

# Best's Life Settlement Cash Flow Model

**Emmanuel Modu**

**Insurance-Linked Securities**

**July 22, 2010**



# Webinar Outline

- Life settlement basics/risks.
- Purpose of model.
- Model platform/systems requirements/disclaimers.
- Mechanics of Modeling Life Settlement Cash Flows
- Significant data transformations in the modeling process.
- Model imperfections and possible remedies.
- How the model's output can be used in rating securities backed by life settlements.



# Life Settlement Basics

## Definition/Characteristics of Life Settlements

- Definition.
- Life expectancy (LE).
- Age of insureds.



# **Life Settlement Basics**

## **Main Risks To Investors**

- **Origination Risk.**
- **Risk of Systematic Mis-Estimation of Life Expectancies**
- **Longevity Risk**
- **Anti-Selection Risk**
- **Servicer Risk**
- **Credit Risk**



# Life Settlement Basics

## Longevity Risk & Medical Underwriting

- Value of a life settlement is related to medical impairments – all things being equal, the higher the impairments, the more valuable the life settlement.
- Medical underwriters use a numerical system developed by reinsurers to quantify medical impairments.
- The “debit” and “credit” system determines how an insured’s health deviates from standard.
- Example: An insured assigned a debit of 50% means that his/her mortality is 50% above “standard mortality,” i.e., 150% of standard – this factor (150%) is commonly referred to as the mortality multiplier or mortality ratings.
- The system requires that the medical examiner establish a standard mortality table and the mortality multiplier is applied to that mortality table to arrive at the life expectancy of the insured.



# Life Settlement Basics

## Example -- Application of Mortality Ratings To Mortality Table

- Life expectancy based on a mortality rating of 100% applied to 2008 VBT is about 10.7 years for a cohort of 80-year-old male non-smokers;
- Life expectancy for the same cohort based on impaired mortality rating of 200% applied to 2008 VBT is about 7.9 years.

### Cumulative Mortality By Year -- 100% vs. 200% Mortality Rating

Cohort of 80-Year-Old Male Non-Smoker  
Standard Mortality Table is 2008 VBT AL B



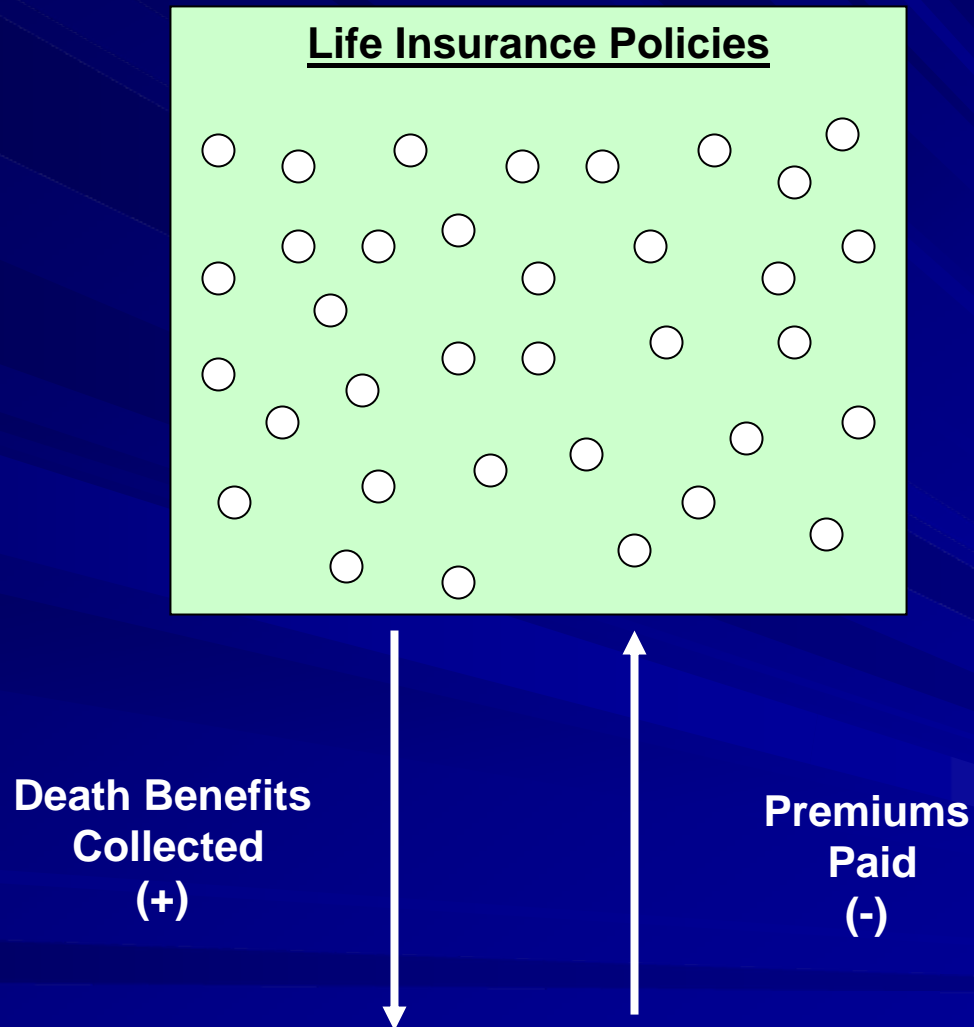
# Purpose of Model

## New Tool for Market Participants

- To give some potential arrangers of life settlement transactions a view to the stochastic nature of their portfolio cash flows.
- We needed a Monte Carlo simulation model to efficiently simulate cash flows over multiple scenarios.
- Excel by itself is inadequate – it is slow and it does not generate good “pseudo” random numbers.

# Purpose of Model

## Stochastic & Expected Cash Flow Generation





# Model Disclaimers / Representations

- Model is being offered to Licensees on an “as-is” basis – no guarantee of quality, accuracy, and performance.
- Licensees can not represent the output of the model as a guarantee of any particular A.M. Best rating, rating action, opinion or assessment for any security which may be backed by life settlements.
- Licensee can not represent that any security backed by life settlements whose cash flows are calculated using the model has been endorsed by A.M. Best.

# Model Platform/Requirements

- Model written in MATLAB® – a matrix-based application by Mathworks, Inc.
- Program is compiled and deployed to the end user.
- User does not need the full version of MATLAB® installed in order to run the compiled “executable”– user just needs to download the run-time compiler, MATLAB® Compiler Runtime(MCR)™, which is available for free.
- User needs the full version of Excel 2007 installed on his or her computer.
- Model is written for the Windows XP environment but may work in the Windows 7 environment depending on the user's configuration.

# Downloading the Model / File Contents

- Model can be downloaded from [www.bestcashflowmodel.com](http://www.bestcashflowmodel.com) – new visitors to the A.M. Best website must register for free.
- File contents:
  - (1) Read\_Me\_First.pdf
  - (2) Instructions.pdf
  - (3) License\_Agreement.pdf
  - (4) MCRInstaller.exe – the MATLAB® Compiler Runtime(MCR)<sup>TM</sup>
  - (5) Best\_Valuation1.exe
  - (6) model\_input.xlsm
  - (7) model\_input\_example.xlsm
  - (8) Frequently\_Asked\_Quesitons.pdf

# Modeling Life Settlement Cash Flows

- Monte Carlo Simulation
- Expected Cash Flow Calculations



# Modeling Life Settlement Cash Flows

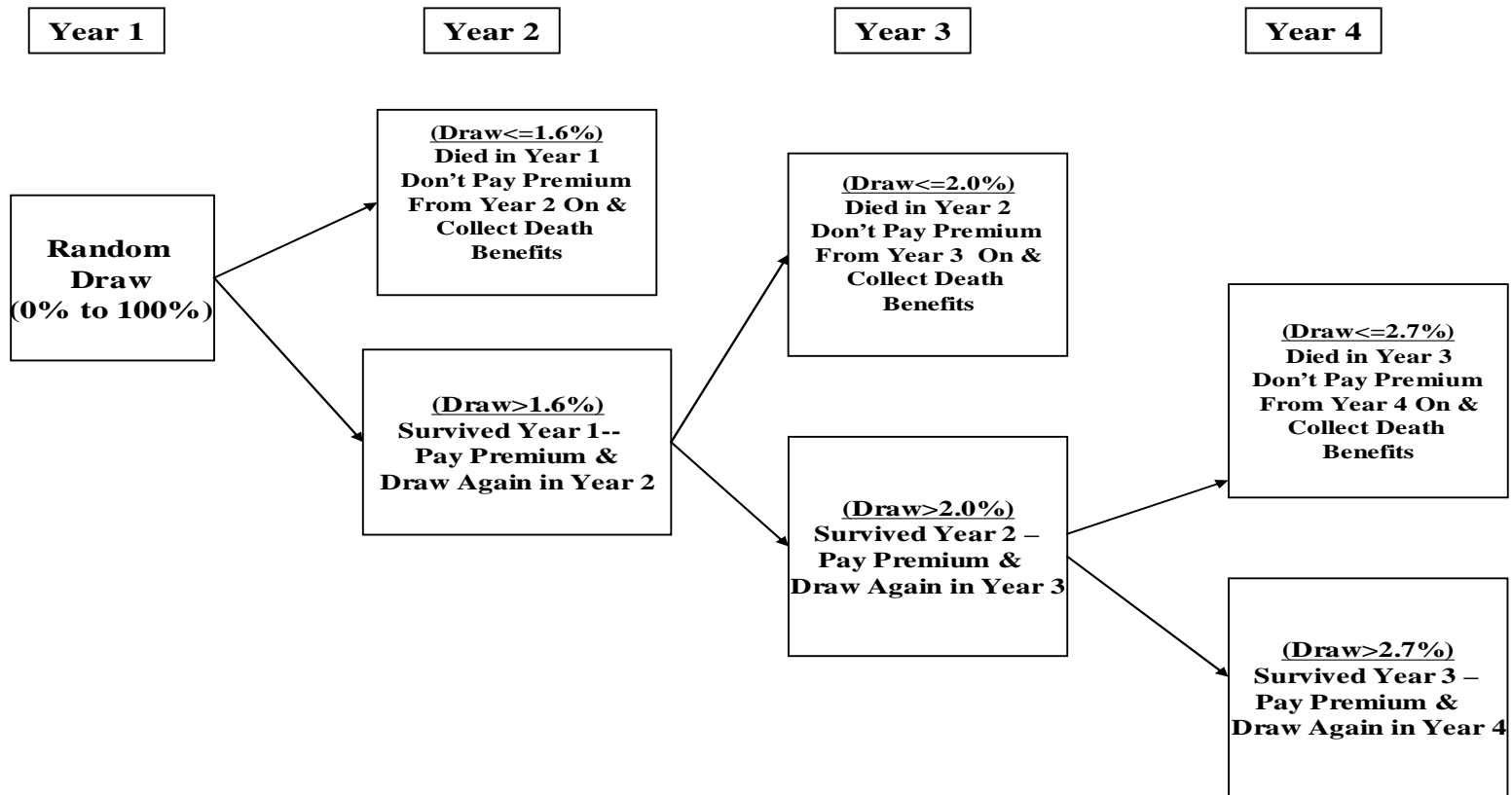
## Monte Carlo Simulation

- A monthly mortality rate vector is assigned to every life in the pool.
- Mortality ratings (provided by medical underwriters) are applied to the monthly mortality rate vector for each life.
- For second-to-die policies, joint monthly mortality rates are derived for all pairs of lives.
- A random number is drawn to determine dead/alive status of each insured.
  - If insured is dead, stop paying premiums (in the subsequent months) and collect death benefits;
  - If insured is alive, pay premiums and draw random number in the next period to determine dead/alive status.



# Modeling Life Settlement Cash Flows

## Monte Carlo Simulation—Diagram



# Modeling Life Settlement Cash Flows

## Expected Cash Flow Calculations

- A monthly mortality rate vector is assigned to every life in the pool.
- Mortality ratings (provided by medical underwriters) are applied to the monthly mortality rate vector for each life.
- For second-to-die policies, joint monthly mortality rates are derived for all pairs of lives.
- The monthly mortality rates are used to calculate fractional mortality each month.
  - each insured is assumed to die fractionally each month until the monthly mortality rate is 100% -- fractional death benefits are collected for each fractional death.
  - fractional premiums are paid for each fractional death benefit of the insured that is still considered “unearned” by the life settlement pool.





# Modeling Life Settlement Cash Flows

## Model Input File Demonstration

INTENTIONALLY BLANK FOR DISPLAY OF MODEL INPUT FILE



# Modeling Life Settlement Cash Flows

## Model Input File Demonstration (“miscinput” worksheet)

- Unique Life Number (column A) – represents a unique life, must be alphanumeric and, preferably, contains no spaces.
- Gender/Smoking Status/Age Last Birthday (column B) – must be in the format FN90, for example; maximum age is 99; minimum age recommended is 40.
- Duration (column C) – the number of whole months that have elapsed between medical underwriting and the time of the valuation of the life settlement pool;
- Mortality Ratings (columns E to RP) – mortality ratings issued by medical underwriters at time of underwriting; mortality ratings can be modified each month if desired – for example, “flat extras” can be handled this way.



# Modeling Life Settlement Cash Flows

## Model Input File Demonstration (“policydata” worksheet)

- Primary Life Number (column A) – must be one of the lives in the “miscinput” worksheet; each row represents a policy.
- Secondary Life Number (column B) – must be either “none” or one of the lives in the “miscinput” worksheet; if “none”, it means that the policy is not a second-to-die policy.
- Monthly Death Benefits (columns C to RN) – the death benefits associated with each policy.
- Monthly Premiums (columns RP to AKA) – the premiums due on the policy; recommend that you do not divide annual premiums by 12 – just enter the premiums in the months in which they are due.



# Modeling Life Settlement Cash Flows

## Model Outputs

- Simulated Death Benefits & Premiums (stochastic)
  - (1) Simulated portfolio death benefits per month
  - (2) Simulated portfolio premium payments per month
- Expected Death Benefits & Premiums (probabilistic)
  - (3) Expected portfolio death benefits per month
  - (4) Expected portfolio premium payments per month
- (5) Monthly mortality rates for each policy (after application of mortality ratings and duration shift).
- (6) Graph of expected death benefits & expected premiums.

# Modeling Life Settlement Cash Flows

## Model Output File Demonstration

INTENTIONALLY BLANK FOR DISPLAY OF MODEL OUTPUT FILE

# Modeling Life Settlement Cash Flows

## Model Output Verification

- If you perform a large number of simulations, the average simulated cash flows should be close to the cumulative expected cash flows; perform the following:
  - Average the monthly simulations in the out file;
  - Sum the monthly expected cash flows;
- The simulation averages should be close to the summation of the expected value of all the policies if:
  - The death benefits in the portfolio are granular – lumpy portfolios require many more simulations.
  - You perform a large number of simulations such as 100,000 simulations – you can combine various simulation runs if you so choose.

# Modeling Life Settlement Cash Flows

## Avoiding Modeling Errors

- Model written for Windows XP but will probably operate under Windows 7 but not Vista.
- Data must be entered only in Excel cells shaded green.
- Make sure that data is rectangular – MATLAB® is a matrix-based language so any data set that is not in true matrix form will throw an error.
- Must install the MATLAB® Compiler Runtime(MCR)™ -- current version is version 7.13; version may change with model updates.
- Unique Life Numbers in “miscinput” worksheet can’t be repeated.
- Primary Life Number or Secondary Life Number in “policydata” worksheet must be in the “miscinput” worksheet; remember that “none” does not have to appear in the “miscinput” worksheet.
- Input file must be properly named – model looks for the file, model\_input.xlsm.
- Excel files must all be closed while trying to run the model – check task manager to make sure all Excel files are closed





# **Significant Data Transformations**

## **Monotonically Increasing Monthly Mortality Rates**

- Yearly mortality rates are transformed to monotonically increasing monthly mortality rates using the cubic spline interpolation method.
- This is different from life settlement industry standard of flat monthly mortality rates in a given calendar year.

# Significant Data Transformations

## Monotonically Increasing Monthly Mortality Rates

### Monthly Mortality Rates 80-Year-Old MNS\*

	Best Model Standard	Industry Standard
Month 1	0.081%	0.103%
Month 2	0.085%	0.103%
Month 3	0.089%	0.103%
Month 4	0.093%	0.103%
Month 5	0.097%	0.103%
Month 6	0.101%	0.103%
Month 7	0.105%	0.103%
Month 8	0.109%	0.103%
Month 9	0.114%	0.103%
Month 10	0.118%	0.103%
Month 11	0.122%	0.103%
Month 12	0.126%	0.103%

\* Annual Rate of 1.233% for the first year. To get our base interpolated mortality rates, use  
24 100% mortality rating with duration 0.





# Significant Data Transformations

## Shifting Monthly Mortalities Based on “Duration”

Monthly Mortality Rates 80-Year-Old MNS -- Example: Duration of 6 Months

	Mortality Rates (Before Duration)*	Mortality Rates (After Duration)
Month 1	0.081%	0.105%
Month 2	0.085%	0.109%
Month 3	0.089%	0.114%
Month 4	0.093%	0.118%
Month 5	0.097%	0.122%
Month 6	0.101%	0.126%
Month 7	0.105%	0.131%
Month 8	0.109%	0.135%
Month 9	0.114%	0.140%
Month 10	0.118%	0.144%
Month 11	0.122%	0.149%
Month 12	0.126%	0.153%

\* Annual Rate of 1.233% for the first year.

# Significant Data Transformations

## Proper Application of Mortality Ratings (MR) vs. Industry Application

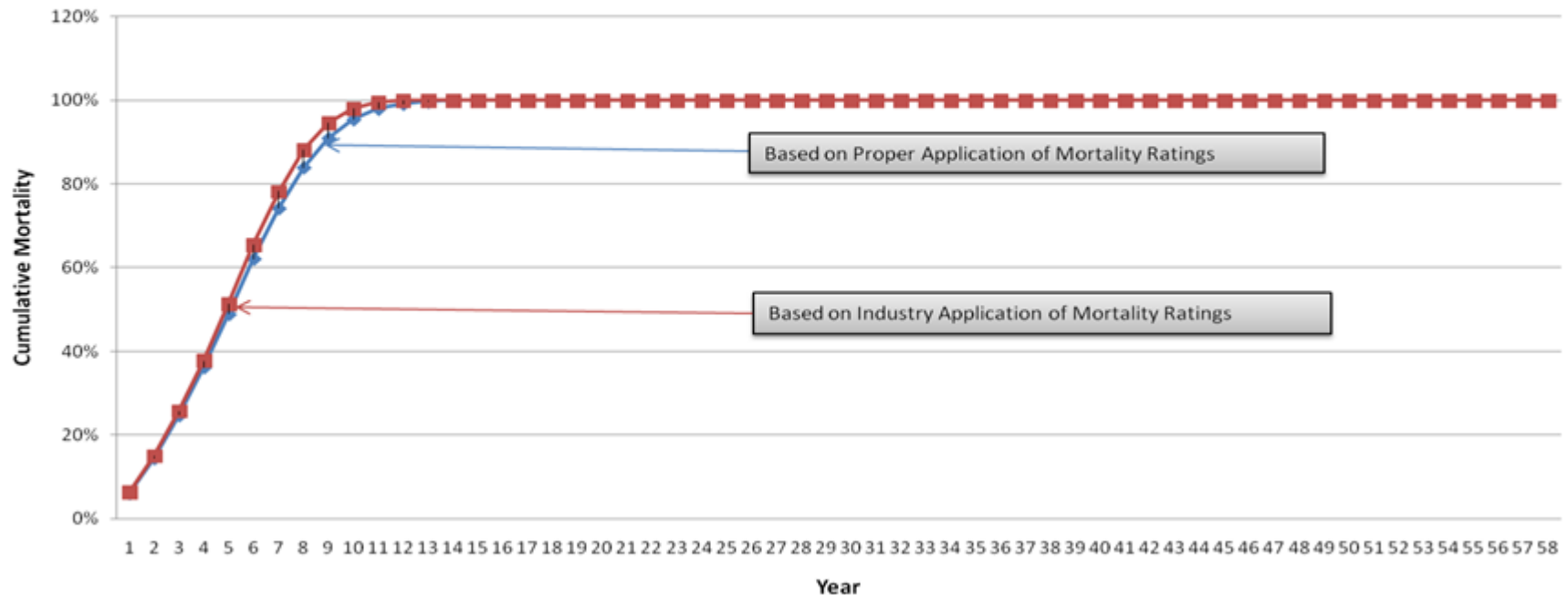
- Industry Application: minimum of a) 100% or, b)  $q_x * MR$  .
- Proper Application:  $1 - (1 - q_x)^{MR}$  .
- Difference is insignificant for low mortality ratings but increases for very high mortality ratings.

### Cumulative Mortality By Year -- 500% Mortality Rating

Proper Application of Mortality Ratings vs. Industry Standard

Cohort of 80-Year-Old Male Non-Smoker

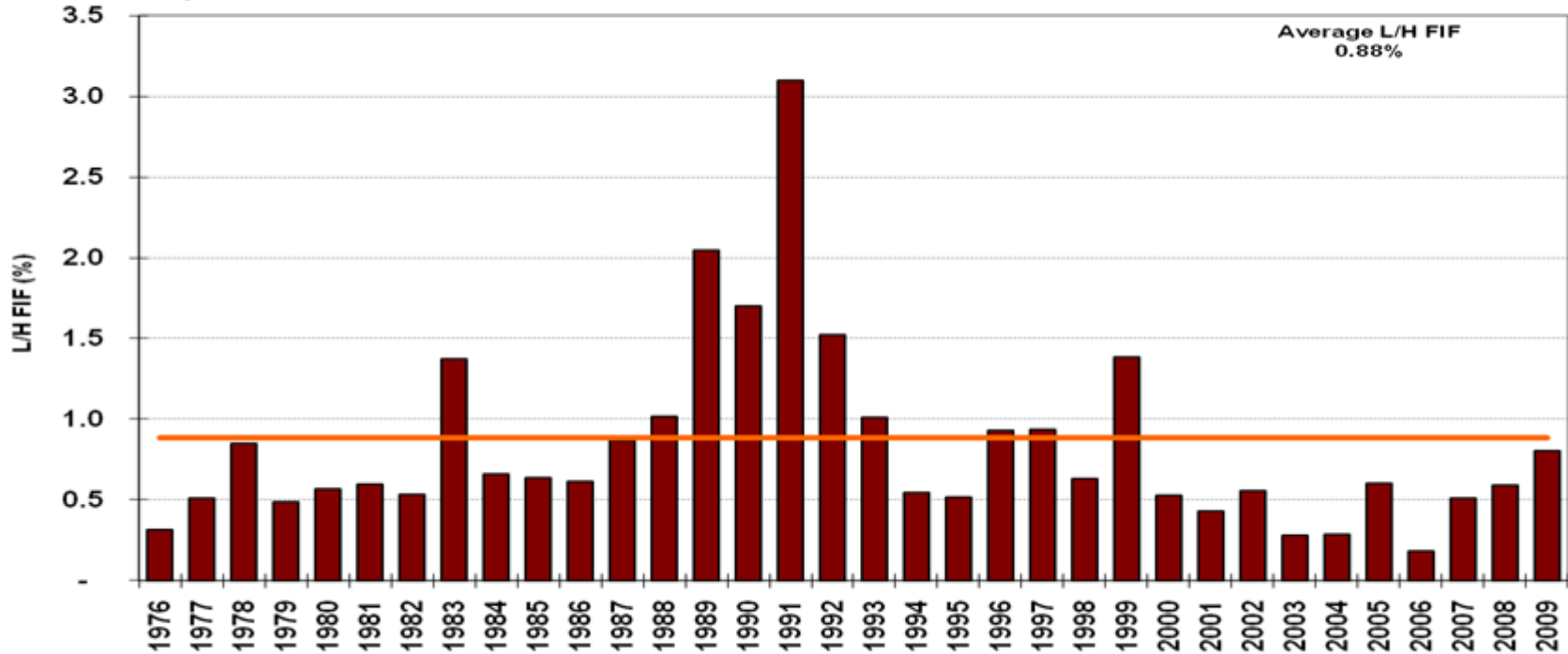
Standard Mortality Table is 2008 VBT AL B



# Modeling Imperfections

## Carrier Impairments -- A.M. Best's Impairment Study

Exhibit 2  
L/H Financial Impairment Frequency (FIF)  
(1976-2009)



Source: A.M. Best

Long-Term Industry Impairment Rate for 2009 was 0.81%

# Modeling Imperfections

## Best's Idealized Default Rate of Insurers (Cumulative)

	aaa	aa+	aa	aa-	a+	a	a-	bbb+	bbb	bbb-
1	0.03%	0.06%	0.11%	0.16%	0.21%	0.23%	0.27%	0.67%	1.20%	2.30%
2	0.11%	0.32%	0.44%	0.56%	0.67%	0.74%	0.89%	1.96%	3.26%	5.28%
3	0.20%	0.58%	0.76%	0.95%	1.13%	1.25%	1.51%	3.18%	2.91%	8.10%
10	1.36%	2.48%	3.03%	3.58%	4.13%	4.58%	5.76%	10.18%	16.67%	23.95%
15	2.53%	3.94%	4.65%	5.36%	6.06%	6.64%	8.34%	13.57%	22.43%	31.59%
	aaa	aa+	aa	aa-	a+	a	a-	bbb+	bbb	bbb-

15-year Cumulative  
Default Rate for a  
“bb+” rated insurer is  
nearly 50%



# Model Imperfections

## Data Requirements from Medical Underwriters for Proper Analysis

- Medical examiners typically provide insufficient data for insureds: a mortality multiplier and a life expectancy.
- For proper analysis, one needs another piece of information: the standard mortality table used by the medical examiner.
- Without the standard mortality table, an investor does not know the “shape” of the mortality curve upon which the life expectancy is based since an infinite number of mortality curves can produce the same life expectancy.
- Life settlement market participants assume that most medical underwriters currently use some version of the 2008 VBT.



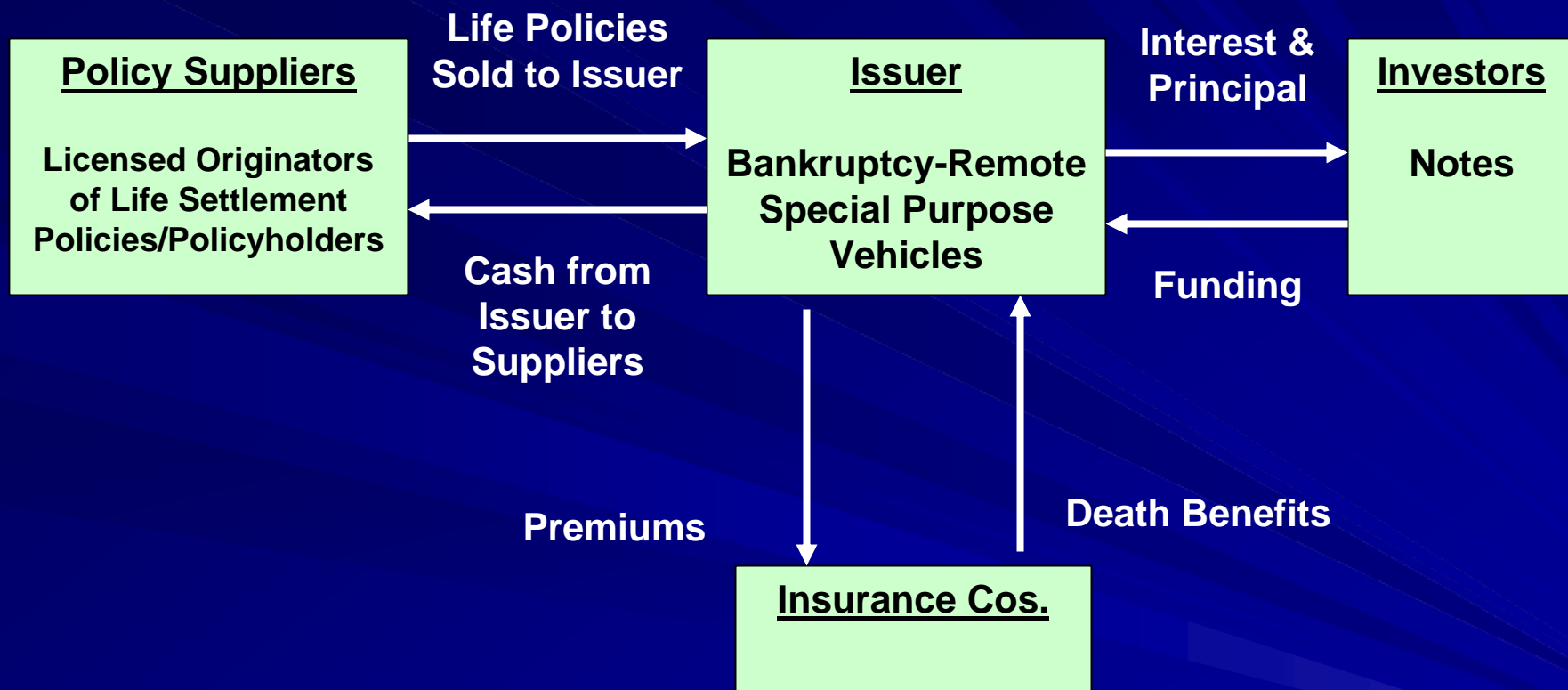
# Modeling Imperfections

## Other Imperfections

- Assumes medical impairments are accurately determined by medical underwriters.
- Mortality improvements not included – can adjust mortality rates through the mortality ratings to reflect mortality improvements.
- Does not include lags between time of death and actual death benefit collection – can shift the cash flows by the number of months of lag desired.
- Assumes no rescissions.
- Does not include self-selection attenuation factors – can adjust mortality ratings to reflect desired self-selection factor.

# How the Model's Output is Used in a Securitization

## Cash Flows To Investors in a Securitization





# How the Model's Output is Used in a Securitization Calculation of Default Probability

- Thousands of Monte Carlo simulations are performed to determine death benefit cash inflows, premium cash outflows, and other cash outflows associated with the transaction's waterfall.
- Probability of ruin (default probability) is calculated – i.e. probability that securities do not receive promised payments during the term of the transaction and at the maturity of the transaction.
  - Default Probability =  
$$\frac{\text{(\#of times noteholders did not get paid fully)}}{\text{( \# of simulations)}}$$



# How the Model's Output is Used in a Securitization Calculation of Default Probability (cont'd)

## A.M. Best's Idealized Default Table

Years	aaa	aa+	aa	aa-	a+	a	a-	bbb+	bbb	bbb-
1	0.026%	0.034%	0.043%	0.053%	0.064%	0.113%	0.162%	0.212%	0.231%	0.270%
2	0.076%	0.105%	0.135%	0.227%	0.318%	0.437%	0.556%	0.674%	0.736%	0.888%
3	0.142%	0.199%	0.257%	0.417%	0.576%	0.761%	0.945%	1.130%	1.252%	1.509%
4	0.221%	0.315%	0.408%	0.623%	0.838%	1.085%	1.332%	1.579%	1.758%	2.131%
5	0.314%	0.449%	0.585%	0.844%	1.103%	1.409%	1.715%	2.021%	2.253%	2.752%
6	0.419%	0.602%	0.786%	1.078%	1.371%	1.733%	2.094%	2.456%	2.738%	3.369%
7	0.534%	0.772%	1.009%	1.326%	1.643%	2.057%	2.470%	2.884%	3.213%	3.981%
8	0.660%	0.956%	1.251%	1.585%	1.918%	2.380%	2.843%	3.306%	3.677%	4.585%
9	0.795%	1.154%	1.512%	1.854%	2.196%	2.704%	3.212%	3.720%	4.131%	5.179%
10	0.937%	1.363%	1.789%	2.134%	2.479%	3.028%	3.578%	4.128%	4.575%	5.762%
11	1.087%	1.583%	2.079%	2.422%	2.764%	3.352%	3.941%	4.529%	5.009%	6.331%
12	1.242%	1.812%	2.381%	2.717%	3.053%	3.676%	4.299%	4.923%	5.432%	6.884%
13	1.402%	2.048%	2.693%	3.019%	3.345%	4.000%	4.655%	5.310%	5.845%	7.419%
14	1.566%	2.289%	3.012%	3.327%	3.641%	4.324%	5.007%	5.690%	6.247%	7.935%
15	1.733%	2.535%	3.337%	3.639%	3.941%	4.648%	5.356%	6.063%	6.639%	8.428%
	aaa	aa+	aa	aa-	a+	a	a-	bbb+	bbb	bbb-

Source: A.M. Best's Idealized Default Matrix, December 5, 2007



**Questions About Best's Life Settlement  
Cash Flow Model Can Be Sent To:  
[BLSmodel@ambest.com](mailto:BLSmodel@ambest.com)**



**Emmanuel Modu  
Managing Director &  
Global Head of Insurance-Linked  
Securities**

**+1-908-439-2200 x5356  
emmanuel.modu@ambest.com**

**A.M. Best's methodology, *Life Settlement Securitization*, published on November 24, 2009 can be downloaded from:  
<http://www.ambest.com/ratings/methodology.html>**

