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The Relatiobnship between a Profit Center's Surplus Needs and its Cost of Equity Capital

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Introduction

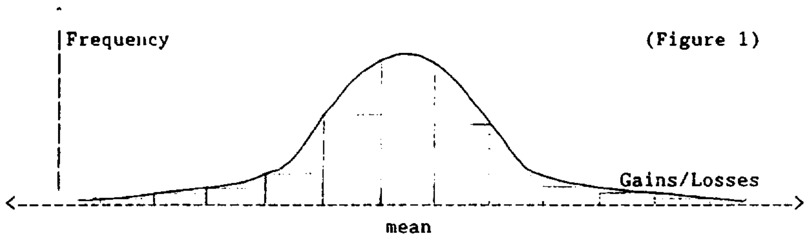
The task of deriving a risk-adjusted hurdle rate for mutual insurance companies has challenged actuaries and finance theorists for years. This rate is a weighted sum of the cost of equity capital and the cost of debt, and each cost is adjusted for company-specific risk and market-specific risk. Estimating risk for debt cost is easily done with the use of credit ratings, but estimating risk for equity costs is not easily done, especially for mutual life insurance companies because they are not publicly traded. Researchers have had difficulty finding balance sheet measures of risk for mutual life companies that behave like the stock returns of publicly traded life companies. If convenient measures were available, the tools of finance could readily be applied to estimate the riskiness and equity costs of mutual life insurance companies, and their lines of business. The intent of this paper is to propose 1) that there is a predictable relationship between surplus needs and the cost of equity capital for profit centers, and 2) more research is needed to develop it.

Surplus Needs

Surplus needs is the amount of surplus John Hancock needs to absorb low probability, catastrophic losses which would adversely affect its net worth. Such losses for insurance companies are typically the result of investment shortfalls or defaults, policy pricing experience shortfalls, changes in interest rates, and other similar events. Corporate actuaries, working with business units and investment areas, predict the likelihood of catastrophe for each event and then make sure the company has the surplus to cover each possibility of loss.

The likelihood of disaster for an event can be modeled by its frequency distribution. This paper is concerned with the frequency distribution of a company's annual gains and losses.[1] Unfortunately, changes in the value of a dollar and structural changes in many companies make it difficult to compare the effect of current cash outflows and inflows to the effect of past cash outflows and inflows on the long run distribution of annual gains and losses. Without certain accounting adjustments, a frequency distribution based solely on Annual Statement gains and losses would be meaningless statistically for some companies. A reasonable alternative approach is to generate this distribution by simulation. One familiar method is called Monte Carlo simulation. Monte Carlo simulation ties together sensitivity analysis and input variable probability distributions to model a desired event.[2] Using Monte Carlo simulation, we can look at how small changes in the components of an annual gain or loss change the size of an annual gain or loss, and the probability of that change.

To develop the relationship between surplus needs and annual gains and losses, we will assume that a Monte Carlo simulation was performed, and the results indicated annual gains/losses are symmetric about their mean, and approach the Normal Distribution for large sample sizes. Therefore, we can apply the probability theory underlying the normal distribution to generate point estimates of the mean and variance for gains/losses from insurance operations. The graph below depicts hypothetical results from a Monte Carlo simulation. A normal curve of best fit was superimposed onto the frequency distribution.

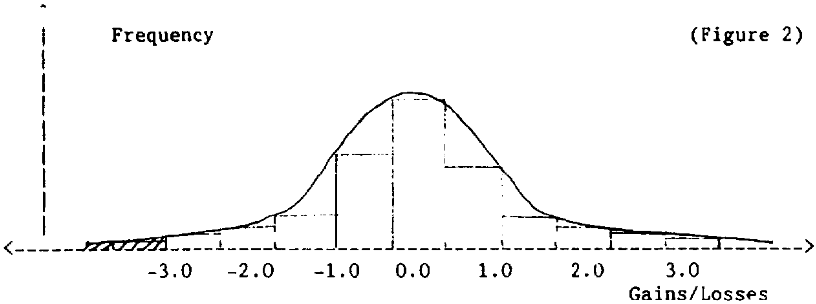


(Figure 1)

This curve has a mean (as indicated in the figure) equal to the mean of the frequency distribution. The variance is unknown, but can be estimated by applying properties of the Standard Normal Distribution, which has a mean of zero and a variance of one. Probability theory says that any normal distribution with a mean and positive variance can be converted to the Standard Normal Distribution,[3] by the following relationship:

$$Z(p) = \frac{\text{Gain/Loss - Average Gain/Loss}}{\text{Standard Deviation of G/L}}$$

Z is referred to as a z-score and it has a probability of occurrence (p) associated with it. Z-scores simply transform the numerical scale of the frequency variable (G/L) for any distribution, across all its values, to make the distribution comparable to the standard normal distribution.



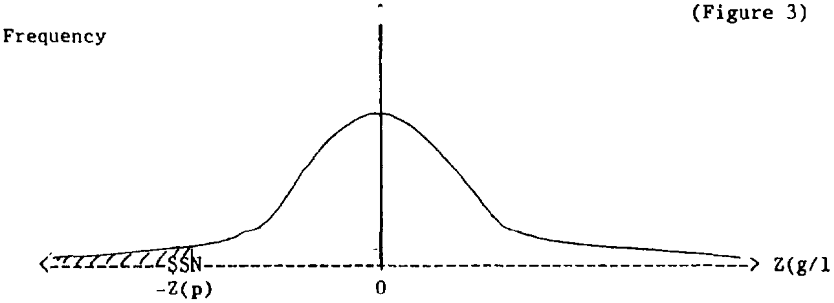
(Figure 2)

As indicated, the Z distribution has a mean of zero, and a variance and standard deviation (also called sigma) of one. This means that on average the z-scores deviate from zero by one z-score. Furthermore, the shape of the curve tells us what percentage of our population of z-scores differ from zero by one standard deviation or more. For example, 68.3% of our z-scores lie between plus and minus one standard deviation; 95.4% lie between plus and minus two standard deviations; and 99.7% lie between plus and minus three standard deviations. The symmetry property of the normal curve allows us to use these percentages to calculate probabilities. For example, the probability that Z is less than or equal to -3.00 is 0.0015. In figure 2, this probability is indicated by the shaded area to the left of the mean and to the left of minus three sigma. The probability that a z-score is greater than +3.00 is 0.0015 as well because of symmetry. This information is useful because the same probability values apply to the distribution of gains/losses.

The theoretical definition of surplus needs is based on the probability distribution of annual gains and losses. This distribution is assumed normal and symmetric, so the probabilities of an extremely large gain and an extremely large loss are very small. Corporate actuaries are concerned with the smallest annual loss that threatens the financial solvency of their companies. Graphically, this smallest annual loss lies to the left of the mean and its location is determined by a prescribed probability value. This probability, in retrospect, describes the likelihood of a most unfavorable loss. For John Hancock, the annual loss, below which larger losses have a probability of occurrence equal to or less than some value **p** is its surplus needs. (The true value of **p** is unknown at this time but some members of the Hancock community feel it may lie in the interval [0.001, 0.01]. It is not unreasonable to adopt this interval in sensitivity testing.) This means the change in surplus for a calendar year is believed to result in a loss at least as great as $SN with a maximum probability of **p**. To illustrate this definition, let's return to the graph of the distribution of annual gains and losses.

To remain solvent, in the event of a catastrophe, JH surplus must be at least as great as surplus needs. Losses greater than $SN will certainly

(Figure 3)



adversely affect John Hancock, but the likelihood of such events are close enough to zero (< p) to be considered negligible by the Corporate Actuary.

The computational definition of surplus needs applies the C1 through C4 risk factors to annual statement items and sums across the products. These factors are a percentage measure of catastrophic loss a company might experience on various products and investments. For example, 50% of all unaffiliated common stock must be included in a companies' total surplus needs, but only 6% of preferred stock needs to be added to the total. The difference in the risk factors, 50% and 6%, means the Corporate Actuary has determined that 50% is the most unfavorable loss on common stock his company might experience in a calendar year, while his company might experience only a 6% loss on preferred stock. Therefore, surplus should be available in these proportions to cover such possible catastrophes. There are several other risk factors that add to the determination of the appropriate level of surplus needs, but they are too numerous to mention here (see appendix for the 1987 edition of surplus needs factors and a discussion of them). Under this method of calculating surplus needs, the riskiness of a profit center is implicit in its $SN total, but totals for different profit centers do not necessarily describe their riskiness relative to each other or an external environment, like the stock market. In the stock market, variances or standard deviations are often used to rank the riskiness of companies. Those with small sigmas are less risky than those with large sigmas. Fortunately, calculating surplus needs with risk factors is equivalent to determining surplus needs from the probability distribution of annual gains and losses, and this distribution has a variance. Hence, profit centers can also be ranked for riskiness by their standard deviations.

To calculate sigma for a profit center, we will need to first assume annual gains and losses are normally distributed. This assumption permits the use of the standard normal distribution to determine the z-score that corresponds to our probability that losses greater than surplus needs is p or less. Second, we calculate a simple and unbiased estimate of the population mean, the sample mean.[4] This information is then used in the following equation to compute the standard deviation of gains and losses:

$$\text{Sigma (G/L)} = \frac{\$SN - \text{Average Gain/Loss}}{Z(p)}$$

This is the z equation, presented on page 3, solved for the standard deviation of gains and losses. Surplus needs can be used in this formula because it theoretically is a point on our distribution of annual gains and losses, and, therefore, has a z-score associated with it for some probability p. The average gain/loss term is the sample mean or arithmetic average of annual gains/losses over some period of time.

The above expression will produce statistically valid variance results for each of the profit centers. However, the results would describe average deviations in dollars. Standard deviations derived from raw closing price or gain/loss data is not usable in the Capital Asset Pricing Model (CAPM). For the CAPM we need standard deviations which describe average proportionate changes in these two variables. In the next section the above expression is refined so the CAPM applies.

Costs of Equity Capital by Profit Center

The Capital Asset Pricing Model (CAPM) has been around for a number of years. It has been criticized by many researchers, who warn that it should not be the sole tool used in decision making. But even some of them admit the CAPM provides some useful information regarding a stock's investment risk. Portfolio managers acknowledge the research that has been done and actively contribute to the development of a better model. They use the CAPM to determine the return a company should give potential investors for assuming the companies' inherent, undiversifiable business risk instead of assuming the inherent risk of a stock market index.

Beta is a measure that summarizes the investment risk of a company relative to a stock index, usually the S & P 500 stock index, which is believed to be efficient. This means the market portfolio provides the highest return for a given level of risk, and the least risk for a given return.[5] Mathematically, beta is defined as:

$$\text{Beta} = \frac{\text{Sigma (Stock\%)}}{\text{Sigma (Market\%)}} \times \text{(Rho for Stock\% and Market\%)}$$

Rho is a correlation coefficient. It is a measure that indicates the degree to which two variables move with each other or against each other, and only takes on values between -1.00 and +1.00. A value of -1.00 or +1.00 implies perfect correlation or co-movement, and the sign indicates the direction of the association. A positive sign means an increase in one variable is associated with an increase in the other variable. A negative sign means a decrease in one variable is associated with an increase in the other variable. Beta measures how much one (dependent) variable increases or decreases, given a unit increase in the other (independent) variable. In the context of CAPM, we would say beta measures the increase or decrease in a stock's return per unit increase in the market's return to its investors.

To calculate equity costs for profit centers with the CAPM, beta needs to have the form:

$$\text{Beta} = \frac{\text{Sigma (G/L\%)}}{\text{Sigma (Market\%)}} \times \text{(Rho for G/L\% and Market\%)}$$

In this relationship, beta is a proportional measure of profit center riskiness relative to the stock market's riskiness. The correlation between gain/loss returns and market returns is the proportional degree of association between beta and the ratio of standard deviations. The greater the value of rho, the stronger the relationship between market return variations and gain/loss variations. (The strength of this relationship is also dependent on the soundness of treating annual gains/losses as a proxy for stock. This may be the weakest part of the model being proposed here and is discussed further in the last section of this paper.)

The value of rho squared provides a measure of confidence a potential investor can have in the overall model. This value indicates how much of the variation in the dependent variable is explained by a simple linear regression, i.e. a regression which uses only one independent variable. For example, as recent as May 1989, Travelers Corp was 76% correlated with the S & P 500, which implies 58% of the variations in their stock returns could be explained through regression onto the variations in the market's returns. Their R-squared (rho squared) value of 58% clearly means the regression could not explain 100% of the variance in their stock returns, the dependent variable. To increase R-squared more independent variables can be added to regression. However, this extension into multiple regression is beyond the scope of this paper. In this paper we hope to delineate how simple regression can be used to calculate a single measure of risk for each profit center.

Simple linear regression, regardless of an R-squared value, can only provide estimates of the true population parameters. The true variance of annual gains/losses, the true market variance and the true correlation between John Hancock's annual gains/losses and the S & P 500's performance will always be unknown. The regression can estimate these parameters from a random sample of observations by plotting annual gains/loss data against market data over a given fixed period of time. Most regressions of this type use monthly data over a five year period. In fact, it has been shown that a period of sixty months helps minimize estimation error.[6] Several beta services, such as Value Line, Merrill Lynch, and Compustat do indeed use a sixty month interval for estimating stock company betas. Unfortunately, this may not be a feasible approach for mutual insurance companies, or at least it is not a feasible approach for John Hancock, because surplus needs or gains/losses is not calculated monthly for each profit center. So, instead of actually performing the regression, the components of beta can be calculated independently of each other using annual year-end data. This approach complicates computing the correlation coefficient, however. Calculating our rho requires matching monthly market data to monthly gain/loss data, which is unavailable. Fortunately, finance theory has enabled us to confidently estimate the correlation coefficient between variations in stock value for insurance companies and the S & P 500 index. We can assume that the correlation between surplus needs and the market lies in the interval 0.5 to 0.7, as it has been demonstrated that the correlation coefficient between any two randomly selected stocks falls in this interval.[7] Furthermore, a survey of the life and health companies in the A.M. Best stock index revealed an average rho of 0.56, which also falls in our interval.[8] (It is not unreasonable to use this interval to calculate a range of beta estimates and equity costs for each profit center in sensitivity testing.)

The variance of fluctuations in the stock market can be computed from year-end, raw data for the past 32 years.[9] Using this data, annual market returns were calculated to obtain estimates of the market variance and average return. Our calculations produced a market standard deviation estimate of 15.9% and a mean estimate of 7.9%. This data tells us that over this period 68% of the market's annual returns fell in the interval (-8.0%, 23.7%). With the implied assumption that these returns were normally distributed, we can sketch a normal curve which would graphically depict whether the distribution of market returns over this period was short and fat, indicating a risky investment, or tall and skinny, indicating a virtually risk-free investment.

The Capital Asset Pricing Model attempts to provide investors with a benchmark return by which they can value an investment. Ideally, the CAPM level of return adequately compensates investors for assuming the level of risk inherent in a particular stock, under the Efficient Market Hypotheses (EMH).[10] EMH assures investors that CAPM fully utilizes all that can be known about a security to determine a risk-adjusted cost of equity. This means the classic CAPM equation:

Return on Stock = Risk-Free Rate + Beta*Risk Premium

is complete; the investor needs no other information for decision making. The equation says the return a company should pay its investors equals the risk-free rate plus a beta adjusted risk premium--the market's return less the risk-free rate. Two things are obvious from this equation. First, if a stock moves exactly as the market does (i.e. its beta is 1.00), then the stock's return must equal the market's return. Second, the risk-free rate defines a baseline level of return and it defines risk premium, the excess of the market return over the risk-free rate. Beta adjusts this premium for stock volatility.

The choice of a risk-free rate has generated a great deal of discussion in the literature because of its impact on equity costs. The issues range from how much of this rate is truly risk-free to how to match investment horizons to durations on riskless assets more methodically. The return on 90-day T-bills has been extensively used as a proxy for the risk-free rate by CAPM practitioners, but not without criticism. Ninety-day T-bill returns are highly volatile, producing an unwanted variance and covariance with the market return, which, in turn, effectively bends the capital market line outward.[11] For this reason, researchers suggest using longer termed assets, and preferably assets with durations similar to the period of the investment under consideration.[12] This study supports using the 5-Year Treasury Bond rate of 8.5% as a proxy for the risk-free rate, for similar reasons.[13] Therefore, 8.5% is the minimum return we should expect from a profit center or business unit.

Further Required Research

In the preceding pages, an approach to calculating equity costs for profit centers using the CAPM has been outlined. More research needs to be done to address two major flaws in this design. The first, though not apparent, is the treatment annual gains/losses for mutual life insurance companies as the equivalent of stock in publicly traded life companies. The theoretical soundness of this equation must be further researched from a finance point of view. One question that needs to answered is do changes in statutory surplus obey the Efficient Market Hypotheses? If so, what are the similarities between changes in statutory surplus and changes in a stock's price? The model proposed here is dependent on how favorably these questions are answered because it imports the standard deviation of annual gains/losses to the Capital Asset Pricing Model.

The second flaw was the assumption of normality for the distributions of annual gains/losses for John Hancock and the market. This assumption needs to be tested empirically. There is a wealth a research in support of the abnormality of stock returns, but not much research exists to counter the claim that the distribution of a companies' annual gains/losses are normally distributed. A research project of this kind is important in its own right as a check for 1) how well our computational definition of surplus needs matches our historical experience, and 2) what probability level of ruin our surplus needs calculation, in the aggregate, protects us against. Research of this kind addressing specific surplus needs factors is currently underway at John Hancock. In the near future, we are sure the results will describe probabilistically how well total company surplus needs protects John Hancock from insolvency.

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Footnotes:

1. The term annual gains and losses is a generic measure of profit. We use it to mean the change in statutory surplus, excluding mandatory security valuation reserves and mortgage and real estate valuation reserves.
2. Hertz, David B., "Risk Analysis in Capital Investments," Harvard Business Review, January-February, 1964, 95-106.
3. Miller, Robert B., and Wichern, Dean W., Intermediate Business Statistics. New York: Holt, Rinehart, and Winston, 1977. It is extremely desirable to convert distributions to the standard normal distribution. By doing so, we are able to use the standard normal distribution tables to calculate probabilities. Without the conversion, we would have to integrate a complicated density function every time we needed a probability value.
4. When a sample statistic is termed unbiased it means that its mathematical expectation is the population parameter. This characteristic of a sample statistic is necessary for the Gauss-Markov Theorem to hold. This theorem applies to a special class of estimators, those that are linear combinations of the dependent variable and unbiased. Given these two requisites, Gauss-Markov says that if our estimators of alpha and beta are least squares estimators, then no other kind of estimator will have a smaller variance (or standard deviation). In simpler terms, a least squares estimate of beta will be closer to the true value of beta than any other kind of estimate.
5. Harrington, Diana R., Modern Portfolio Theory, The Capital Asset Pricing Model, and Arbitrage Pricing Theory: A User's Guide. New Jersey: Prentice-Hall, Inc., 1987, p. 11.
6. ________________, "Whose Beta is Best?," Financial Analysts Journal, July-August, 1983, pp. 67-73.
7. Brigham, Eugene F., Financial Management: Theory and Practice. Dryden Press, 1982, pp. 131-132.
8. See Table B in the appendix. To develop this table, we used the May 1989 edition of the Merrill Lynch Beta Book to get R-Squared values for the life/health stock companies in the A.M. Best Stock Index. The square root of those R-Squared values gave us the correlation coefficients for most these companies.
9. You are probably wondering why we used the last 32 years of market data and not the last 31 or 33 or some other number. Well, statistically speaking, we wanted to make sure we had just enough degrees of freedom to use the normal distribution tables. The best way to describe what degrees of freedom are is by example. Suppose you know that two numbers add up to 10. Well, if I say the first of those numbers is 4 then the second number is automatically determined. The point is I have an infinite range of values to choose from for the first number, but once it's picked, there is only one possibility for the second number. Statistically, I would say that this problem has

only 1 degree of freedom. If I had said three numbers add up to 10, then the problem would have 2 degrees of freedom, as the possible values for 2 of the numbers is infinite. On a more complex level, this analogy applies to probability distributions. If we have fewer than 30 degrees of freedom in a problem, then a "t-distribution" is more appropriate than a normal distribution. By using 32 years of raw closing price data, we get 31 yearly returns or 31 measures of past proportionate changes in surplus, and by subtracting 1 we have 30 degrees of freedom, as desired.

10. Fama, Eugene F., "Efficient Capital Markets: A Review of Theory and Empirical Work," The Journal of Finance, May 1970, pp. 383-423. There are three parts of the Efficient Market Hypotheses(EMH), the weak form, the semi-strong form, and the strong form. The weak form says that historical information is fully reflected in a stock's price. The semi-strong form says that historical information and current publicly available information (e.g. annual report data, press releases, etc.) are fully reflected in a stock's price. And, the strong form says even those with information (about a stock) that is not generally available to the public cannot capitalize on that information in the market. (This last form is certainly debatable, but such a debate will be avoided here.) In essence, these three forms mean that everything that can be known about a stock is fully reflected in its price and because the market reacts quickly to information (i.e. it regulates itself), it is impossible to profit from the use of such information in the marketplace.
11. Harrington, Diana F., Modern Portfolio Theory, The Capital Asset Pricing Model, and Arbitrage Pricing Theory: A User's Guide. New Jersey: Prentice-Hall, Inc., 1987, pp. 149-151.
12. Ibid., pp. 153-158.
13. Kischuk, Richard K., "Strategic Management of Life Insurance Company Surplus," Society of Actuaries Study Note, pp. 112-113. John Hancock, like other companies that Kischuk has observed, has a financial planning horizon of five years. However, Kischuk does contend that there is nothing magical about a five-year planning horizon and that it is wise for companies to update the plans yearly to reflect current financials.

Appendix:

Table A: 1987 Edition of Surplus Needs Factors
Table B: Correlation Coefficients for S&P 500 and Selected Companies in the A.M. Best Insurance Stock Index.

Table A

Surplus Needs Factors
1987 Edition

It must be remembered that these factors are intended to represent the degree of fluctuation in experience that could occur in one year under extremely serious conditions.

I. Investment Experience Factors

A. Asset-Based Factors (applied to year-end asset values)

1. Unaffiliated Common Stock: 50%
   Although the maximum decline in market value that has been experienced in one calendar year is about 40%, it was felt that 50% was certainly possible. The experience of 1974 (which in retrospect hardly seems a "catastrophe" and yet that year produced a drop of close to 40%), gives us an indication of what can happen.

2. Preferred Stock: 6%. Since preferred stocks are carried at book, market value declines do not concern us. A default rate similar to bonds is assumed, but with full principal loss.

3. Bonds: 2 1/2%. We assume that a worst-case default rate of 6% will produce an actual loss of principal of less than half the face, on average. We also feel that the reasoning is dependent on the quality of the portfolio, so that portfolios of significantly higher quality than John Hancock general account could deserve a factor as low as 2% (complete details of this not yet worked out). A factor of zero will apply to bonds backed by the full faith and credit of the U.S. government.

4. Mortgages: 1 1/2%. Recent experience has made it clear that mortgages, despite margins between debt and total value, involve considerable risk.

5. Surplus needs for any subsidiary holdings, where the carrying value is derived from the net worth of the subsidiary, should be based on the calculated surplus needs of the subsidiary.

6. All other invested assets: 1/2%. This may seem surprisingly low for such inherently risky investments as limit losses in statement value during a crisis.

B. Income-based factors.

1. Common Stock: 20%. Based on historical experience in common stock dividend reductions.

2. Bonds and Preferred Stocks: 10%. We feel that there will be a nearly complete loss of income on securities in default during a crisis(6% assumed default rate) plus some loss of income on securities not in default.

Table A

3. Real Estate (Gross Income): 10%. Note that the factor is to be applied to gross income, after deduction of expenses but before taxes and depreciation. This factor is also to be applied to oil and gas partnerships and similar investments.

4. Mortgages and other Invested Assets: 10%.

II. **Insurance Experience Factors** (where the word "claims" is used, the actuary may use "expected claims" rather than "actual claims").

1. Death: 25% of claims (after reserves released) plus $0.25 per $1,000 of the enforce (net amount at risk). Excess mortality of 25% occurred in the 1918 flu epidemic (and even greater percentages in some 19th century situations) and that was on a much greater per-thousand base. Improved public health measures may be some protection against similar occurrences, but we prefer not to place much reliance on that. The factors are expressed as a percentage a constant to reflect the greater variability of mortality at young ages. (For Accidental Death Benefits, we use a flat $ > 25 per $1,000 factor.)

2. Disability: 50% of claims incurred.

3. Other Health Benefits: 25% of claims insured.

4. Insurance Expense: 12%, to provide for the increase in expenses that could occur within a calendar year in a period of high inflation.

III. **Offsets against the factors.**

1. In the case where capital losses or income losses can be directly and contractually passed through to the customer, there may be a reduction in the factors, based on the judgment of the actuary in the line.

2. In Group Insurance, the existence of retroactive rating provisions and similar devices has the affect of greatly reducing the risk to the insurer. Formulas approved by the Group Actuary will be used to provide the appropriate offsets.

3. Dividends serve as a line of defense against surplus depletion, because dividends can be reduced to offset some losses in the time of crisis. It would be unwise to assume, however, that the entire amount of dividends paid in a year is a complete offset. Reflecting the varying ability of business lines to cut dividends in a crisis, factors of 50% were used in Retail Insurance, 75% in Group Pension and 112.5% in Group Insurance.

4. Some claim is made that discount bonds are not as risky as par bonds, because the loss of principal and interest in case of default is not as great. This matter has not previously been considered because of its unimportance, but with discount bonds becoming a significant part of the assets in one very sensitive segment of the company (GBSA), we will allow an adjustment.

5. Annuity mortality goes counter to the major mortality risks in the company. At a time of sudden increase in mortality, we would expect a gain on the annuity side. Factors provided by Boermeester can be used to provide for this offset. (Group Annuity reserves for income payable, -0.8%: for deferred income, -0.1%: Individual Lines, -0.6%).

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Table B

**Correlation Coefficients Between
Selected Stock Companies in
A.M. Best Insurance Stock Index
and the
S&P 500 Stock Index.**

Life/Health Company	Correlation
Amer. General Corp.	.74
Amer. Heritage Life Inv.	.47
Amer. National Ins.	.67
Aon Corp.	.74
BMA Corp.	.--
Capital Holding Corp.	.74
Colonial Life & Acc.	.47
Durham Corp.	.--
Equitable of Iowa	.53
First Executive Corp.	.58
Home Beneficial Corp.	.61
Independent Ins. Group	.49
Jefferson-Pilot Corp.	.62
Kansas City Life	.30
Liberty Corp.	.51
Monarch Capital Corp.	.73
NWNL Cos.	.44
Protective Life Corp.	.41
Provident Life & Acc.	.50
Torchmark Corp.	.54
UNUM Corp.	.57
USLICO Corp.	.--
USLIFE Corp.	.58
Washington Nat'l Corp.	.58
Total Index	**.56**

Note: Correlation coefficients were not available for three of the above companies, as indicated by "--". These companies could not be included in the total index rho. Correlations provided by Merrill Lynch, May 1989, Beta Book.