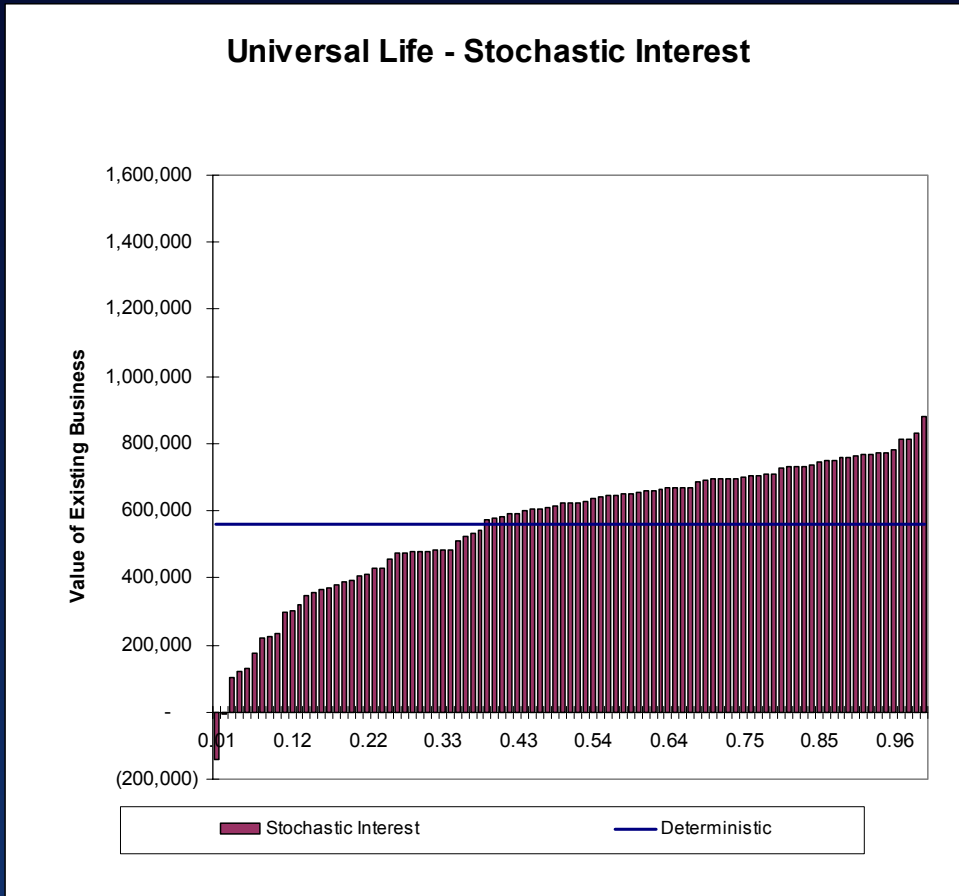
Statistics		
	Result	**% of Mean**
Mean	561,599	100.00%
Median	621,222	110.62%
Minimum	(142,731)	-25.42%
Maximum	879,532	156.61%
Deterministic	561,872	100.05%

Percentile		
	Result	**% of Mean**
5th	163,304	29.08%
25th	463,958	82.61%
50th	621,222	110.62%
75th	700,990	124.82%
95th	775,944	138.17%

ERNST & YOUNG

Quality In Everything We Do

Results of Ernst & Young Universal Life Model

Stochastic Default Results

Universal Life Results - Stochastic Default				Percentile				
	Deterministic	Mean	EaRisk	5th	25th	50th	75th	95th
GAAP Eanings 2002	$ 179,232	$ 178,931	$ 2,349	$ 176,582	$ 177,572	$ 178,645	$ 180,024	$ 182,448
GAAP Earnings 2002-2005	$ 778,388	$ 777,722	$ 9,758	$ 767,964	$ 774,227	$ 777,732	$ 782,375	$ 786,094
Embedded Value	$ 1,324,758	$ 1,320,977	$ 213,532	$1,107,445	$1,234,911	$1,314,282	$1,443,076	$1,554,656
Embedded Value w/o TS	$ 561,872	$ 558,091	$ 213,532	$ 344,560	$ 472,025	$ 551,397	$ 680,191	$ 791,770

Observations:

- 2002 GAAP earnings at risk is about 1.3% versus the mean results while EV@Risk ^{TM} is about 16.2%.

- EV@Risk ^{TM} is 38.3% when calculated without target surplus

ERNST & YOUNG

Quality In Everything We Do

Results of Ernst & Young Universal Life Model

Stochastic Default Results

Universal Life - Stochastic Default
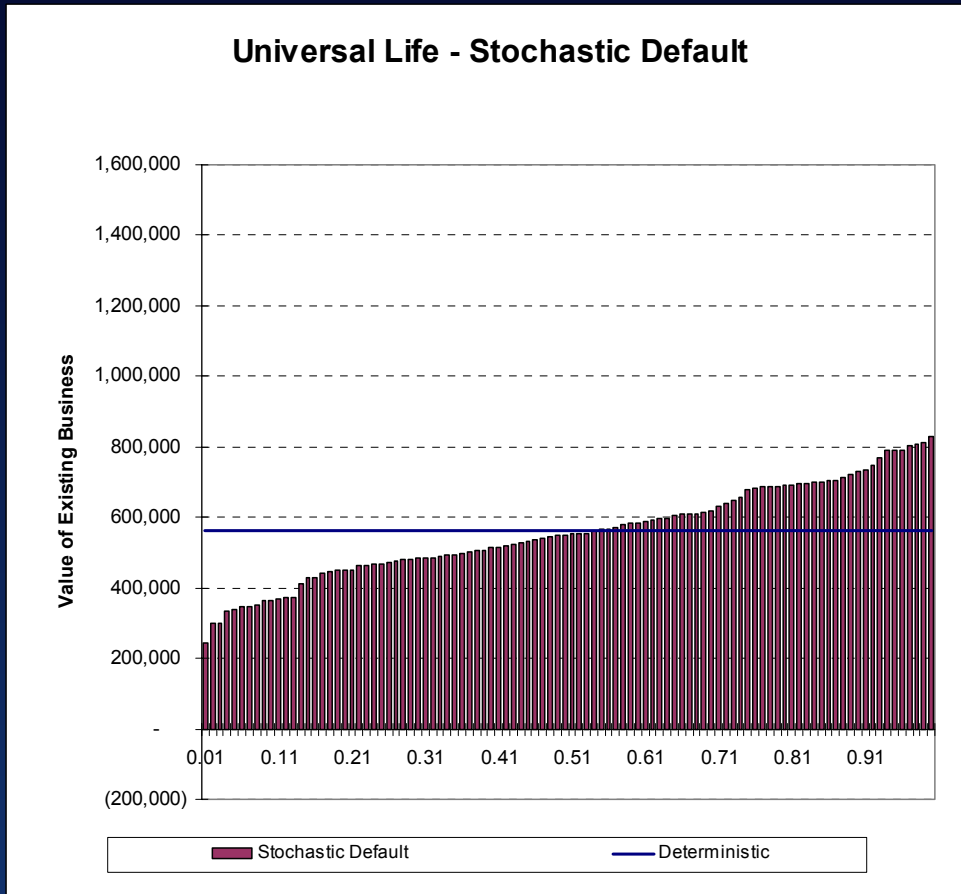
Statistics		
	Result	**% of Mean**
Mean	558,091	100.00%
Median	551,397	98.80%
Minimum	244,159	43.75%
Maximum	828,807	148.51%
Deterministic	561,872	100.68%

Percentile		
	Result	**% of Mean**
5th	344,560	61.74%
25th	472,025	84.58%
50th	551,397	98.80%
75th	680,191	121.88%
95th	791,770	141.87%

ERNST & YOUNG

Quality In Everything We Do

Results of Ernst & Young Universal Life Model

Stochastic All Results

Universal Life Results - Stochastic All				Percentile				
	Deterministic	Mean	EaRisk	5th	25th	50th	75th	95th
GAAP Eanings 2002	$ 179,232	$ 179,116	$ 5,254	$ 173,862	$ 177,220	$ 179,126	$ 180,976	$ 184,316
GAAP Earnings 2002-2005	$ 778,388	$ 778,128	$ 14,723	$ 763,404	$ 772,176	$ 778,936	$ 785,524	$ 788,847
Embedded Value	$ 1,324,758	$ 1,323,899	$ 369,460	$ 954,438	$1,137,281	$1,337,677	$1,514,501	$1,692,022
Embedded Value w/o TS	$ 561,872	$ 561,013	$ 369,460	$ 191,553	$ 374,396	$ 574,791	$ 751,616	$ 929,136

Observations:

- 2002 GAAP earnings at risk is about 2.9% versus the mean results while EV@Risk ^{TM} is about 27.9%.

- EV@Risk ^{TM} is 65.9% when calculated without target surplus

ERNST & YOUNG

Quality In Everything We Do

Results of Ernst & Young Universal Life Model

Stochastic All Results

Universal Life - Stochastic All
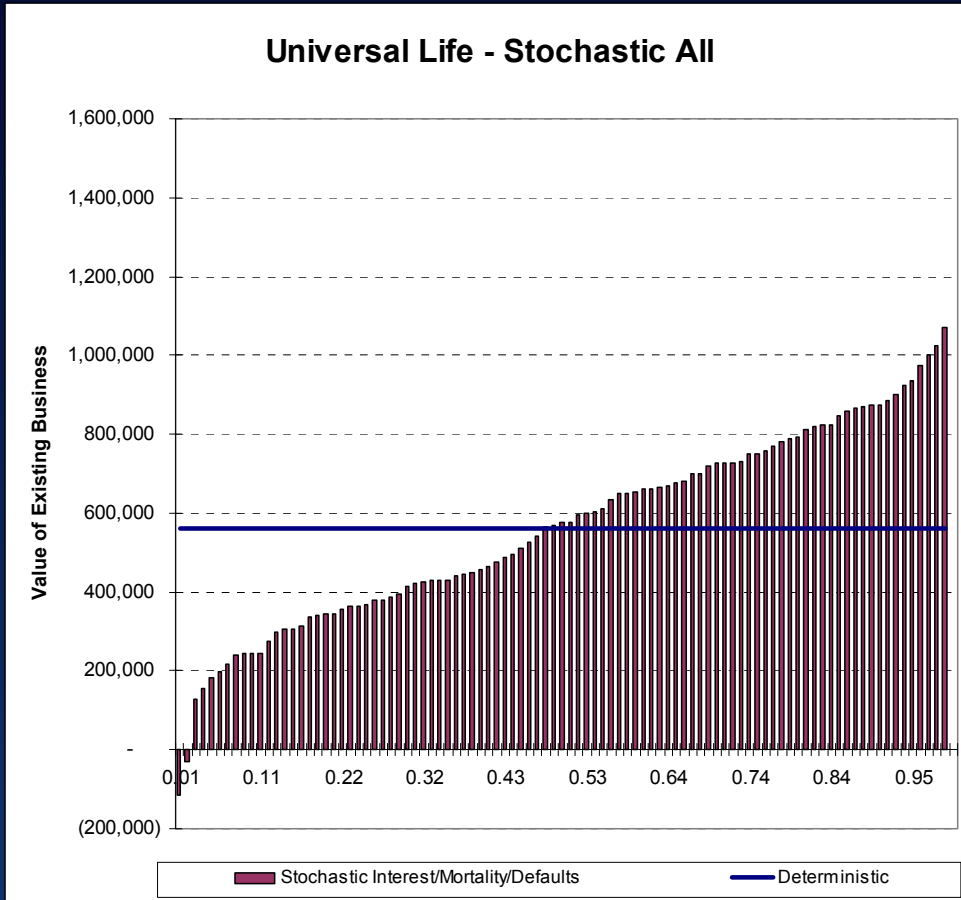
Statistics	Result	% of Mean
Mean	561,013	100.00%
Median	574,791	102.46%
Minimum	(115,201)	-20.53%
Maximum	1,070,196	190.76%
Deterministic	561,872	100.15%

Percentile	Result	% of Mean
5th	191,553	34.14%
25th	374,396	66.74%
50th	574,791	102.46%
75th	751,616	133.97%
95th	929,136	165.62%

Results of Ernst & Young Universal Life Model

Summary of Stochastic Results

2002 Operating Earnings - Universal Life				
Percentile	**All**	**Interest**	**Mortality**	**Defaults**
5th	173,862	178,958	174,652	176,582
25th	177,220	178,996	177,198	177,572
50th	179,126	179,018	178,679	178,645
75th	180,976	179,034	180,672	180,024
95th	184,316	179,077	182,711	182,448
Mean	179,116	179,014	178,764	178,931
EaRisk	5,254	56	4,112	2,349
Correlation	(1,264)			
Deterministic	179,232			

2002 Embedded Value - Universal Life				
Percentile	**All**	**Interest**	**Mortality**	**Defaults**
5th	954,438	926,190	1,264,557	1,107,445
25th	1,137,281	1,226,844	1,298,890	1,234,911
50th	1,337,677	1,384,108	1,319,582	1,314,282
75th	1,514,501	1,463,875	1,344,527	1,443,076
95th	1,692,022	1,538,830	1,377,207	1,554,656
Mean	1,323,899	1,324,485	1,321,195	1,320,977
EVaRisk	369,460	398,295	56,637	213,532
Correlation	(299,004)			
Deterministic	1,324,758			

Recap of Key Learning

- Can be used to create an effective decision support framework
    - Competitive advantage
    - Risk optimization

- Risk measurement and management across risks & product lines is doable

- Profitability and productivity metrics for distribution system

- Facilitate capital allocation

- Segue to IAS accounting and RAROC

ERNST & YOUNG

Quality In Everything We Do