The Effect of Life Settlement Portfolio Size on Longevity Risk

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This paper reports statistical research of the effect portfolio size has on investment returns resulting from the risk that insured live longer than their estimated life expectancies.

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Introduction

In recent years, life settlements have emerged as a growing alternative investment class for institutional investors because they offer returns which are "non-correlated" with external market influences. However, institutional investors aggregating and owning portfolios of life settlements require knowledge and understanding of longevity risk, the primary risk in a life settlement transaction. Accordingly, various management techniques and tools have evolved for managing longevity risk including: mortality indices, hedges, swaps, insurance guarantees and portfolio structuring. The purpose of this study is to analyze longevity risk in conjunction with the relative size of the life settlement portfolio. The issue is how longevity risk affects a portfolio with a small number of insured versus a large number of insured, and how many insured are required to achieve a normalized risk of longevity. This research report uses statistical analysis to explain the magnitude of the affect sample size has on the longevity risk and investor return for a portfolio of life settlements. This report seeks to demonstrate the minimum portfolio size of insured lives required to achieve a predictable variance of longevity risk while concurrently maintaining a stable investment return.

Risk and Return

It is universally accepted that investors require higher rates of return on investments as their perception of risk and uncertainty increase. The uncertainty of an expected rate of return is a "risk" for which investors seek higher investment returns. Generally, an investment asset consists of two types of risk: fundamental risk and systematic or market risk. Fundamental risk is the risk associated with an individual asset, such as liquidity or the threat of insolvency. Systematic or market risk refers to the movements of the whole economy, i.e., the volatility of return for an asset relative to the returns of other assets held for investment.[1] Portfolio theory suggests that by combining individual assets in a portfolio, fundamental risk can be mitigated, or even eliminated through diversification while the market risk cannot.

[1] Reilly, F.K. and Brown, K.C. (2006). Investment Analysis and Portfolio Management, 8th ed., Thompson/South-Western. Mason, OH.

Portfolio Investment Management

Correlation is a measure of the degree to which two variables are positively or inversely related; and it is one of the most common measures used by investors to create a diversified portfolio with diversified returns. Individual stocks differ in the extent to which their returns correlate with other market factors. For example, a stock that performs well during periods of poor economic conditions would have a low correlation with a stock that performs poorly during this same time period. Combining two such stocks reduces the volatility of the portfolio's returns and creates smoother period to period returns. Assembling a portfolio of stocks with low correlations reduces the variability, and thus, the risk, of the portfolio. Aggregating large pools of assets to maximize investor returns is the objective of portfolio management.

As the capital markets become more developed and efficient, the struggle for portfolio managers to find assets that have low correlations has become increasingly difficult. Thus, the non-correlation attribute of a life settlement portfolio is an attractive feature for portfolio managers. Like a portfolio of stocks, a portfolio of life settlements carries risk. However, unlike a stock portfolio, a portfolio of life settlements carries no systematic risk (risk related to movements of the economy) and provides non-correlated return diversification. The performance of life insurance policies are tied only to mortality and are therefore independent of the factors contributing to economic downturns, such as interest rate fluctuations, commodity prices, and other economic change.[2] (The exception to this would be those who engage in trading portfolios of life settlements where capital market yield requirements can affect the market value of a life settlement portfolio.)

While a life settlements portfolio avoids systematic risk, it is not risk free. The fundamental risks associated with a life settlements portfolio are longevity risk and underwriter risk. Longevity risk is the variance between actual mortality versus expected mortality, resulting from the insured's health management, medical advances and good fortune. Through aggregating life settlements into a portfolio, the impact of longevity risk can be better understood, managed and hedged, and thus, reduced. Medical underwriter risk is the risk that the underwriter accurately estimates the life expectancy ("LE") of the insured. A flawed methodology used by the medical underwriter in either (i) how the mortality tables were constructed, or (ii) how the mortality tables were applied to derive a life expectancy estimate cannot be eliminated by combining a pool of life settlements. In the event of underwriter risk, the systematic error becomes replicated across the entire portfolio regardless of its size. Thus, the affect of longevity risk can be reduced with portfolio management practices, but underwriter risk cannot be reduced other than by structuring a balanced diversity of LE underwriters for each insured and/or for all insured in a portfolio. This paper does not focus on the affect of LE underwriter diversity, the techniques for building diversity of LE underwriters into

[2] Conning Research and Consulting, Inc. (2007). Life Settlement Market, *Increasing Capital and Investor Demand*.

a portfolio, or how to identify and evaluate the methodologies and performances of respective LE underwriters.

The value of a life settlement is substantially based on the LE of the insured, which in turn is based on the age and health condition of the insured. Simply stated, the valuation of a life settlement is a function of the discounted premiums and servicing costs over the life expectancy of the insured, including the policy death benefit received. The discount rate utilized in such valuation becomes the investor's internal rate of return on the life settlement. Accordingly, shorter LEs support higher policy valuations and longer LEs support lower policy valuations. If a person lives longer than the expected LE, the continuing premiums required to maintain the policy and the delayed receipt of the death benefit cause a decrease in the investor's investment yield as compared to the expected rate of return at the time the policy was purchased. It is the deviation between the expected and actual mortality that can greatly affect the return on a life settlement policy; the greater the potential deviation the greater the risk. Understanding and planning the distribution of such deviations enables the portfolio management of longevity risk.

Portfolio Risk Management

One of the most commonly used measures of risk distribution is the variance, or standard deviation of expected returns. The standard deviation is a statistical measure of the dispersion of actual values around an expected value, or mean. A larger variance, or standard deviation, indicates a greater dispersion. In terms of investment returns, the more disperse the target returns, the greater the uncertainty of realized returns. As the number of randomly selected securities having otherwise consistent relationships in a portfolio increases, the standard deviation will decline due to normalization of the portfolio diversity.[3] This management technique is accomplished in life settlement portfolios by increasing the number of insured lives.

Statistical theory states that the distribution of a large number of independent observations will mirror the distribution of the population. Furthermore, the normality of distribution steadily increases as the number of observations increases if the samples are drawn from a normal population. Applying this theorem to life settlements concludes that the distribution of life expectancies randomly drawn from a large sample will emulate the population distribution. This allows for the use of probability calculations in the mortality estimations, and consequently the valuation of a life settlement portfolio.

This conclusion means that the mortality estimations and valuation of a portfolio become increasingly more accurate and reliable as more insured are added to a portfolio. This result is driven by the fact that as the number of insured who live longer than their estimated LEs will be

[3] Reilly, F.K. and Brown, K.C. (2006). Investment Analysis and Portfolio Management, 8th ed., Thompson/South-Western. Mason, OH.

offset by the number of insured who live shorter. Ultimately, these two groups cancel each other out and the expected return on investment becomes more certain. Thus, as a portfolio grows in number of insured lives, the standard deviations of the estimated LE's and the individual policy returns decrease.

Longevity Risk Management

Longevity risk as defined above is the risk of the insured living longer than the estimated LE. Because longevity risk is the single largest variable affecting the return on an investment in a life settlement, the objective of this study is to identify the minimum number of insured lives a life settlement portfolio requires to achieve longevity risk stability. Stability as defined in this study means consistent and reasonably predictable standard deviations. As previously discussed, the ability to accurately predict the longevity risk and the return on investment of a life settlement portfolio increases with normalization of the standard deviations for the estimated LE's. The LE is developed by a medical underwriter and is used to estimate the probable mortality of an individual. The LE estimate is not an exact time period. It is typically stated as the point at which 50% of the cohort population should have died, also meaning that the other 50% should then be living. The insured will most likely live longer or shorter than the LE estimate. This divergence causes deviations in the return of a policy and is why a life settlement portfolio is created, i.e., the idea being that each insured that lives longer than their estimated LE will be offset by another insured that lives shorter than their estimated LE.

A portfolio with fewer insured lives is more vulnerable to longevity risk than a portfolio with a greater number of insured lives. This is because the smaller the number of insured lives, the greater the influence of an individual's longevity on the return of the portfolio. The attempt of this study is to identify the minimum number of lives required in a portfolio to achieve normalization of the standard deviations for the estimated LE's.

Testing Methodology

A data set of life settlement policies was obtained from which to extract testing samples. The data set included over 2,000 insured with ages ranging from 65 to 95 and estimated LEs ranging from 64 to 96 months. The policy face values ranged from $70,000 to $10,000,000. A simple model was constructed to test the difference in deviation of LEs amongst different sized random sample distributions.

The objective of this model is to identify the number of polices required by a portfolio to reach stability in standard deviations. This research uses basic statistical analysis to demonstrate that the stability of a portfolio increases as the number of insured increases. Stability as used in this study means consistent and statistically predictable standard deviations.

While this research attempts to analyze the stability of a portfolio as the number of insured increases, it does not attempt to reach a definitive conclusion on the level of stability for a portfolio. This is because stability is subjective and different investors have different risk and investment profiles. However this study does demonstrate that the distribution of the sample converges to the distribution of the population as the size of the distributions increases.

Testing Results

The first analysis examines the affect extended longevity has on a portfolio. The two portfolios in this test have sample sizes of 100 and 300 randomly chosen insured. For each portfolio the LE of a select number of insured has been extended by increments of 10, 20, 30, 50, and 100 percent. Table 1 (page 7) illustrates the affect this has on the average LE, standard deviation and an internal rate of return (IRR) measure. This analysis quantifies the absolute change and the percent change caused by extending the LEs. These results demonstrate that extended longevity has a greater impact on a smaller portfolio. For example, by extending the LE of 50 of the insured in both the portfolios in Table 1 (page 7) by 10%, the standard deviation for the portfolio of 100 increases by 36.51% while the portfolio of 300 only increases by 17.97%.

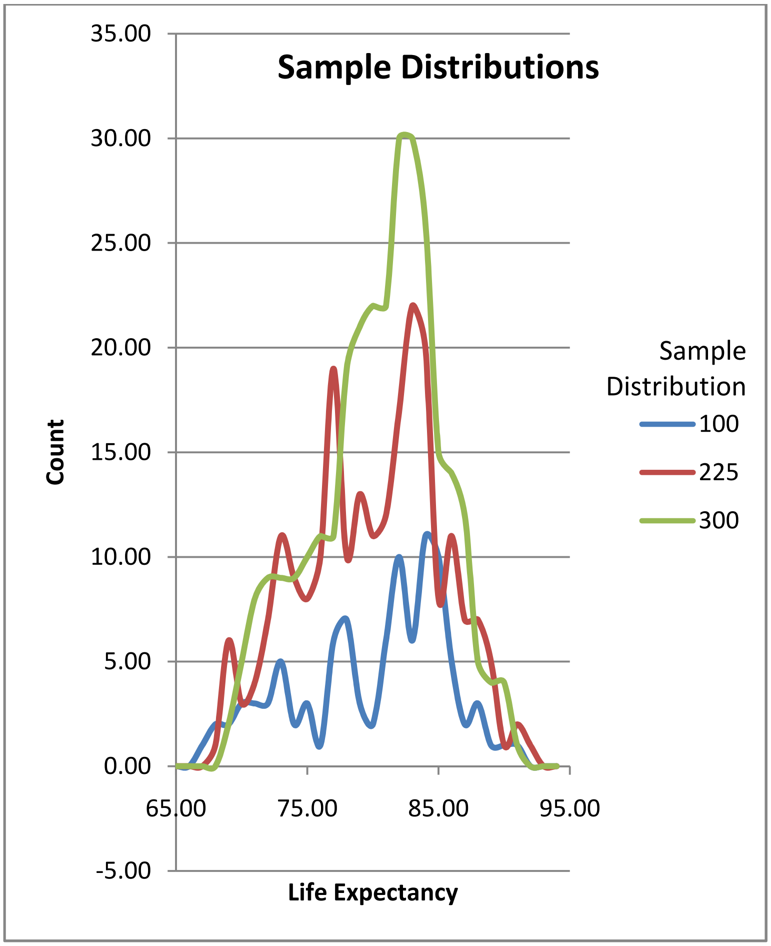
A test also examines the relationship between IRR and extended longevity. This portion of the model makes the assumption that all insured are weighted equally in terms of face value and there is a linear relationship between IRR and LE extension. This assumes that if the LE of the insured is extended by 10% the IRR for that individual insured policy will decrease by 10%. In practice, the IRR does not move with same magnitude as the LE. However, the change in the IRR is an approximation of the LE. The IRR represented in the table represents the average of the portfolio. Like the average LE and standard deviation, the IRR for the smaller portfolio is affected to a greater degree than the large portfolio. This demonstrates that a portfolio with fewer insured lives is more vulnerable to longevity risk.

Table 1

LE Extension	100 Insured			300 Insured		
	Avg. LE	St Dev	IRR	Avg. LE	St Dev	IRR
Original	79.97	5.59	10.05%	79.97	5.24	10.04%
Δ10	80.78	6.25	9.96%	80.23	5.36	10.01%
Δ20	81.53	7.01	9.88%	80.51	5.66	9.98%
Δ30	82.33	7.31	9.79%	80.77	5.84	9.95%
Δ50	83.86	7.63	9.62%	81.31	6.18	9.89%
Δ100	87.97	6.15	9.14%	82.64	6.65	9.74%
	Percentage Change					
Δ10	1.01%	11.78%	-0.90%	0.33%	2.29%	-0.31%
Δ20	1.95%	25.40%	-1.69%	0.67%	8.13%	-0.60%
Δ30	2.95%	30.64%	-2.59%	1.00%	11.56%	-0.90%
Δ50	4.86%	36.51%	-4.31%	1.67%	17.97%	-1.51%
Δ100	10.00%	10.00%	-9.09%	3.34%	26.98%	-3.03%

To test the relationship between sample size and normality, a simple test was created by randomly selecting three distributions of LE's for pools of: 100, 225, and 300 insured. The purpose of this test is to show that the greater the number of insured, the greater the predictability of the LE distribution for the portfolio. This is illustrated in Exhibit 1 (page 8). As the graph shows, the distribution for 300 random insured has greater predictability than the random distributions of fewer insured. While this test doesn't prove or disprove stability of a portfolio, it does demonstrate that a portfolio with a greater number of insured is a more efficient estimator of the true mean.

Exhibit 1



To further test the relationship between sample size and normality, additional independent random sample distributions were drawn from the data set. The size of the sampling distributions tested ranged from 100 to 400 cases, each case being a unique insured. The sample sets and results are presented in Table 2 (page 9). For each sample size, 100 random sample distributions were created. For example, 100 sample distributions were created with a sample size of 100, and 100 sample distributions were created with a sample size of 150. This was repeated for every sample distribution size listed in Table 2 (page 9).

Table 2

One-Sample Statistics	N	Mean LE	Avg. Standard Deviation	Std. Error Mean	95% Confidence Interval Lower	Upper	CI Range
100 Cases	100	79.03	5.23	0.52	78.00	80.07	2.08
150 Cases	150	79.85	5.25	0.43	79.01	80.70	1.68
200 Cases	200	79.99	5.27	0.37	79.25	80.72	1.47
225 Cases	225	79.97	5.26	0.35	79.27	80.66	1.38
250 Cases	250	80.30	5.25	0.33	79.64	80.95	1.31
275 Cases	275	80.14	5.26	0.32	79.51	80.76	1.25
300 Cases	300	79.59	5.21	0.30	78.99	80.18	1.18
325 Cases	325	79.97	5.30	0.29	79.39	80.55	1.16
350 Cases	350	80.04	5.22	0.28	79.49	80.59	1.10
375 Cases	375	79.72	5.25	0.27	79.18	80.25	1.07
400 Cases	400	79.97	5.29	0.26	79.45	80.49	1.04

The average LE and the average standard deviation (both measured in months) of the sample distributions remained relatively constant regardless of sample size. However, the standard error of the mean and the range in confidence levels improved as the sample size increased. The range of the 95% confidence interval reduced to 1.04 months for 400 insured compared to 2.08 for 100 insured. This suggests that the confidence in the expected results of a portfolio increases as the sample size increases.

However, it may appear that the output of these results is in conflict with each other. The 95% confidence interval shows evidence of increased stability while the standard deviation measure shows evidence that there is no improvement with increased sample size. The conflicting results are caused by mean reversion, which is a limitation of stochastic modeling. Mean reversion is a tendency for a stochastic process to remain near, or tend to return over time in a long-run, to an average value.[4] Because the output of each portfolio size is the average of 100 sample distributions the results are normalized (homoskedastic), i.e., the average standard deviation does not reveal the whole story behind the dispersion of different sized portfolio distributions.

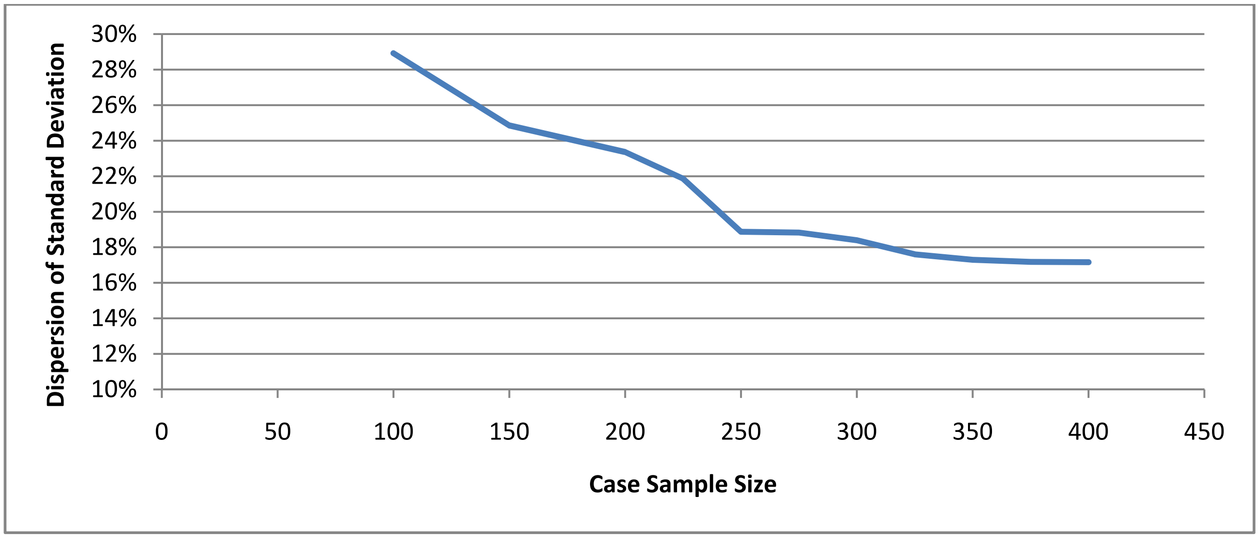
[4] Mean Reversion. Available at: http://www.riskglossary.com/link/mean_reversion.htm. Retrieved on July 15, 2007.

To compensate for these results and to better identify stability indications, the dispersion of the standard deviations for the different sample sizes was analyzed. Basically, the dispersion of the standard deviations is the standard deviation of the standard deviations. Table 3 below shows the dispersion of the standard deviations for the different sample sizes. This data set reveals the level of dispersion for the different sample distributions. When the sample size increases the dispersion of the standard deviation steadily decreases. The graph in Exhibit 2 below illustrates a visual representation for the dispersion of the standard deviations.

Table 3

	Distributions Samples	Average Standard Deviation	Dispersion of Standard Deviations
100 Cases	100	5.23	28.92%
150 Cases	100	5.25	24.85%
200 Cases	100	5.27	23.36%
225 Cases	100	5.26	21.86%
250 Cases	100	5.25	18.87%
275 Cases	100	5.26	18.82%
300 Cases	100	5.22	18.39%
325 Cases	100	5.30	17.60%
350 Cases	100	5.25	17.29%
375 Cases	100	5.25	17.17%
400 Cases	100	5.25	17.16%

Exhibit 2



Conclusion of Test Results

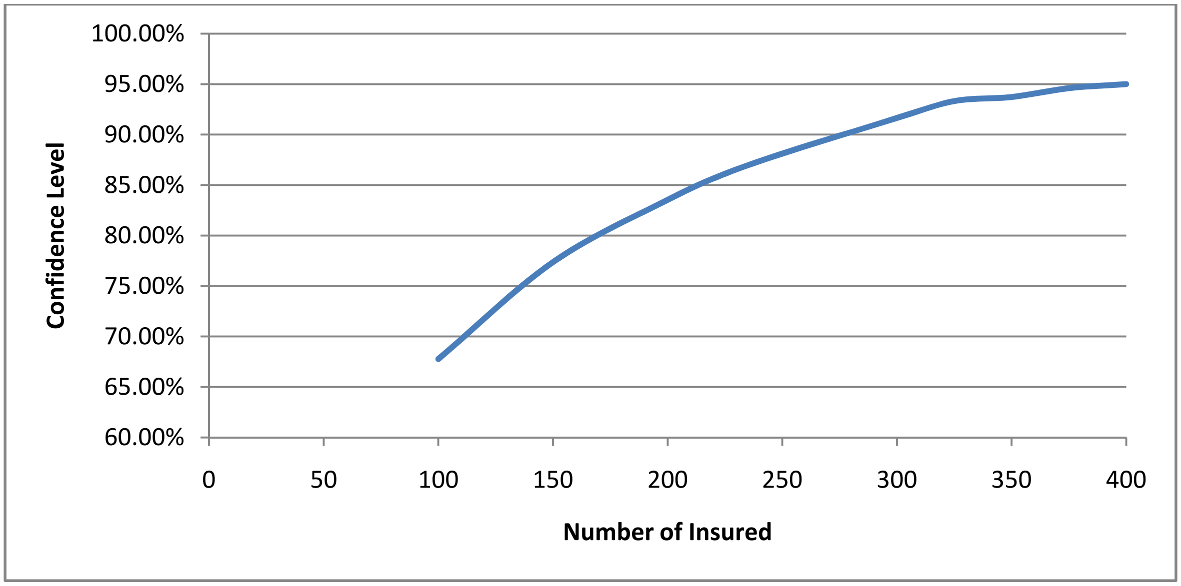
With the identification of a decreasing dispersion of the standard deviation as the portfolio size increases, the question remains, "What constitutes a significant change in the dispersion of the standard deviations to obtain stability?" Obviously, the more lives in a portfolio translates into reduced longevity risk, but investors must also balance the marginal benefit gained by increasing the number of lives in a portfolio with the costs required to do so. Based on the dispersion of the standard deviations it appears that a portfolio begins to stabilize at around 300 insured lives. For purposes of obtaining optimal stability at 300 insured lives, the incremental benefit of achieving further reduction of longevity risk by adding additional lives may not exceed the costs of accumulating a larger portfolio. Ultimately, this is a question of how much risk the investor wants to assume and how large a portfolio is designed to provide the investor an adequate return on investment.

Another way to answer questions about the variations in stability is to look at the spread of confidence intervals. Looking back at Table 2, the 95% confidence interval range for 400 cases had a spread of 1.04 months. Table 4 below illustrates the confidence for the smaller sample distributions using the same range of 1.04 months. For the 400 case distribution sample, the true population mean falls within the 1.04 month LE range 95% of the time. For the 100 case distribution sample, this occurs only 68% of the time. Thus, the confidence in a portfolio of 400 cases is 1.4 times greater than a portfolio with only 100 cases. At a 300 case distribution sample, we achieve the cross-over point whereby the confidence of the interval range surpasses 90% confidence. These data points are graphed in Exhibit 3 (page 12).

Table 4

One-Sample Statistics	N	Mean LE	CI Range	Interval Range Lower	Interval Range Upper	Confidence In Range
100 Cases	100	79.03	1.04	78.51	79.55	67.78%
150 Cases	150	79.85	1.04	79.33	80.37	77.38%
200 Cases	200	79.99	1.04	79.47	80.51	83.54%
225 Cases	225	79.97	1.04	79.45	80.49	86.12%
250 Cases	250	80.30	1.04	79.78	80.82	88.12%
275 Cases	275	80.14	1.04	79.62	80.66	89.90%
300 Cases	300	79.59	1.04	79.07	80.11	91.64%
325 Cases	325	79.97	1.04	79.45	80.49	93.32%
350 Cases	350	80.04	1.04	79.52	80.56	93.72%
375 Cases	375	79.72	1.04	79.20	80.24	94.60%
400 Cases	400	79.97	1.04	79.45	80.49	95.00%

Exhibit 3



Similar Studies

A.M. Best recently published a similar study to show the portfolio valuation, expressed as a percentage of total death benefits of a portfolio, for 100, 200, 300, and 400 lives. In the A.M. Best report, each tested portfolio had an average LE of 9.6 years. The study showed that the expected portfolio valuation of each portfolio, expressed as the percentage of total death benefits of each portfolio, was about 19%. The standard deviations of the portfolios' valuation, in terms of percent of the total death benefits were as follows: 3.8% for 100 lives, 2.7% for 200 lives, 2.2% for 300 lives, and 1.9% for 400 lives. A.M. Best concluded that a portfolio of life settlements should consist of at least 300 lives in order to evaluate the credit quality of a life settlement securitization.[5]

A presentation by a leading investment bank at the Institute for International Research Conference illustrated that when age and life expectancy of the insured are held constant, the standard deviation for a pool of life settlements closes around the LE as lives are added to the pool of insured.[6] The presentation demonstrated that the predicted accuracy of a LE for one person is very low. The standard deviation around the LE for one person with a 10.5 year life expectancy is +-15.5 years. The Deutsche Bank illustration showed that if four additional lives with a 10.5 year life expectancy are added to the pool, the accuracy of the LE improves substantially, i.e., the standard deviation around the LE for the pool of five lives is only +-5.3 years. If the pool is further increased with 495

[5] Modu, Emmanuel. (2008). Life Settlement Securitization. A.M. Best Company, Inc.
[6] Institute for International Research. Discussion by Michael T. Crane. Amsterdam. December 12, 2007.

additional lives with the same 10.5 year life expectancy the accuracy of the LE improves more dramatically, i.e., the standard deviation around the LE for the pool of lives is only +-4 months.

Conclusion

Life settlements offer institutional investors an asset class that provides diversified returns which are not correlated or dependent on movements of the economy. Life settlements do not share the same types of risk typically associated with most investment assets. The two major risks associated with life settlements are LE underwriter risk and longevity risk. LE underwriter risk is subject to proprietary methodologies and the accuracies of the underwriters and can be managed and reduced by structuring a balanced diversity of LE underwriters for each insured and/or for all insured in a portfolio, and by evaluating the performance records of the underwriters. Longevity risk, while it cannot be eliminated, can be statistically predicted, managed and reduced by aggregating 300 or more insured lives in a portfolio. A portfolio of such size provides predictable stability and mitigation of longevity risk, thus increasing the efficiency of other longevity risk management tools, e.g., hedges, swaps, and guarantees, and enhances the potential attractiveness of the portfolio for securitization.

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