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Relationship of IRR to ROI on a Level Term Life Insurance Policy

by Wayne E. Stuenkel

One of the primary pricing measures for individual life insurance products is the internal rate of return on a statutory basis. The internal rate of return (IRR) for a policy is a single interest rate that discounts all policy cash flows back to the issue date of the policy, such that the sum of discounted cash flows equals zero. "Cash flows" include statutory income, taxes, required capital and imputed interest on required capital. An insurer will often require that products be priced to achieve a certain minimum IRR threshold.

Additionally, many companies report annual earnings on a GAAP basis. As a by-product of preparation of GAAP income, an annual return on GAAP investment (ROI) at the line of business level or the product level can be calculated. A GAAP ROI calculation typically includes GAAP income plus imputed interest on required capital in the numerator, and required capital plus stat/GAAP differences (DAC, reserves, taxes) in the denominator.

We found that it is possible to construct a hypothetical product such that expected annual GAAP ROIs are level and equal to the lifetime statutory IRR.

A recurring question from those who look at product profitability concerns the relationship of lifetime IRR to annual ROI. Some observers (often including insurance company CEOs) expect that the annual ROI for a product should be equal in all years to the lifetime IRR for the product, assuming that product assumptions (lapse, mortality, interest rate, etc.) are met. However, in practice, annual ROI never seems to be equal to lifetime IRR, even if product assumptions are met.

Several excellent papers have been written which examine the relationship between lifetime statutory IRR and annual GAAP ROI. Especially notable in this regard are papers written by Brad Smith (*TSA* 39, pp. 257-293) and Bob Beal (*NAAJ* Volume 4, Number 4, pp. 1-11). However, neither of these papers specifically identified those product variables that cause annual ROI to vary from the lifetime IRR.

So that we could more fully understand the relationship between IRR and ROI, we constructed a term life insurance product. The product provides a level amount of insurance for 20 years, in exchange for equal annual premium payments for 20 years. At the end of 20 years, all policies lapse without value, while the product continues as a whole life product with a high guaranteed premium rate. There are no cash values or dividends. This product is generally consistent with products that are currently being sold; however, it is constructed for the purpose of demonstrating the relationship of IRR and ROI, and does not duplicate the products sold by our company or any other company.

The product was constructed in a spreadsheet for ease of manipulation, and therefore includes several simplifying assumptions (annual premiums and expenses at the start of the policy year, death claims and lapses at the end of the policy year, etc.) The spreadsheet was used to calculate the lifetime statutory IRR and the annual GAAP ROI assuming that all experience emerges exactly as expected.

We found that it is possible to construct a hypothetical product such that expected annual GAAP ROIs are level and equal to the lifetime statutory IRR. The assumptions and methodologies for this product are shown in Appendix A (on page 16).

However, some of the assumptions and methodologies that are necessary to produce expected level annual ROIs equal to lifetime IRR are either actuarially unsound or outside of statutory and GAAP accounting conventions. The assumptions and methodologies that are necessary to produce level annual ROIs equal to lifetime IRR include:

- DAC interest rate equal to IRR rate
- No required capital based on assets, reserves, or insurance inforce net of reserves

• No DAC tax

• Statutory reserves equal to GAAP reserves

• GAAP reserve mortality equal to pricing mortality
• GAAP reserve interest rate equal to pricing earned interest rate

• Lapse rate for GAAP reserves and DAC amortization equal to pricing lapse rate.

In this article, we will refer to the variables above as the "slope-introducing variables," or SIVs.

It was interesting to observe which of the assumptions and methodologies, while changing the *level* of ROI and IRR, did not affect the *relationship* of ROI to IRR. These assumptions included:
• Premium rate per thousand and policy size

• Slope and level of mortality rates

• Lapse rates – both absolute level and pattern (so long as GAAP = pricing)

• Earned interest rate on required capital

• Tax rate

• Reinsurance (if the form is coinsurance)

• Commissions and expenses (both direct and ceded)

• Required capital based on direct premiums.

To examine the effect of the SIVs, we constructed a hypothetical product that had a level ROI that was equal to IRR. (To produce a level ROI that was equal to IRR, the SIVs were set at a level which was either actuarially unsound or outside of accounting conventions.) We then changed each SIV individually to a setting that is typically found in practice, and observed the effect of the change in the SIV on the relationship of ROI to IRR.

The different patterns of ROI that we observed when the SIVs were changed to more typical settings were as follows:
• "Positive sloping ROI", defined as ROIs that are lower than IRR in the early durations, then rise to be greater than IRR in later durations, was observed when (a) the DAC interest rate was set lower than the IRR rate, (b) GAAP reserve mortality was higher than pricing mortality, or (c) GAAP reserve interest rate was less than pricing earned interest rate.

• "Negative sloping ROI", defined as ROIs that are greater than IRR in the early durations, then decline to be less than IRR in later durations, was observed when (a) DAC tax was used or (b) required capital based on reserves, assets, or inforce net of reserves and reinsurance was used.

• The effect of statutory reserves on the slope of ROI depended on the statutory reserving method. Using reserves that are typical of XXX product designs (segmented reserves, no deficiencies) produces a negatively sloping ROI. Using reserves that were typical of pre-XXX product designs (mean reserve of 1/2 cx) produces a positively sloping ROI.

The largest effects on ROI slope arose from the DAC interest rate (positive slope), DAC tax (negative slope), and statutory reserve (both slopes) variables. When we combined all of the assumptions, we found that the product ROI had a generally positive slope for pre-XXX products, and a generally negative slope for XXX products. The slopes of both types of products would become more positive if the loading of GAAP reserve mortality over pricing mortality were increased, or if the reduction in the GAAP reserve interest rate from the pricing earned interest rate were increased. The IRRs and ROIs for the tested variables are displayed in Appendix B. (See both Appendix A and B on page 16). □

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Wayne E. Stuenkel , FSA, MAAA, is senior vice president and chief actuary at Protective Life Corp in Birmingham, AL. He can be reached at wayne.stuenkel@protective.com.

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Appendix A
Illustrative Assumptions for Level Term Product

"Slope Introducing Variables" are those *Italicized* Assumptions for which "Typcial" Setting is Different from "Level ROI" Setting

Variable	Setting for "Level ROI=IRR" *	"Typical Setting"
Premium rate	$0.80/M/year	Same
Earned interest rate	7.00%	Same
Tax rate	35.00%	Same
Lapse rate (pricing, GAAP)	12, 11, 10, 9, 8, 7, 6....	Same
DAC tax rate	*0.00%*	*7.70% of net consideration*
Pricing mortallity	45% of 1975-80 S&U	Same
Direct commission + expense	190% (1), 10% (2-10), 4% (11+)	Same
Reinsurance percentage	90%	Same
Resinsurance method	Coinsurance	Same
Reinsurance allowance	100% (1), 50% (2-10), 12% (11+)	Same
GAAP *reserve interest rate*	*Same as earned rate*	*95% of earned rate*
GAAP *reserve mortality*	*Same as pricing mortality*	*105% of pricing mortality*
GAAP reserve method	Net Level	Same
Statutory reserve interest rate	*Same as GAAP rate*	*4.00%*
Statutory reserve mortality	*Same as GAAP mortality*	*100% of 1980 CSO*
Statutory reserve method	*Same as GAAP method*	*CRVM - segmented or unitary (minimum 1/2 cx mean reserve)*
RBC - % of direct premium	3.40%	Same
RBC - *% of net resources*	*0.00%*	*2.76%*
RBC - *% of net inforce*	*0.00%*	*0.14%*
DAC *interest rate*	*Equal to IRR rate*	*7.00%*

* Variables that are not "slope-introducing variables" can be set at any level. Setting at a level different than shown will change the *level* of ROI and IRR, but not the *relationship* between ROI and IRR.

Based on our work, we believe that it is impossible for the annual GAAP ROI for level term life insurance policies to be level and equal to IRR. Even if a company perfectly met all of its pricing assumptions, we believe that certain assumptions and methodologies that are required either by accounting convention or by sound actuarial practice introduce a slope to the pattern of annual GAAP ROIs.

We would be interested to know whether other actuaries have performed similar calculations on other types of business. □

Appendix B
Illustrative Results for Level Term Product

(1) Statutory Lifetime Internal Rate of Return

"Level ROI = IRR" setting	"Typical setting (stat reserves = semented)	"Typical" setting (stat reserves = unitary)
19.10%	11.40%	15.30%

(2) Annual GAAP Return on Investment

Duration	"Level ROI = IRR" setting	"Typical" setting (stat reserves = segmented)	"Typical" setting (stat reserves = unitary)
1	19.1%	13.1%	13.1%
2	19.1%	13.2%	13.2%
3	19.1%	12.1%	13.6%
4	19.1%	11.3%	14.0%
5	19.1%	10.8%	14.7%
6	19.1%	10.5%	16.1%
7	19.1%	10.3%	19.0%
8	19.1%	10.3%	26.4%
9	19.1%	10.3%	75.2%
10	19.1%	10.5%	Undefined
11	19.1%	10.3%	Undefined
12	19.1%	10.3%	Undefined
13	19.1%	10.2%	Undefined
14	19.1%	10.2%	Undefined
15	19.1%	10.3%	Undefined
16	19.1%	10.3%	Undefined
17	19.1%	10.4%	Undefined
18	19.1%	10.6%	60.2%
19	19.1%	10.9%	24.9%
20	19.1%	11.4%	16.2%

* "Undefined" means that the numerator of ROI calculation is positive, but the denominator is negative.