ACTUARIAL RESEARCH CLEARING HOUSE
1994 VOL. 2

# THE EFFECT OF REINSURANCE ON PRICING

# INDIVIDUAL SUBSTANDARD LIFE INSURANCE

by Robert J. Reynolds, ASA

Fellowship Credit Research Paper 94-1

Approved by Society of Actuaries
Education and Examination Research Paper Committee

Effective January 10, 1994

# SYNOPSIS

*The substandard reinsurance market has undergone several changes in the past decade, primarily in the facultative market. Ceding companies must react appropriately to these changes to avoid losses on this business. The actuarial department should be involved not only in the pricing process, but also the placement of individual substandard policies with reinsurers. By using the substandard/reinsurance pricing algorithms presented in this paper, ceding companies may develop an effective placement method and thereby avoid potential future losses.*

## Table of Contents

## Introduction

This paper studies how ceding individual substandard life insurance to a reinsurer affects the product's profitability. On average, substandard policies constitute between three to ten percent of a company's life insurance business. In order to place as many substandard cases as possible, hence increasing the field force's ability to market the product, many of these cases are reinsured. However, companies do not always analyze the financial impact of these reinsurance programs. This paper analyzes potential problems in reinsuring substandard cases and suggests possible solutions.

There appears to be a shortage of actuarial literature written to date on this subject. While substandard business has been cited in existing actuarial publications as a reason to purchase reinsurance, and while reinsurance has been mentioned as a consideration in pricing substandard business, the impact of reinsurance in pricing substandard business has not been directly demonstrated.

This paper attempts to fill this gap in information by analyzing various profit scenarios when reinsurance is employed. To illustrate the impact of reinsurance, the profit scenarios which result under facultative shopping programs will be analyzed. The paper concentrates on facultative shopping programs for the following reasons:

- The majority of substandard reinsurance is facultative - this reinsurance is normally shopped to several reinsurers to place the policy more competitively. Several large mutual companies are in this category. Automatic reinsurance makes up the remainder of substandard reinsurance.

- These programs are arguably where most of the problems exist in today's substandard reinsurance programs.

- The solutions offered in this paper apply equally well to automatic reinsurance. Any differences that occur are pointed out.

The paper is comprised of four major sections. The first section provides an overview of reinsurance and its role in the substandard individual life insurance market. The second section incorporates reinsurance into the traditional pricing model; a basic recursive asset share formula is modified to reflect reinsurance. The third section demonstrates, using the traditional pricing model developed in the second section, the impact reinsurance has on the profitability of substandard business. Various scenarios are illustrated and discussed in order to demonstrate the wide realm of profit outcomes produced by reinsurance. Then a model solution using the traditional approach is discussed. The fourth section demonstrates a macro pricing solution based on Shane Chalke's macro pricing model. The macro approach converges to an optimal solution by aligning incentives between actuarial, marketing, and also the underwriting department, which is critical to this issue.

Pricing substandard cases is an important part of pricing any individual life insurance product. Because reinsurance is a key element in placing substandard cases, it must be addressed as part of the pricing process. This paper adds to actuarial literature by illustrating potential financial problems with reinsurance, and also suggests solutions. Future work in this area could entail analyzing the impact of reinsurance on other lines of business such as health insurance; it might also include developing a model to analyze the impact of current reinsurance programs on inforce business.

Contributions from the following individuals are acknowledged and appreciated: Joseph F. Kolodney, Senior Vice President of the Life, Accident and Health Reinsurance Division at Alexander Reinsurance Intermediaries, Inc.

in Stamford, Connecticut; Tim Pfeifer, FSA, MAAA, Consulting Actuary at Milliman & Robertson in Chicago, also the editor of the Society of Actuaries Product Development Section Newsletter; Larry Thoen, FSA, Associate Actuary at Minnesota Mutual Life in St. Paul, Minnesota; Philip Velazquez, FSA, MAAA, at North American Reassurance Co. in New York; and most of all, my supervisor Tess Post, FSA.

## 1. OVERVIEW OF THE ROLE REINSURANCE PLAYS IN SUBSTANDARD INSURANCE

### 1.1 Today's reinsurance environment

Recently, there has been a lot of attention given to the "tightening up" of the reinsurance market with regard to underwriting and price (Hug 730). There are several reasons many reinsurers are tightening up.

First, minimum capital necessary to be a serious player in the reinsurance market has essentially increased. Not many companies are able to meet these increased surplus standards (Mosca S38-S39).

Second, some "reinsurers are overpricing their life products to make up for losses they have incurred in other areas" (Crosson 33). An influx of reinsurers in the 80's, along with the term wars, intensified competition in the reinsurance market (Hug 724). As a result, in the late 70's and early 80's, "reinsurance was cheap and plentiful" (Freedman 50). Ceding companies, finding the reinsurers' rates to be quite competitive, would cede 100% of the business. But some "reinsurers underpriced their products to get business in the intensely competitive market of the 1980's" (Crosson). Also, "many reinsurers were plagued by low placement ratios, because cases were being 'shopped' to a large number of reinsurers" (Crosson 33). Reinsurers, in turn, experienced poor results on this business. As a result, the reinsurers raised prices significantly (Hug, 721). "What we are finding now is that reinsurers have reacted to that bad mortality and pulled back too far" (Hug, 721)[1]. Ceding companies are now finding some reinsurance rates to be quite expensive. In addition, reinsurers now usually require ceding companies to retain a percentage of each facultative risk.

So, the mid to late 80's into the 90's have been a time of retrenchment for many reinsurers. With stricter underwriting and higher prices,

---

1 In the panel discussion moderated by Mark Anthony Hug, the information in this paragraph was contributed by Ronald A. Colligan, Vice President of Underwriting, Research and Development at Transamerica Life in Los Angeles, California. (His comments were specific to facultative reinsurance and shopping programs.)

primarily in the facultative market, some are attempting to offset the losses of the previous decade.

### 1.2 Ceding company responses to the changes in the market

Given higher reinsurance prices and stricter underwriting by many reinsurers, ceding companies have looked for ways to improve their reinsurance programs. If the ceding company writes a significant amount of substandard business, it may choose to reduce the amount of business that it sells. A company can also combat the "tightening" reinsurance market by increasing its retention limit. In addition, using a reinsurance "shopping" program, whose function, when properly used, is to shop for the best reinsurance price, will also help combat the tightening reinsurance market. These responses to the tightening reinsurance market are discussed below.

#### 1.2.1 Size of substandard block

Companies actively participating in the substandard market often use reinsurers when placing cases. Reinsurers can provide underwriting guidance, and can also provide manuals and training (Tiller 46). This may improve a company's confidence in underwriting substandard risks, ultimately increasing the size of its substandard block. Given the "tightening" of the reinsurance market, however, the benefits listed above must be weighed against rising reinsurance costs.

When weighing the reinsurance benefits against rising costs, the ceding company must decide how actively it wants to participate in the substandard market. In doing so, it should consider the following items:

- Confidence in company's underwriters.
- Aging population - fewer older applicants qualify as standard (Riehm 38).

- Requests by existing policyholders for more coverage which may now be rated.
- Agent pressures (Barken 73-74).
- Ceding company's profit objective on substandard cases.

So, although the reinsurance market has tightened up, a ceding company must consider a number of issues when it decides on the size of its substandard block.

### 1.2.2 Retention limits

In an environment of increasing reinsurance rates, increasing the retention limit can enhance profitability for the ceding company. For substandard facultative business, retention is applied to each case separately. As mentioned earlier, when reinsurance rates and underwriting were extremely competitive, ceding companies would cede 100% of each case. Now that this reinsurance market has tightened up, the opposite is true.

However, if ceding companies use high retention limits, they increase the amount of their risk. The ceding company must weigh increasing reinsurance costs against retaining larger portions of substandard risks. So "risk versus return" theory must be applied to the company's retention philosophy.

### 1.2.3 Substandard shopping programs

Another tool ceding companies have used to combat the tightened reinsurance market is to submit cases facultatively in order to get the most competitive rating. This practice is known as shopping (Tiller 40). Under a facultative shopping program, the ceding company first underwrites the substandard case. The ceding company then sends the underwriting papers and application of the case to each reinsurer participating in the program, usually three or four (Tiller 40). Each reinsurer then returns a rating such as standard (100%), 125% of standard, etc. This rating is called the reinsurer's "offer". The rating is applied to a table of yearly renewable term (YRT) rates which are agreed upon between the ceding company and reinsurer. Usually, the reinsurer has rates that apply to standard and extra rates that apply to substandard mortality. Offers are usually expressed in terms of a multiple of the standard table, where one table means an underwriting rating equivalent to 25% extra mortality. So, a table 2 case would have expected mortality equal to 150% of standard (Tiller 40).

Because the ceding company is "shopping" for competitive ratings, usually it will cede the policy to the first reinsurer to "bid" the case as standard. If no standard offers are received, the ceding company waits for all offers and usually accepts the lowest offered rating.

Shopping programs were used in the 70's and early 80's to capitalize on the competitive facultative reinsurance prices, usually at zero retention. In light of the tightening market and the expense involved in facultative reinsurance, many ceding companies have become less reliant on facultative shopping. A trend is developing where ceding companies look to their automatic reinsurers for facultative help. But since this approach is a subset of a shopping program, this paper will use facultative shopping programs to demonstrate the impact of reinsurance on substandard business.

**1.2.4 Number of reinsurers**

When shopping out a substandard case, obviously the more reinsurers the case is shopped to, the more competitive the best offer will likely be. However, if too many reinsurers are used, shopping costs increase for the ceding company and placement ratios are reduced for participating reinsurers. A balance must be found. It is typically five or fewer reinsurers.

As with any reinsurance program, the quality of each reinsurer should be considered. An analysis should be made of its surplus position, premium-to-surplus ratio, ratings record, capacity, claims payment speed, price, professionalism, service quality, and value-added services such as making experts available to answer technical questions (Mosca S40-S41).

**1.2.5 Impact of differences in reinsurers' underwriting philosophies**

As one method of reinsuring substandard business, a few companies have formed facultative reinsurance pools, where the reinsurers take turns underwriting the risk but all reinsurers share each risk (Tiller 50-51). This can only be successful if the underwriting philosophy of the participating reinsurers is similar and they agree on the rating assigned the risk (Tiller 50-51). Although only a few companies have formed facultative pools, this method highlights the importance of compatible underwriting among reinsurers participating in pools.

Unlike these facultative pools, the underwriting of reinsurers in facultative shopping programs can be significantly different. To ensure the optimum placement of the case, it is important that the ceding company recognize differences in the reinsurers' underwriting. "Optimum placement" involves a variety of factors which are discussed below.

Rated cases are often difficult to place with the applicant. No applicant wishes to feel they are "substandard". In addition, no applicant wants to pay a higher premium. So the lower the rating assigned to the policy, the happier the insured, the agent, and the company. Reinsurers, realizing this, want to bid the lowest rating possible in order to increase their chances of getting the business.

As the reinsurance market intensified in the 80's, some reinsurers became more aggressive in their underwriting to increase their market share. But as the mortality deteriorated in the reinsurance market, another more subtle practice occurred that enabled reinsurers to increase their market share <u>and</u> profitability. Some reinsurers, while lowering the ratings they assigned the cases, raised the rates attached to those ratings. So while the rating assigned to the case, e.g. 125%, may appear more competitive than a 150% or 200% rating returned by other reinsurers, the actual rates charged per thousand may be higher than the 150% or 200% offers. As a result of this practice, it is not uncommon for a ceding company to receive a wide range of offered ratings from its reinsurers. In addition, the rates corresponding to the ratings also show great differences.

To illustrate the wide disparity in rates at a standard rating, sample rates for five reinsurers participating in a ceding company's substandard shopping program are compared to the ceding company's mortality charges in figure 1.1a. The standard rates are for the first ten durations for a male nonsmoker age 45. While the ratings are all standard, i.e. 100%, the reinsurance rates seem far from standard.

Looking at the ten-year present value of standard rates, the ceding company's present value is 11.4. Reinsurer E's present value is 17.5. If the ceding company's rating is increased by one table addition (125% rating) and applied to its rates, it results in a present value of 16.6, which is still less than the present value of reinsurer E's standard rates. This means that reinsurer E's standard rates can absorb over one table of the ceding company's mortality charges. This is illustrated in figure 1.1b for all five reinsurers. It shows the ten-year present value of the ceding company's mortality charges at various ratings so the ten-year present value of each reinsurer's standard rates can be compared.

Not surprisingly, each reinsurer can absorb at least one additional table of mortality. What is surprising is that reinsurers B and C can absorb between three and four tables. This means that what they call standard can actually be between 175% to 200% of the ceding company's standard mortality charges. So if the ceding company places business with reinsurers B and C, it will be charged significantly higher rates than the other reinsurers would charge.

Figures 1.2a and b illustrate the same comparisons for a male smoker age 45. The number of tables that can be absorbed varies from one to six. Figures 1.3a and b illustrate the comparisons for a female nonsmoker age 45. The number of tables that can be absorbed in this case varies from less than one to six. Figures 1.4a and b illustrate the comparisons for a female smoker age 45. The number of tables that can be absorbed varies from less than one to 13!

This practice of offering low ratings with corresponding rates which are significantly higher relative to other companies' rates at the same rating will be defined as "inverse underwriting".

While there appears to be a pattern in rates charged by each reinsurer at issue age 45, other issue ages display different patterns for these same companies. Hence, a significant amount of complexity is added to pricing substandard business when inverse underwriting is taking place.

So there are a variety of factors affecting the cost of a company's reinsurance program. The discussion will now turn to how these reinsurance costs can be recovered.

Figure 1.1a STANDARD MORTALITY CHARGES
Male Nonsmoker Age 45

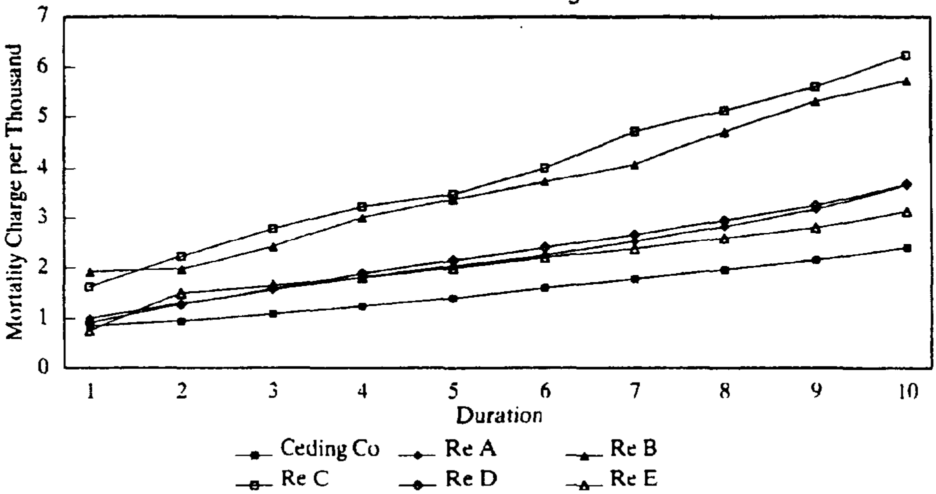



Figure 1.1b MORTALITY CHARGE COMPARISONS
Present Value Over 10 Years, Male Nonsmoker Age 45

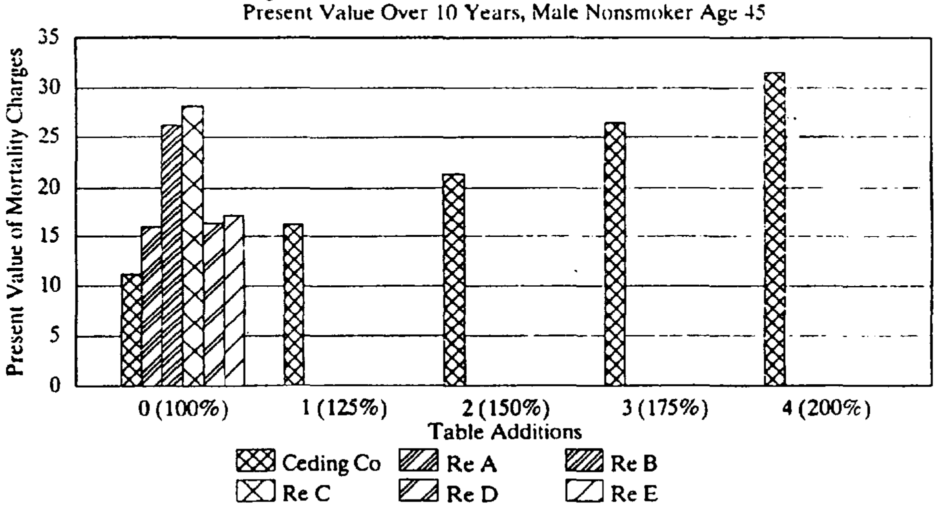


Figure 1.2a – STANDARD MORTALITY CHARGES
Male Smoker Age 45

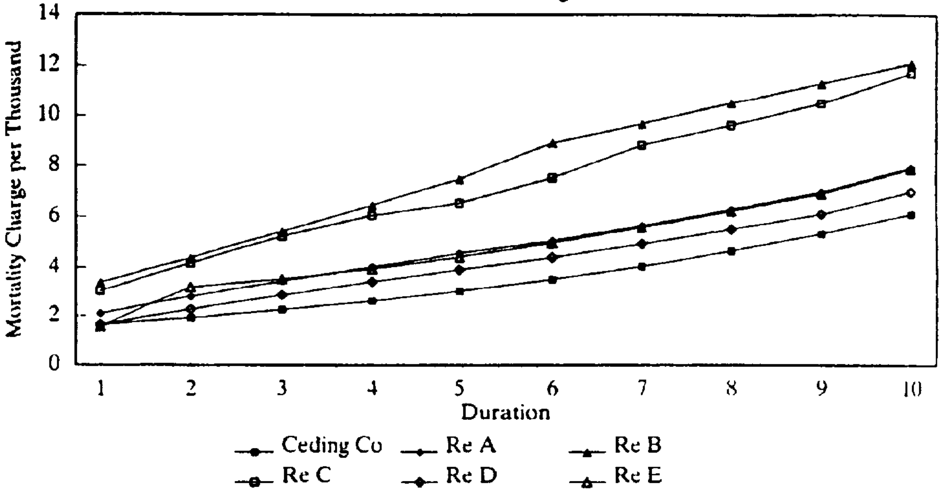



Figure 1.2b – MORTALITY CHARGE COMPARISONS
Present Value Over 10 Years, Male Smoker Age 45

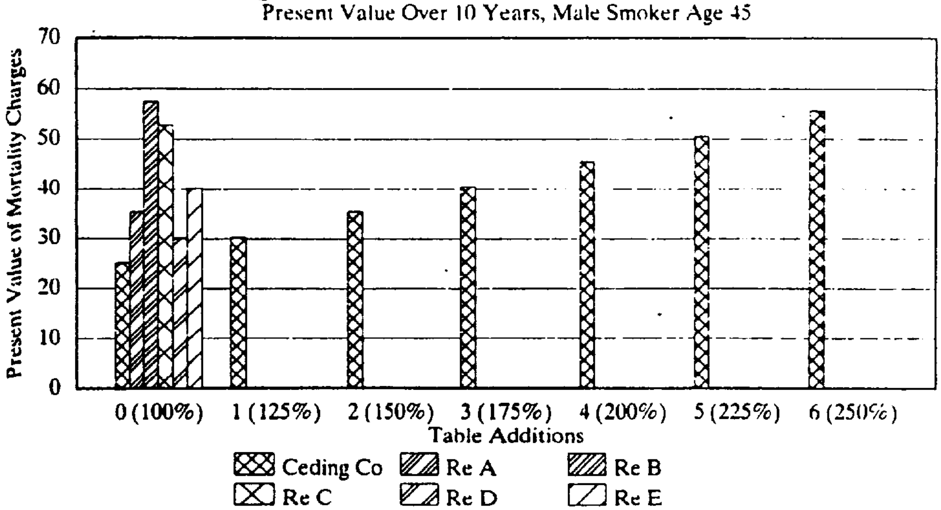


Figure 1.3a – STANDARD MORTALITY CHARGES
Female Nonsmoker Age 45

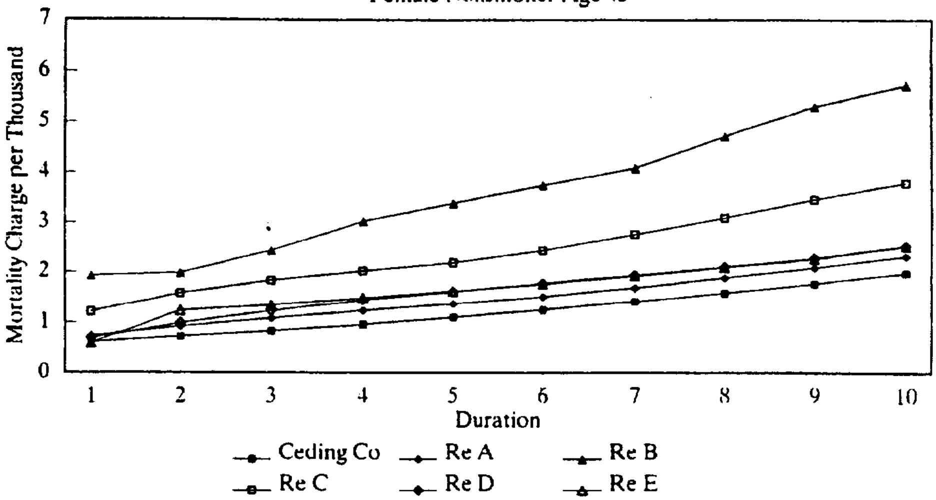



Figure 1.3b – MORTALITY CHARGE COMPARISONS
Present Value Over 10 Years, Female Nonsmoker Age 45

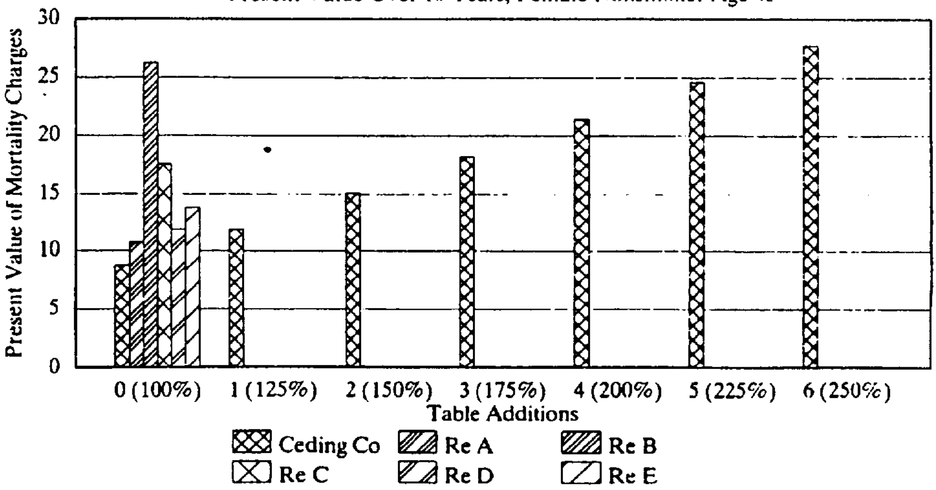


Figure 1.4a – STANDARD MORTALITY CHARGES
Female Smoker Age 45

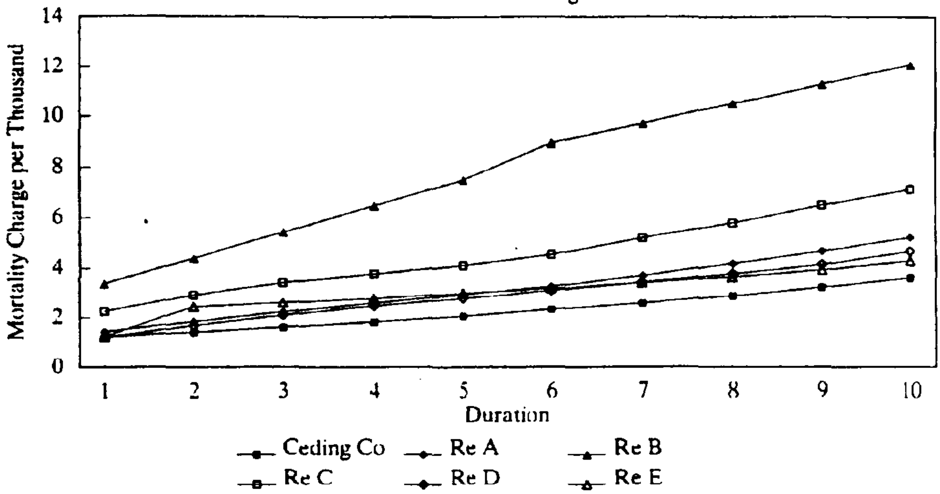
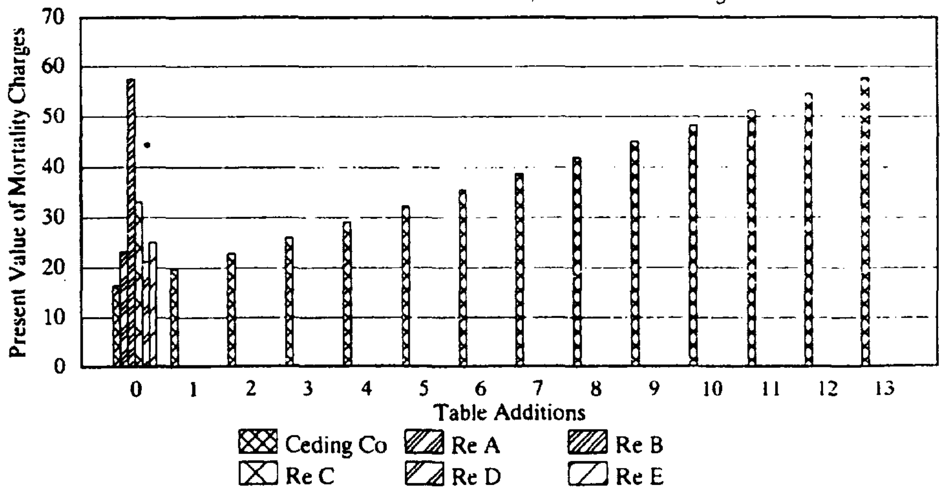



Figure 1.4b – MORTALITY CHARGE COMPARISONS
Present Value Over 10 Years, Female Smoker Age 45



### 1.3 Recovering reinsurance costs

In the late 1970's and early 1980's, the decision to place a substandard policy with a reinsurer usually rested with the underwriter. As the complexity of reinsurance has increased, the actuarial department has become more involved in placing substandard cases. Because of the use of inverse underwriting in the facultative reinsurance market, the decisions to place such cases are no longer straightforward.

When an insurer shops a case from a particularly productive agent, it will try to be as competitive as possible. This may mean placing a case the company would usually not insure and/or placing the case at a rating that is "too" competitive, i.e. with excess reinsurance costs. Knowing that the majority of this agent's business is profitable, the company may feel safe subsidizing a few impaired-risk cases. Companies typically view these situations, those resulting in high reinsurance expenses, as a "cost of doing business". If inverse underwriting is taking place, this "cost" can be significant, and may be taking place on more cases than a company believes to be the case. The actuarial department should be involved in the company's substandard shopping program to help avoid excessive reinsurance costs.

There are three methods that can be used to "place" shopped cases, i.e. determine with which reinsurer to place the case: the aggressive placement method, the conservative placement method, and the compromise placement method. Each spreads costs differently and, hence, produces different profit outcomes for the ceding company.

The three methods will be described in this section. Numerical examples demonstrating the outcomes under each method using a traditional pricing algorithm will be shown in section 3, and a macro pricing algorithm in section 4.

Before describing these placement methods, four ratings must be defined. First, there is the "issue rating" which is the rating that the ceding company assigns the insured. Second, there is the "reinsurance rating" which is the rating that the reinsurer assigns the policy. Third, there is the "ceding company rating" which is the the ceding company's initially underwritten rating. Finally, there is the "actual rating" which represents the insured's true mortality and is used in the asset share as the mortality rate.

### 1.3.1 The aggressive placement method

Under the aggressive placement method, the ceding company looks only at the reinsurers' offered ratings and accepts the lowest offer. This rating becomes the issue rating as well as the reinsurance rating. No evaluation of the underlying reinsurance rates is performed.

For example, assume the ceding company accepts a rating of 150% from a reinsurer on a substandard applicant. The ceding company pays the reinsurer premiums based on the reinsurer's YRT rates at a 150% rating. It issues the policy to the applicant and charges premiums based on the same 150% rating.

Because of its simplicity and its marketing appeal, this method has become the one used most often to place substandard cases. If all participating reinsurers have fairly consistent underwriting standards and reinsurance rates, this method can work well for all parties. But when underwriting practices and reinsurance rates are significantly different, this approach can have major disadvantages - mainly for the ceding company.

For example, assume the "ceding company rating" is 150% and also assume the ceding company is correct, i.e. the "actual rating" is 150%. Now assume that the ceding company receives offers of standard from reinsurer A, 125% from reinsurer B, and 150% from reinsurer C. It accepts reinsurer A's standard rating. But assume reinsurer A's rates are about 150% of the ceding company's standard mortality. The ceding company will issue the policy at a standard rating, but actually experience 150% on its retained portion, and

150% on the ceded portion. This means the agent will be happy, the insured will be happy, the reinsurer will be happy, and the ceding company may lose money.

### 1.3.2 The conservative placement method

Under the conservative placement method, the ceding company issues the policy at the "ceding company rating" and reinsures the policy with the reinsurer with the lowest offered rates (not rating).

For example, assume the ceding company rating is 200%. After receiving all of the reinsurers' offers, it finds that reinsurer A has the lowest present value of rates at a rating of 150% even though it did not offer the lowest rating. So it cedes the policy to reinsurer A at 150%, but issues the policy to the applicant at a 200% rating.

This requires more analysis than the aggressive placement method because the offered rates, as well as the rating, must be analyzed. It is also more difficult to administer because two ratings must be stored in the administration system: the issue rating for policy values and the reinsurance rating for reinsurance administrative tasks such as billing and tracking mortality experience.

Generally, the reinsurer wants the right to approve a case where there is a higher issue rating than reinsurance rating (Tiller 40). This is to avoid having agents mistakenly perceive the higher issue rating as the rating bid by the reinsurer, thus making the reinsurer appear less competitive.

The conservative placement method can be profitable, but it has two possible drawbacks. First, it places all of the reinsurance cost burden on the policyholder. The issue rating charged to the policyholder is not reduced, but the reinsurance rating charged to the ceding company by the reinsurer is reduced. So the policyholder is paying the difference between the issue rating and reinsurance rating. This is used by the ceding company to cover reinsurance costs.

Second, agents may view the ceding company as uncompetitive. Because the issue rating is not reduced, the agent must either attempt to place the case at the ceding company rating or submit the application with another company. As a result, the ceding company may place little substandard business.

On the other hand, this method would result in low placement ratios for those reinsurers using inverse underwriting. This could eventually lead to the elimination of such practice because these companies would probably adjust their rates and ratings in order to place business.

Unfortunately, because of the two drawbacks cited above, this method cannot realistically be used. However, analyzing the outcomes under this method can provide valuable information about the offered ratings and their underlying rates.

### 1.3.3 The compromise placement method

Under the third method, the compromise placement method, the policy is issued, if feasible, at the lowest offered rating. The policy is ceded to the reinsurer with the lowest offered rates. For example, assume the following reinsurers' offers:

Reinsurer A: 125% rating, pv(rates per thousand) = \$20.
Reinsurer B: 100% rating, pv(rates per thousand) = \$25.
Reinsurer C: 100% rating, pv(rates per thousand) = \$30.
Reinsurer D: 150% rating, pv(rates per thousand) = \$15.
Reinsurer E: 150% rating, pv(rates per thousand) = \$20.

The ceding company then <u>issues</u> the policy to the applicant at the lowest rating, 100% (standard). However, it <u>reinsures</u> the policy with reinsurer D at 150% because it has the lowest present value of rates.

Here the agent and applicant will receive the most competitive rating. The ceding company will use the reinsurer that offers the lowest offered rates. So the reinsurance costs are spread between the ceding company and reinsurers. They are spread to the reinsurers by means of placing the policy with the company offering the lowest rates. The effect is that the reinsurers charging higher rates may be pressured into lowering their rates.

It may be, however, that under the above scenario, the substandard policy does not meet the same profit goals as standard policies for this product. If so, the ceding company may choose to reduce the profit goals and/or issue the policy at a rating higher than standard. To proceed with these options, a "compromise profit goal" should first be decided. Then the company can determine if the goal can be met by spreading the costs between the ceding company and reinsurers, i.e. issued at standard. If not, the compromise profit goal may also be met by spreading the costs to the policyholder and/or agent through increased policy charges (a higher issue rating), and possibly reduced commissions.

Expanding on the example above, assume the ceding company reduced its profit goal from a profit margin of 5% to a compromise profit margin of 1%. Assume it did not meet its compromise profit goal at the standard rating, but by increasing the issue rating to 125% and not paying agent commissions on the <u>increase</u> in premium, it meets its compromise profit goal. Under this scenario, the cost is borne partially by the policyholder who pays a 125% premium, partially by the agent who receives full commissions only on the standard portion of the premium, and partially by the ceding company who accepts reduced profit.

The compromise placement method can be summarized in the following seven step algorithm:

1. Decide compromise profit goal.

2. Analyze the profit when the case is <u>issued</u> at the lowest offered rating but the case is placed with the reinsurer with the lowest rates. This step

will be termed the "initial compromise method", since it involves spreading the costs only between the reinsurers and the ceding company. This step results in the same issue rating as the aggressive placement method since it uses the lowest offered rating.

3. If the compromise profit goal is not met in step 2, determine how much the issue rating must be increased above the lowest offered rating (increasing the insured's premium) to meet the compromise profit goal. This step will be termed the "issue rating increase" method. The issue rating increase is subject to a maximum which is the rating of the reinsurer with the lowest rates. This restriction is made to avoid straining the relationship with this reinsurer. This step now includes the policyholder in sharing the reinsurance costs.

4. Determine how much the issue rating must be increased above the lowest offered rating, when paying commissions only on the base policy, to meet the compromise profit goal. This step will be termed the "reduced commissions" method. Again, the issue rating increase is subject to the maximum rating of the reinsurer with the lowest rates. This step now includes the agent in sharing the reinsurance costs, so all parties share in the cost.

5. If none of steps 2, 3 or 4 result in meeting the compromise profit goals, consider adjusting the compromise profit goal downward and repeat these steps. If no compromise goals can be met, go to step seven.

6. Depending on which of the steps produces results which meet the compromise goal, decide which method to use. This decision depends on company philosophy and competition. Perhaps the most equitable and competitive decision would be to use the "reduced commissions" method since all parties

share in the reinsurance costs. In addition, this step produces the lowest rating because reduced commissions are used to offset increases in the issue rating.

7. In the unlikely event that profit is not possible, the ceding company may choose to renegotiate the facultative rates with all participating reinsurers. This would mean that all participating reinsurers are using inverse underwriting, which is highly unlikely. Hopefully, this step will never have to be performed.

The compromise placement method is the most complex of the three because of the amount of analysis involved. It requires the actuarial department to be involved in the post-pricing activities of placing and issuing the case. However, it may require all parties to share in the reinsurance costs. It can also result in the same amount of placement as the aggressive placement method.

So the end-result of the compromise method is an "everybody wins" situation. The case is issued at the most competitive rating possible. The reinsurer with the "best" offer gets the business because the ceding company is now shopping the price, not the rating. The agent places the case. And the ceding company makes a profit.

## 2. INCORPORATING REINSURANCE INTO THE TRADITIONAL PRICING MODEL

Building on the concepts presented in section 1, sections 2 and 3 will address the impact of reinsurance by analyzing three important phases of a product's life:

Phase I. The pricing of the product <u>without</u> reinsurance will be addressed in this section after a substandard/reinsurance asset share formula is developed.

Phase II. The pricing of the product with reinsurance and its effect will be addressed in section 3.

Phase III. Effectively <u>placing</u> a substandard policy with a reinsurer <u>after</u> the product is priced is addressed at the end of section 3.

In this section, section 2, a substandard asset share formula will be developed using a recursive traditional asset share formula. Then reinsurance will be incorporated into this substandard formula. This modified asset share formula will then be used in section 3 to compare the profit outcome without reinsurance to the profit outcomes under the various reinsurance scenarios using the aggressive, conservative, and compromise placement methods.

The demonstrations in this section will assume that substandard extra premiums on an ordinary whole life participating product have already been priced using the traditional recursive asset share formula. This means that it is assumed that the premiums were developed without considering reinsurance.

Illustrations without reinsurance will be shown for issue age 45 for male nonsmoker, male smoker, female nonsmoker, and female smoker classifications.

## 2.1 Asset share formula

The traditional formula developed by David B. Atkinson will be used as a basis in developing the substandard/reinsurance traditional recursive asset share formula[2]. The tax portion of the formula will be expanded to include deferred.acquisition cost taxes, (DAC taxes), which are incurred as a result of the 1990 Revenue Reconciliation Act. Current tax reserves will be added as well. Then the reinsurance variables will be integrated into the formula.

### 2.1.1 The basic formula

Some timing assumptions must be made regarding decrements. Deaths are assumed to occur, on average, in the middle of the year. Lapses are assumed to occur at year end. Additional assumptions are annual premiums, all issues occur on January 1, taxes are paid at the end of the year, and all policies are are of the same (average) size. Once all assumptions and pricing items are decided, the recursive asset share formula can be used to determine surplus and asset shares, where these are:

$$\text{surplus}_{x,t} = \text{assets}_{x,t} - \text{liab}_{x,t};$$

$$AS_{x,t} = \frac{\text{assets}_{x,t}}{l_{x,t}};$$

where x is the issue age and t is the policy year.

Liabilities and assets are:

$$\text{liab}_{x,t} = V_{x,t}\, l_{x,t};$$

$$\text{assets}_{x,t} = \text{assets}_{x,t-1} + \text{premium}_{x,t-1} + \text{invinc}_{x,t} - \text{expense}_{x,t} - \text{polben}_{x,t} - \text{tax}_{x,t}.$$

2 For a detailed discussion of the formula, refer to the study notes Introduction to Pricing and Asset Shares (210-25-90) and Pricing Individual Life Insurance (340-32-89) published by the Society of Actuaries.

The premium portion of the assets, paid at the beginning of policy year t, is:

$$premium_{x,t-1} = \left[ premrate_{x,t-1} + \frac{polfee}{avgsize_x} \right] l_{x,t-1}.$$

The expense portion of the assets each year is:

$$expense_{x,t} = begexp_{x,t} + endexp_{x,t} + dthexp_{x,t};$$

where

$$begexp_{x,t} = \left[ \frac{exppol_{x,t}}{avgsize_x} + \frac{expthou_{x,t}\ DB_{x,t}}{1000} \right] l_{x,t-1} + expprem_{x,t}\ premium_{x,t-1};$$

$$endexp_{x,t} = \frac{explapse_t}{avgsize_x} l_{x,t-1}\ qw_{x,t-1}$$
$$+ \frac{expdiv_t}{avgsize_x} l_{x,t-1}\ (1 - qd_{x,t-1});$$

and death expense is:

$$dthexp_{x,t} = \frac{expdeath_t}{avgsize_x} l_{x,t-1}\ qd_{x,t-1}.$$

The policy benefits portion of the assets each year is:

$$polben_{x,t} = deathben_{x,t} + surrben_{x,t} + divben_{x,t};$$

where (given that the unearned premium is returned at death):

$$deathben_{x,t} = (DB_{x,t}\ l_{x,t-1} + \tfrac{1}{2}premium_{x,t-1})\ qd_{x,t-1};$$

$$surrben_{x,t} = CV_{x,t}\ l_{x,t-1}\ qw_{x,t-1};$$

and the yearly dividend benefit is:

$$divben_{x,t} = dividend_{x,t}\ l_{x,t-1}\ (1 - qd_{x,t-1}).$$

The investment income portion of the assets each year is:

$$invinc_{x,t} = (assets_{x,t-1} + premium_{x,t-1} - begexp_{x,t})\ i_t$$
$$- (deathben_{x,t} + dthexp_{x,t})\ [(1 + i_t)^{\frac{1}{2}} - 1].$$

The tax portion of the assets each year is:

$$tax_{x,t} = taxinc_{x,t}\ taxrate_t.$$

The taxable income is ($DACtax_{x,t}$ represents the DAC taxable amount):

$$taxinc_{x,t} = premium_{x,t-1} + invinc_{x,t} - expense_{x,t} - polben_{x,t} - (taxV_{x,t}\, l_{x,t} - taxV_{x,t-1}\, l_{x,t-1}) + DACtax_{x,t}.$$

Tax reserves are:

$$taxV_{x,t} = \min[V_{x,t}, \max(CV_{x,t}, {}_{fp}V_{x,t})]$$

where:

$V_{x,t}$ is the statutory reserve,

$CV_{x,t}$ is the cash value,

and ${}_{fp}V_{x,t}$ is the federally prescribed reserve.

The federally prescribed reserve mandates the CRVM method using the prevailing mortality and interest rate. For 1992, the mortality table is the 1980 Commissioners Standard Ordinary (CSO) table and the applicable federal rate is 8.4%. The applicable federal rate applies on an issue year basis, so these calculations assume 8.4% for all years[3].

The DAC taxable amount for individual life insurance is 7.7% of premium paid each year. According to Internal Revenue Code (IRC) section 848, this premium is treated as capital expense and is "allowed as a deduction ratably over the 120-month period beginning with the first month in the second half of such taxable year" (Deloitte & Touche 5565-3). This means 10% of the 7.7% of the premium paid each year (the tax) is deductible each year over this 120 month period. But a special adjustment must be made due to the second half of the year provision. This translates to a 5% deduction (½ year deduction) in the first year, 10% in years two through ten, and the remaining 5% in the eleventh year. DAC tax adds complexity because $premium_{x,t-1}$ for each policy year must be carried for 11 years in the calculations.

3 The 1993 applicable federal rate (AFR) is 8.1%. With the volitile interest enviroment, the pricing actuary should be up to date on AFR and possibly project anticipated changes.

To calculate the profit margin to be used as a profit goal, four additional items must be calculated:

$$\text{gain}_{x,t} = \text{premium}_{x,t-1} + \text{invinc}_{x,t} - \text{expense}_{x,t} - \text{polben}_{x,t} - \text{tax}_{x,t} - (V_{x,t}\ l_{x,t} - V_{x,t-1}\ l_{x,t-1});$$

$$\text{profit}_{x,t} = \text{gain}_{x,t} - \text{surplus}_{x,t-1}\ i_t\ (1 - \text{taxrate}_t);$$

$$\text{pvprofit}_x = \sum_{t=1}^{n} \text{profit}_{x,t}\ D_t;$$

$$\text{pvprem}_x = \sum_{t=1}^{n} \text{premium}_{x,t-1}\ D_{t-1}.$$

The targeted profit goal year is n. $D_t$ is the interest-only discount factor and uses the after tax interest rate ($j_t$):

$$j_t = i_t\ (1 - \text{taxrate}_t);$$

$$D_0 = 1;$$

$$D_t = \frac{D_{t-1}}{1 + j_t}.$$

Now the profit margin of present value of profit over present value of premium can be calculated as:

$$\text{pvprofprem}_x = \frac{\text{pvprofit}_x}{\text{pvprem}_x}.$$

In addition to $\text{pvprofprem}_x$, a Modified Anderson Book Profit internal rate of return profit margin which reflects target surplus will also be used. Target surplus has many uses in pricing. These include maintaining minimum acceptable operating capital levels necessary for solvency, adverse deviations in pricing assumptions, commercial ratings, expansion plans, and regulatory purposes. Risk based capital formulas provide for similar objectives and are often used in target surplus pricing. As the name implies, "risk" protection is the main objective of the formulas. Asset depreciation (C-1 risk), pricing inadequacy (C-2 risk), interest rate risk (C-3 risk), and a general contingency risk (C-4 risk) all should be considered when developing a formula. The risk based capital formula for target surplus that will be used is:

$$\begin{aligned} targsurplus_{x,t} &= asset\%_x \; assets_{x,t} \\ &+ NAR\%_x \; NAR_{x,t} \; l_{x,t} \\ &+ reserve\%_x \; V_{x,t} \; l_{x,t} \\ &+ prem\%_x \; premium_{x,t-1}. \end{aligned}$$

The percent coefficients represent risk factors which should be set appropriately by product line. For a life insurance product, the asset factor could be used to represent asset depreciation based on the company's split of invested assets. The net amount at risk (NAR) factor could be used to represent pricing inadequacy from adverse mortality and lapse experience. The reserve factor could be used to represent interest rate risk or disintermediation. And the premium factor could be used to represent a general contingency risk such as guarantee fund assessments. Both the formula and the factors are specific to each company and are therefore difficult to define on an industry-wide basis[4]. Once the target surplus is determined, the annual surplus must be adjusted as follows:

$$surplus_{x,t} = surplus_{x,t} - targsurplus_{x,t}.$$

This surplus is then used in $profit_{x,t}$ which, in turn, is used for $pvprofit_x$. Now the Modified Anderson Book Profit internal rate of return, which is essentially the return on investment using target surplus ($targsurpROI_x$) can be solved for. The yield rate is found when the relationship $pvprofit_x = 0$ is satisfied.

### 2.1.2 Pricing assumption variables

For substandard/reinsurance pricing, additional consideration is needed for

---

4 For additional information on target surplus and risk based capital, refer to the study notes Target Surplus Formulas (443-26-92), Risk-Based Capital: Is Your Company Ready (443-80-93) published by the Society of Actuaries. Also refer to Report of the Industry Advisory Committee to the Life Risk Based Capital Working Group Part I, American Council of Life Insurance, 1991.

expenses, lapses, mortality, and retention. Expenses are higher than standard, as are lapses (Atkinson, Introduction to Pricing and Asset Shares 36-37). Studies should be conducted to determine the additional amounts. This can be done in-house if enough experience exists to make the results credible, otherwise industry studies are available.

Additional expenses for substandard/reinsurance pricing are attending physician statement costs, EKG's, stress tests, blood testing, reinsurance administration costs, and shopping costs such as paper, telephone, postage, and facsimiles. Depending on the ceding company's underwriting, some of these expenses apply to standard applications as well, but these expenses are always associated with substandard shopped cases. Sample expenses which will be assumed in the asset share calculations are listed below:

| | |
|---|---|
| Attending physician average cost: | $32 |
| EKG average cost: | $29 |
| Stress test average cost: | $3 |
| Reinsurance annual administration cost: | $5 |
| Average shopping costs: | $15 |

LIMRA studies state that lapse rates are higher for substandard policies versus standard, with the biggest difference in the first year and almost no difference by the fourth year (Atkinson, Introduction to Pricing and Asset Shares 36). Reasons lapse rates are higher are that: the premium is high in the eyes of the insured, the insured and agent have an incentive to shop for lower rates, and substandard conditions may "wear off" over time (Atkinson, Introduction to Pricing and Asset Shares 37).

The most important assumption in pricing substandard in a facultative shopping program is the actual mortality rating. This is usually represented by a percentage, 100% being standard. Complexity is introduced here because four ratings must be considered: the ceding company rating, the issue rating, the reinsurance rating, and the actual rating. The issue and reinsurance ratings depend on the placement method being used. The actual rating depends on the ceding company's confidence in its underwriting and the reinsurers' offers.

When inverse underwriting is being used by a reinsurer, large differences can exist between the ceding company rating and the reinsurer's offered rating. When the rates behind the reinsurer's rating are studied, a better idea can be gotten of the mortality that the reinsurer actually expects. This information may be used to decide on the "actual mortality" used in the asset share calculations.

Retention is another item that must be included as a variable in the pricing scheme because it can have a significant impact on profit results. No matter what the reinsurer's offered rating is, if aggressively low rates are offered in relation to what the ceding company's rates are, the ceding company will be inclined to cede a larger percentage of the policy than it would otherwise. Retention is not a static assumption because it will vary depending on the profitability of placing the case with a particular reinsurer. Adjusting the retention to enhance profitability will be discussed further in section 3.

Because the focus of this paper is not on interest rate assumption(s) by duration, a simplified assumption for investment income based on a constant rate of return is made.

### 2.1.3 The reinsurance integrated formula

Now that the basic formula has been developed to account for DAC taxes and the current tax reserves, provisions for reinsurance will be added. Proportional facultative yearly renewable term (YRT) reinsurance agreements are typically used in substandard shopping programs. To incorporate reinsurance in the formula, several adjustments must be made to the calculations.

At the beginning of the year, $begexp_{x,t}$ must include the reinsurance premium based on the YRT rate for policy year t and the amount reinsured.

The amount reinsured is the percent of the policy ceded multiplied by the net amount at risk for the year ($NAR_{x,t}$). The reinsurance premium is then:

$$reinprem_{x,t-1} = (1 - retention_{x,t})\ NAR_{x,t}\ \frac{YRTrate_{x,t}}{avgsize_x}\ l_{x,t-1}$$

The expenses incurred by the ceding company regarding reinsurance ($exprein_t$), like shopping and administrative costs, must also be included in the beginning of the year expenses. This expense is calculated as follows:

$$reinexp_{x,t} = \frac{exprein_t}{avgsize_x}\ l_{x,t-1}.$$

The amount of premium tax represented by the reinsurance premium is typically reimbursed by the reinsurer at the end of the year but will be assumed to be deducted at the beginning of the year when premiums are paid (Atkinson, Pricing Individual Life Insurance 106). This is done as a convenience and is part of the facultative agreement.

So the adjusted $begexp_{x,t}$ is calculated as follows:

$$begexp_{x,t} = begexp_{x,t} + reinprem_{x,t-1} + reinexp_{x,t} - reinprem_{x,t-1}\ premtaxrate.$$

The DAC taxable amount must also be adjusted. IRC section 848(d) defines the amount of premium to which the tax applies as the excess of the gross premium less considerations incurred for reinsurance (Deloitte & Touche 5565-3)[4]. This means the DAC taxable amount and deduction each year must be offset by the reinsurer's portion ($reinprem_{x,t-1}$). This makes the DAC tax calculation even more complex. An illustration of DAC tax calculations and the development of the $DACtax_{x,t}$ formula are shown in appendix 3.

4 On December 28, 1992, the IRS issued final DAC tax regulations that defined DAC net reinsurance premiums as the net entire cash flow under the reinsurance agreement, including, but not limited to:

- actual premiums paid to the reinsurer,
- ceding commissions and annual allowances,
- reimbursement of claims and benefits, and
- termination payments.

One last adjustment must be made. The death benefit must be reduced by the amount of the claim paid by the reinsurer and the unearned premium returned by the reinsurer:

$$\text{deathben}_{x,t} = \text{deathben}_{x,t} - \tfrac{1}{2}\text{reinprem}_{x,t-1}$$
$$- (1 - \text{retention}_{x,t})\ \text{NAR}_{x,t}\ l_{x,t-1}\ qd_{x,t-1}.$$

## 2.2 Profit outcomes without reinsurance

To illustrate the impact of reinsurance on profitability, the profit outcomes of the product without reinsurance first need to be determined. These figures will then be compared to the profit outcomes after reinsurance is employed.

This section will show that the product meets the ceding company's profit goals when no reinsurance is used. This is done so the impact of reinsurance can later be shown on a product known to be profitable.

For these illustrations, the ceding company's federal corporate income tax rate is assumed to be 34% and the premium tax rate is assumed to be 2½%. Also assume that the ceding company makes the following non-reinsurance related decisions based on company philosophy regarding profitability and competition:

Base policy (standard portion) reserves: CRVM 1980 CSO mortality table at a 5% valuation interest rate.

Base cash values: Minimum permitted by the Standard Nonforfeiture Law method using the adjusted premium formula with a 6% guaranteed interest rate.

Base dividends: Contribution principle's three factor formula.

Substandard extra reserves: Net level premium method based on the 1980 CSO mortality table at a 5% valuation interest rate.

Substandard extra cash values: None. (Base only)

Substandard extra dividends: None. (Base only)

Premium load: 10% load on gross premium.

Policy fee: $50

Agent commissions: 50% of premium first year, 4% renewal years. Equal overrides for the general agent.

Profit goals without reinsurance: Recover acquisition expenses before 15 years (break-even year < 15); a goal of 5%, after taxes, for the ratio of the present value of profit over present value of premium for n = 30 years; and a goal of 12% return on investment, after taxes, with an annual target surplus of 3% of reserve plus 50¢ per thousand net amout at risk to cover pricing and interest rate risks, again for n = 30 years.

The following asset share assumptions are made based on the ceding company's experience studies:

| | |
|---|---|
| $avgsize_x$: | $200 |
| $DB_{x,t}$: | $1000 |
| $expthou_{x,1}$: | $1.10 |
| $expthou_{x,t>1}$: | $0.00 |
| $expdeath_t$: | $225 |
| $explapse_t$: | $4.00 |
| $expdiv_t$: | $5.00 |

average actual rating: 200%

The net level substandard extra premium is calculated as follows:

$$subextraprem_x = \frac{avgsize_x \; ({}^{s+e}A_x - {}^{s}A_x)}{{}^{s+e}\ddot{a}_x}$$

where "s" represents standard mortality and "e" represents the extra mortality; s+e superscripted factors are fully substandard and are based on

$$^{80CSO}q_{x,t} + (\text{issue rating} - 1)\ {}^{e}q_{x,t};$$

s superscripted factors are standard mortality only and are based on $^{80CSO}q_{x,t}$.

Substandard extra reserves are calculated using the prospective reserve formula as follows:

$$ {}^{e}V_{x,t} = \text{avgsize}_x \left( {}^{s+e}A_{x+t} - {}^{s}A_{x+t} \right) - \text{subextraprem}_x \; {}^{s+e}\ddot{a}_{x+t} $$

Both the substandard extra premium and reserve formulas charge mortality based on the difference between fully substandard and standard net single premiums, and discount the extra premium using a fully substandard life annuity due.

Due to the separate reserves, separately identified premium, and the fact that the policy's net surrender value is not affected or used to pay the premiums, this is a qualified substandard risk and separate tax reserves will be calculated as described by IRC section 807(e)(5) (Deloitte & Touche 5511).

The actual rating to be assumed in the asset share calculations was developed by conducting a mortality study on the ceding company's substandard business. Based on the results of the study, the average was determined to be 200%. This average will be used as the actual rating in all asset share calculations.

Because the actual rating is based on the ceding company's experience, the ceding company rating is also assumed to be 200%. So the issue rating, which is the ceding company rating when reinsurance is not considered, is assumed to be 200%

To summarize, the following assumptions will be made for the four classifications to be illustrated:

| Classification | Age | Actual rating | Issue rating |
|---|---|---|---|
| Male nonsmoker | 45 | 200% | 200% |
| Male smoker | 45 | 200% | 200% |
| Female nonsmoker | 45 | 200% | 200% |
| Female smoker | 45 | 200% | 200% |

Figure 2.1 on the following page shows surplus results for these four classifications. If all assumptions are met, the illustrations show that without the use of reinsurance, all four policies will meet the ceding company's profit goals of recovering acquisition costs (breaking even) before 15 years with 30 year profit margins of at least 8%. The aggregate 30$^{th}$ year

surplus for these four classifications is found by multiplying the average size ($avgsize_{45} = 200$) by the sum of the individual surplus positions in the $30^{th}$ year ($surplus_{45,30}$):

$$aggsurplus_{45,30} = 200\ (42.86 + 50.08 + 43.93 + 47.19) = \$36,812.$$

For a complete illustration of the asset share calculations for the male nonsmoker, see appendix 1.

**Figure 2.1 - Asset Share Results Without Reinsurance**

| Parameters for the asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| reinsurer: | N/A | N/A | N/A | N/A |
| retention: | 100% | 100% | 100% | 100% |
| reinsurer rtg: | N/A | N/A | N/A | N/A |
| issue rtg: | 200% | 200% | 200% | 200% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| *substd extra: | 4.46 | 3.70 | 3.35 | 3.07 |
| $premium_{45,0}$: | 22.85 | 29.06 | 18.51 | 21.44 |
| policy year(t) | Per unit $surplus_{45,t}$ | | | |
| 1 | -10.39 | -11.79 | -8.36 | -9.16 |
| 2 | -11.06 | -11.66 | -8.85 | -9.19 |
| 3 | -11.42 | -11.31 | -8.87 | -8.75 |
| 4 | -10.95 | -10.02 | -8.25 | -7.63 |
| 5 | -10.24 | -8.48 | -7.49 | -6.41 |
| 6 | -9.32 | -7.16 | -6.64 | -5.38 |
| 7 | -8.42 | -6.16 | -6.03 | -4.71 |
| 8 | -7.41 | -5.03 | -5.37 | -4.00 |
| 9 | -6.30 | -3.75 | -4.64 | -3.21 |
| 10 | -5.09 | -2.31 | -3.79 | -2.30 |
| 11 | -3.26 | -0.13 | -2.41 | -0.79 |
| 12 | -1.39 | 2.07 | -0.95 | 0.79 |
| 13 | 0.56 | 4.32 | 0.60 | 2.53 |
| 14 | 2.58 | 6.60 | 2.26 | 4.39 |
| 15 | 4.65 | 8.92 | 4.05 | 6.35 |
| 16 | 6.73 | 11.24 | 5.99 | 8.40 |
| 17 | 8.90 | 13.66 | 8.05 | 10.56 |
| 18 | 11.15 | 16.13 | 10.23 | 12.83 |
| 19 | 13.49 | 18.66 | 12.51 | 15.21 |
| 20 | 15.92 | 21.26 | 14.88 | 17.67 |
| 21 | 18.42 | 23.90 | 17.35 | 20.21 |
| 22 | 20.98 | 26.60 | 19.92 | 22.84 |
| 23 | 23.58 | 29.33 | 22.58 | 25.56 |
| 24 | 26.20 | 32.11 | 25.33 | 28.36 |
| 25 | 28.86 | 34.94 | 28.18 | 31.25 |
| 26 | 31.42 | 37.82 | 31.12 | 34.23 |
| 27 | 34.18 | 40.77 | 34.15 | 37.30 |
| 28 | 36.99 | 43.79 | 37.28 | 40.48 |
| 29 | 39.88 | 46.89 | 40.55 | 43.78 |
| 30 | 42.86 | 50.08 | 43.93 | 47.19 |
| $pvprofprem_{45}$: | 5.12% | 4.79% | 6.40% | 5.99% |
| $targsurpROI_{45}$: | 12.28% | 13.70% | 13.27% | 14.17% |

* Note that the substandard extra premiums are smaller for smokers than nonsmokers. This is because the substandard assessment is based on aggregate mortality, not on smoker distinct mortality.

## 3. TRADITIONAL PRICING MODEL ANALYSES

As mentioned in section 2, the three phases of a product's life that are being studied are: pricing without reinsurance, pricing with reinsurance, and effectively placing the individual substandard policies after pricing is completed.

The last section addressed the first phase and demonstrated that without reinsurance, all four policies meet the ceding company's profit goals. This section will concentrate on the last two phases using a traditional pricing algorithm. These are outlined in more detail below.

II. Pricing the product <u>with</u> reinsurance.

A. Negotiate facultative agreements with each reinsurer and obtain their YRT rates.

B. Assuming that the actual rating is based on the ceding company's experience, and using simplified assumptions, make an assumption as to each reinsurer's offered rating to be used for pricing purposes. This is done using "equivalent rating tables", which are discussed in section 3.1.

C. Determine if the aggressive placement method produces profitable results. This method is the "lower bound" in the search for the most effective placement method.

D. Determine if the conservative placement method produces profitable results. This method is the "upper bound". If this method does not produce profit, then it can be assumed that no profit can be made if reinsurance is used.

E. If profit is attainable with reinsurance, use the compromise placement method to determine which method best suits the company's objectives. Within the compromise method, three alternatives may be used, each spreading the reinsurance costs differently. These alternatives produce profit results which fall somewhere between the aggressive and conservative methods.

III. Effectively placing individual policies after pricing is completed.

A. Retention will be shown to be a valuable placement tool which can be used to precisely meet profit goals.

B. A computer program can be developed to be used for both pricing and placing the product.

So phase II, in a sense, uses a binary search to find the most effective reinsurance placement method. Phase III points out the importance of the actuarial department's involvement in placing individual policies once the pricing is completed.

This section will follow the order of the outline. A model solution using the traditional pricing approach will be given between phase II and III. Step A of phase II is described sufficiently in the outline for now, but will be given more attention throughout the section and in the model solution. The focus will now turn to step B of phase II - developing equivalent rating tables.

### 3.1 Equivalent rating tables

In order to measure how aggressive a reinsurer is in its underwriting, "equivalent rating" tables will be developed. To develop equivalent rating tables, some simplifying assumptions must be made. It will be assumed that the "actual rating" is a constant variable. This implies that the rate of mortality is known. From this actual rating, hypothetical offers are developed for each company, starting with the ceding company.

Since the actual rating is representative of the ceding company's average substandard experience of 200%, it will be assumed that the ceding company rating is 200%. The 30-year present value of 200% mortality charges is calculated for the ceding company.

Once an assumption has been made for the actual rating, a second simplifying assumption is that the ceding company and all the reinsurers want to charge the same price. This is where the equivalent rating is developed. Based on the 30-year present values of each reinsurer's YRT rates, the table rating which produces the value nearest to the present value of the ceding company's rates is assumed to be the reinsurer's offer.

For example, assume the 30-year present value of the ceding company's 200% mortality charges per thousand is $50. (This is the ultimate mortality charged to the policyholder by the ceding company <u>before</u> reinsurance.) Reinsurer A's 30-year present value of its per thousand YRT rates at 150% is $44 and $51 at 175%. It would then be assumed that reinsurer A's offer is 175% since it is closest to the ceding company's 200% present value.

**Figure 3.1a - Equivalent rating table**

| CEDING COMPANY RATING AND REINSURERS OFFERS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 200% | 150% | 125% | 125% | 225% | 175% |
| Male Smoker | 200% | 200% | 150% | 100% | 100% | 150% | 175% |
| Female Non | 200% | 200% | 150% | 100% | 125% | 225% | 175% |
| Female Smk | 200% | 200% | 125% | 100% | 100% | 150% | 175% |

Figure 3.1a shows the resulting equivalent rating table based on the reinsurer's rates introduced in section 1.2.5. Figures 3.1b-e on the following two pages illustrate the 30-year present value of each company's rates at its equivalent rating.

For the male nonsmoker (figure 3.1b), assuming each company feels the 30-year present value of their charges should be about $200 per thousand, the

Figure 3.1b – Equivalent rating table, mortality charge comparisons
Male nonsmoker age 45

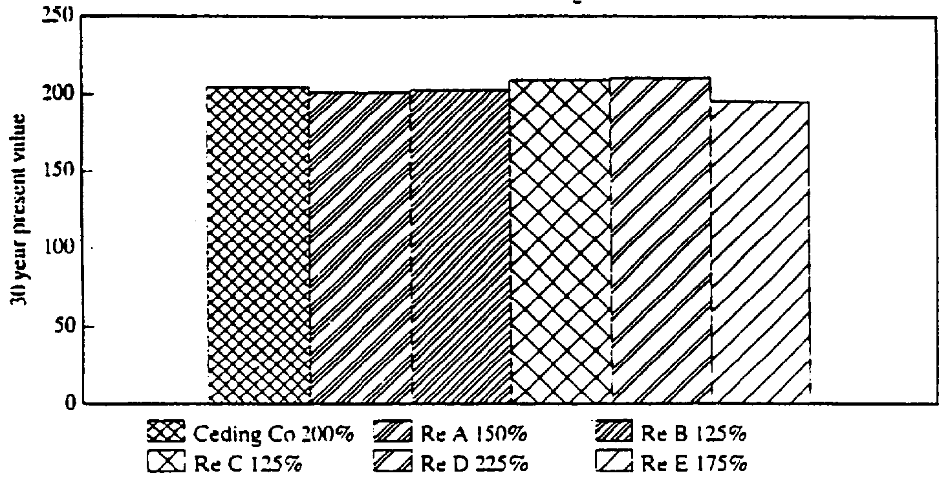



Figure 3.1c – Equivalent rating table, mortality charge comparisons
Male smoker age 45

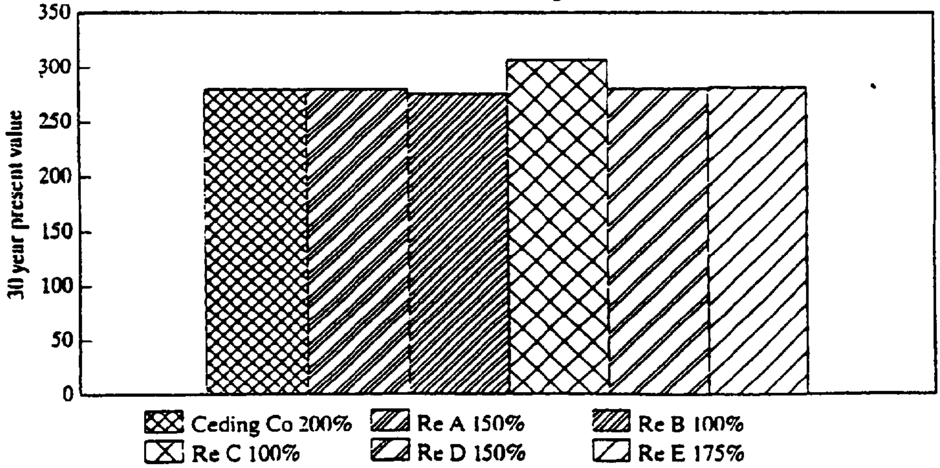


Figure 3.1d – Equivalent rating table, mortality charge comparisons
Female nonsmoker age 45

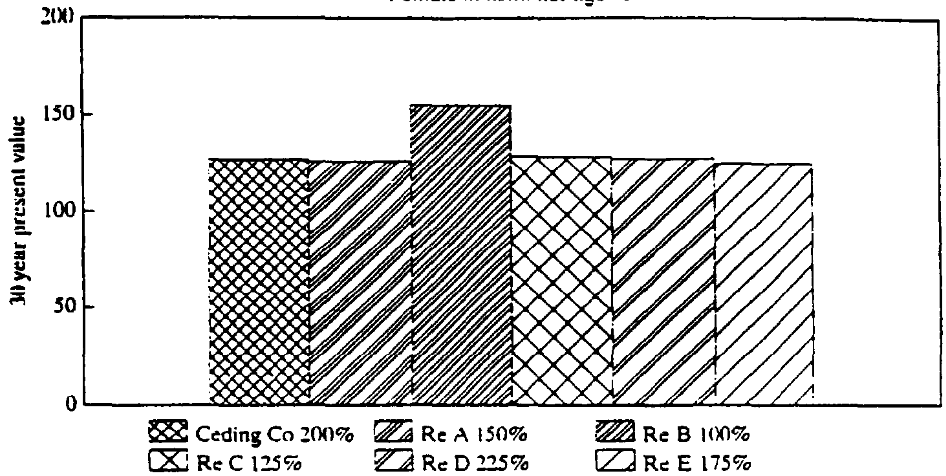
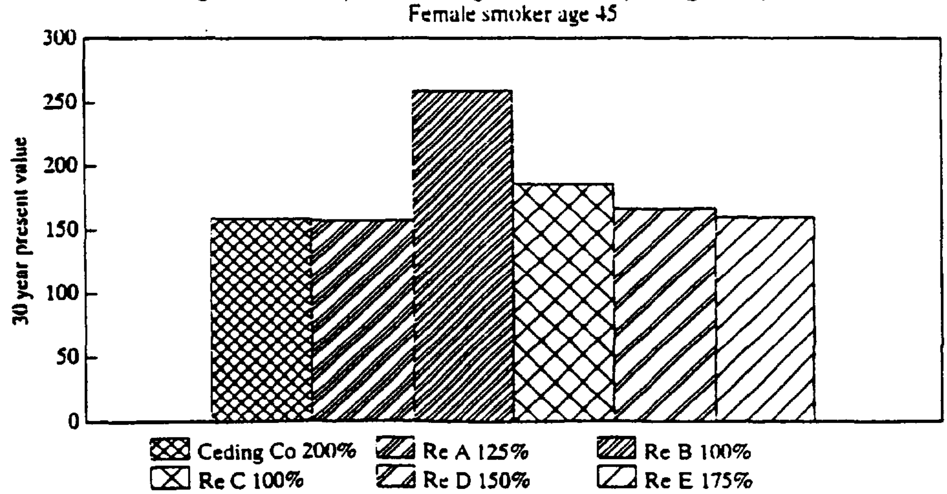



Figure 3.1e – Equivalent rating table, mortality charge comparisons
Female smoker age 45



present values are very close to being equal. So a rating that equates each reinsurer's YRT rates to the ceding company's 200% mortality charges was found. However, reinsurers B and C are able to "shave" three table ratings, i.e. 75%, from the ceding company rating due to their higher underlying rates. For the male smoker (figure 3.1c), the assumed present value of charges, of about $285 per thousand, cannot be met by reinsurer C. This is because reinsurer C's lowest rating, standard, produces a present value that significantly exceeds $285. From this, it must be assumed that reinsurer C's offer is standard, since there is no lower rating. The same is true, to a greater extent, for reinsurer B for both female classifications (figures 3.1d and e). This implies that their standard rates are more than sufficient to cover a risk rated 200% by the ceding company.

The above assumptions must be made because this is the pricing stage. There is no way of knowing exactly how aggressive each reinsurer's underwriting is and hence, what ratings they will offer. However, the reinsurers' rates are known. With these rates it can be estimated what rating equates them to the ceding company's rates at the ceding company rating.

As in the illustration above, it is reasonable to expect a reinsurer's facultative YRT rates to be able to absorb at least one table of the ceding company's mortality charges. But when nine tables of mortality charges can be absorbed at the lowest offer (100%) as with reinsurer B in figure 3.1e, a reinsurer can be extremely aggressive in its underwriting. This is rare, but it does happen.

In summary, equivalent rating tables are a "best guess" at the reinsurers' offers. The equivalent ratings developed in this section will be used throughout the illustrations in section 3.

### 3.2 The aggressive placement method

The aggressive placement method, as described in section 1.3.1, has been the most common method used when placing substandard reinsurance. This section will demonstrate the profit outcomes using the equivalent ratings.

#### 3.2.1 Scenario 1: Ceding entire policy to reinsurer

Figure 3.2a on the following page shows the resulting profitability when the case is ceded to each reinsurer under the four classifications using the aggressive placement method. It shows that reinsurance could produce profitable results if the policies were placed with specific reinsurers and the assumed reinsurance offers were correct. However, the aggressive placement method does not analyze the offers in this manner. The method merely accepts the <u>lowest rating</u> and does not consider the impact on profitability. This rating becomes <u>both</u> the issue and reinsurance rating.

For example, for the male nonsmoker, the company would be most profitable placing the case with reinsurer E, but because it did not offer the lowest rating (175%), it would not place the case with that reinsurer. Placing the case with reinsurers B and C, on the other hand, produces the lowest profitability, but these reinsurers have the lowest ratings (125%), so the case is placed with reinsurer B or C since profitability is not considered. The issue and reinsurance ratings would then be 125%.

Figure 3.2b in appendix 4 shows the yearly per unit surplus and how significant the impact on profitability can be when the following lowest offers are accepted:

| Classification | Actual Rating | Reinsurer | Offered Rating | $\text{Surplus}_{45,30}$ |
|---|---|---|---|---|
| male nonsmoker | 200% | C | 125% | -32.25 |
| male smoker | 200% | C | standard (100%) | -40.01 |
| female nonsmoker | 200% | B | standard (100%) | -32.02 |
| female smoker | 200% | B | standard (100%) | -95.26 |

**Figure 3.2a Aggressive placement method**

Equivalent rating table

| CEDING COMPANY RATING AND REINSURERS OFFERS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 200% | 150% | 125% | 125% | 225% | 175% |
| Male Smoker | 200% | 200% | 150% | 100% | 100% | 150% | 175% |
| Female Non | 200% | 200% | 150% | 100% | 125% | 225% | 175% |
| Female Smk | 200% | 200% | 125% | 100% | 100% | 150% | 175% |

Profit margins

| 30 YEAR PRESENT VALUE OF PROFIT / PRESENT VALUE OF PREMIUM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Issue Rtg | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | = offer | 200% | 5.03% | 0.76% | -3.44% | -4.58% | *5.73% | 4.46% |
| Male Smoker | = offer | 200% | 4.71% | 0.83% | -3.34% | -4.45% | 1.99% | 1.92% |
| Female Non | = offer | 200% | 6.28% | 3.45% | -5.84% | -0.46% | *7.11% | 4.28% |
| Female Smk | = offer | 200% | 5.88% | 1.87% | -14.37% | -3.32% | 2.26% | 3.65% |

| 30 YEAR RETURN ON INVESTMENT USING TARGET SURPLUS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Issue Rtg | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | = offer | 200% | 12.13% | 7.72% | 2.25% | 0.61% | *12.62% | 10.97% |
| Male Smoker | = offer | 200% | 13.54% | 8.11% | 1.35% | &n/a | 10.44% | 9.13% |
| Female Non | = offer | 200% | 13.08% | 10.76% | -5.69% | 6.25% | *13.28% | 10.46% |
| Female Smk | = offer | 200% | 13.97% | 9.85% | #n/a | 0.38% | 9.93% | 10.37% |

'&' Denotes where return on investment was unable to be calculated due to multiple sign changes on profit.

'#' Denotes where return on investment was unable to be calculated due to no sign change on profit (always negative).

Surplus

| 30th YEAR SURPLUS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Issue Rtg | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | = offer | 200% | 42.05 | 5.72 | -24.22 | -32.25 | *50.25 | 35.43 |
| Male Smoker | = offer | 200% | 49.29 | 8.06 | -29.97 | -40.01 | 19.40 | 19.40 |
| Female Non | = offer | 200% | 43.11 | 21.41 | -32.02 | -2.68 | *51.06 | 28.00 |
| Female Smk | = offer | 200% | 46.38 | 12.99 | -95.26 | -21.99 | 16.46 | 27.70 |

Profit margins and surplus were determined using the asset share calculations. For each reinsurer, the calculations used the offered rating as the issue rating and zero retention. For the ceding company, the calculations used the ceding company rating as the issue rating for each classification and full retention.

'*' Denotes where the reinsurer's offered rating is higher than the ceding company rating.

These figures are far below the profit goals set by the ceding company, which were to recover acquisition costs within 15 years with a 30 year present value of profit over premium of 5% and a target surplus return on investment of 12%. The aggregate surplus position at the end of 30 years for these four policies under this scenario is:

$aggsurplus_{45,30}$ = 200 [(-32.25) + (-40.01) + (-32.02) + (-95.26)] = -\$39,908.

To understand why profit has gone from \$36,812 without reinsurance to -\$39,908 after reinsurance, specific pieces of the asset share can be compared. A complete illustration of the calculations for the male nonsmoker is shown in appendix 2. Appendix 2 can be compared to appendix 1 to see how reinsurance impacts $begexp_{x,t}$, $deathben_{x,t}$, and $DACtax_{x,t}$.

Comparing the appendices shows that $begexp_{x,t}$ increases significantly when reinsurance is used in all years except the first. Without reinsurance the issue rating would be 200%, resulting in a significantly higher premium than when the issue rating is 125% under the aggressive placement method. The first year $begexp_{x,t}$ without reinsurance is higher because of the larger first year commissions paid on the higher premium due to the higher issue rating. This increase in commissions outweighs the reinsurance premium and expenses when reinsurance is used. Comparing appendix 1 and 2, $begexp_{45,1}$ is 29.04 with reinsurance versus 31.46 without reinsurance, but $begexp_{45,2}$ is 6.06 with reinsurance versus 4.24 without reinsurance, $begexp_{45,3}$ is 5.79 with reinsurance versus 3.70 without reinsurance and this pattern continues.

The appendices also show a decrease in $deathben_{x,t}$ for all years when reinsurance is used. This is because a portion of the death benefit is paid by the reinsurer. However, the decrease is not enough to offset the increase in $begexp_{x,t}$, which contains the premium paid to the reinsurer. This can be seen by looking at the total expenses for each year, $expense_{x,t}$, which includes both $begexp_{x,t}$ and $deathben_{x,t}$. Only the first year total expense is lower when reinsurance is used (29.07 vs. 31.49). The total expense is significantly higher in years 2 through 30.

The $DACtax_{x,t}$ is slightly reduced in the first nine years when reinsurance is used. In years 10 through 30, $DACtax_{x,t}$, which is now a credit, is lower when no reinsurance is used.

So even though reinsurance lowers first year expenses and the first 9 years' DAC tax, the significant increase in total renewal expenses substantially reduces profitability ($aggsurplus_{45,30}$ of -$39,908 vs. $36,812).

### 3.2.2 Scenario 2: Increasing retention

When retention is increased to 50%, figure 3.2c in appendix 4 shows that the loss is significantly reduced for each classification. The aggregate surplus position at the end of 30 years would now be a loss of -$24,354. However, this is still far from profitable.

### 3.2.3 Conclusions

For these four policies, increasing retention mitigated the loss. However, none of the profit results under the aggressive placement method are close to the target profit goals. So it appears that some reinsurers are using inverse underwriting.

If reinsurers B and C did not participate in the shopping program and only the reinsurers not using inverse underwriting were utilized, the aggressive placement method could produce profitable results. In fact, a 30th year aggregate surplus of $11,904 would result if only reinsurers A, D, and E were considered for the aggressive placement method using the given offers.

| Classification | Actual Rating | Reinsurer | Offered Rating | $Surplus_{45,30}$ |
|---|---|---|---|---|
| male nonsmoker | 200% | A | 150% | 5.72 |
| male smoker | 200% | D | 150% | 19.40 |
| female nonsmoker | 200% | A | 150% | 21.41 |
| female smoker | 200% | A | 125% | 12.99 |

Since the ceding company solicitated offers from five reinsurers, these profit results are not the true results under this placement method. The initial purpose of analyzing this method is not to determine which reinsurers to use, but to determine the financial outcomes under the placement method.

It is possible that a ceding company, even knowing the profit results under this method, may choose to place business with reinsurers B and C in order to obtain the lowest possible rating for their client. This may be justified by the rationale that the aggressive placement method may result in additional standard sales from agents.

If a ceding company finds inverse underwriting is taking place but still wishes to pursue only an aggressive placement method, it could approach the reinsurers which are using inverse underwriting and renegotiate the rates. If it does not wish to renegotiate the rates, then it may choose not to include them in there shopping program. However, it may also wish to utilize another placement method to enhance the profitability. These are demonstrated in the next two sections.

### 3.3 The conservative placement method

Under this method, the policy is issued at the ceding company rating, but is reinsured with the reinsurer which offers the lowest rates. This method is probably not practiced because it defeats one of the main purposes of facultative shopping programs - to place the case at the most competitive issue rating possible.

So analyzing this method is for instructional purposes only. It gives an indication of whether there is profit potential with reinsurance. Since this method is the "upper bound" in the pricing search for a reinsurance placement method, it serves only as a check to see with which reinsurers profit is attainable. If a reinsurer consistently produces losses for each classification, the ceding company may wish to renegotiate the facultative agreement with that reinsurer.

### 3.3.1 Scenario 1: Ceding the entire policy to reinsurer

Figure 3.3a on the following page shows the offers and the resulting profitability with each reinsurer under the conservative placement method. It shows that profit is not attainable for the female smoker when using reinsurer B.

If the hypothetical offers are correct, the best profit is attainable as follows:

| Classification | Actual Rating | Reinsurer | Offered Rating | $Surplus_{45,30}$ |
|---|---|---|---|---|
| male nonsmoker | 200% | E | 175% | 54.36 |
| male smoker | 200% | D | 150% | 49.54 |
| female nonsmoker | 200% | A | 150% | 48.51 |
| female smoker | 200% | A | 125% | 50.36 |

Figure 3.3b in appendix 4 shows that the profit using the above reinsurers under this method is greater than the profit if no reinsurance is used (shown in figure 2.1). The $30^{th}$ year aggregate surplus position is increased from $36,812 to $40,556.

### 3.3.2 Scenario 2: Increasing retention

Figure 3.3c in appendix 4 shows that increasing the retention from 0% to 50%, reduces profitability on all four policies. The $30^{th}$ year aggregate surplus position for the four policies is reduced to $38,361 from $40,556.

### 3.3.3 Conclusions

With the exception of reinsuring the female smoker with reinsurer B, the conservative placement method analysis indicated that profit is attainable in each classification with each reinsurer. This does not mean that profit goals can be met using reasonable techniques. It simply means that by using the ceding company rating, the upper bound, as the issue rating, the ceding company can reduce its risk and still be profitable.

**Figure 3.3a Conservative placement method**

Equivalent rating table

| CEDING COMPANY RATING AND REINSURERS OFFERS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 200% | 150% | 125% | 125% | 225% | 175% |
| Male Smoker | 200% | 200% | 150% | 100% | 100% | 150% | 175% |
| Female Non | 200% | 200% | 150% | 100% | 125% | 225% | 175% |
| Female Smk | 200% | 200% | 125% | 100% | 100% | 150% | 175% |

Profit margins

| 30 YEAR PRESENT VALUE OF PROFIT / PRESENT VALUE OF PREMIUM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Issue Rtg | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 200% | 5.03% | 5.19% | 3.90% | 2.94% | 3.72% | **6.50%** |
| Male Smoker | 200% | 200% | 4.71% | 3.65% | 3.04% | 2.08% | **4.73%** | 3.29% |
| Female Non | 200% | 200% | 6.28% | **7.07%** | 3.44% | 5.60% | 5.35% | 6.04% |
| Female Smk | 200% | 200% | 5.88% | **6.39%** | -5.67% | 3.63% | 5.21% | 5.06% |

| 30 YEAR RETURN ON INVESTMENT USING TARGET SURPLUS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Issue Rtg | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 200% | 12.13% | 12.55% | 10.46% | 9.55% | 10.60% | 12.94% |
| Male Smoker | 200% | 200% | 13.54% | 12.00% | 10.07% | 9.83% | 14.15% | 10.85% |
| Female Non | 200% | 200% | 13.08% | 14.22% | 10.34% | 12.12% | 11.64% | 12.02% |
| Female Smk | 200% | 200% | 13.97% | 15.00% | -0.82% | 11.39% | 13.28% | 11.77% |

Surplus

| 30th YEAR SURPLUS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Issue Rtg | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 200% | 42.05 | 43.37 | 32.61 | 24.58 | 31.15 | **54.36** |
| Male Smoker | 200% | 200% | 49.29 | 38.19 | 31.78 | 21.74 | **49.54** | 34.39 |
| Female Non | 200% | 200% | 43.11 | **48.51** | 23.64 | 38.44 | 36.73 | 41.46 |
| Female Smk | 200% | 200% | 46.38 | **50.36** | -44.69 | 28.58 | 41.08 | 39.91 |

Profit margins and surplus were determined using the asset share calculations. With each reinsurer, the calculations used the ceding company rating as the issue rating, the offered rating as the reinsurance rating and zero retention. For the ceding company, the calculations used the ceding company rating as the issue rating with full retention.

Now it can be determined how much lower than the upper bound the issue rating can be, while still producing a profitable outcome. This is determined in the next section through the compromise placement method.

### 3.4 The compromise placement method

At this point, it is known that the aggressive placement method results in large losses when significant inverse underwriting is taking place. In addition, it has been shown that profitable results can occur under a method that cannot effectively be used. The compromise method will attempt to find a balance between these two methods.

As stated in section 1.3.3, the first step in the compromise method is to determine the compromise profit goal. Assume the ceding company's compromise profit goals are:

- Break even within 20 years.
- Have a positive 30 year present value of profits over premium.
- A goal of 8% for the 30 year return on investment using target surplus.

Step 2, the "initial compromise" method, is to determine whether the compromise profit goals can be attained by issuing the policy at the lowest offered rating but reinsuring the case with the reinsurer with the lowest rates (but not necessarily the lowest rating).

Figure 3.4a on the following page shows the offers and the resulting profitability with each reinsurer under the "initial compromise method". It shows that none of the offers meet the compromise profit goals.

If the hypothetical offers are correct, the best profitability would result from the following placement:

| Classification | Actual rtg | Issue rtg | the lowest rates | $\text{Surplus}_{45,30}$ |
|---|---|---|---|---|
| male nonsmoker | 200% | 125% | Reinsurer E, 175% | -2.47 |
| male smoker | 200% | 100% | Reinsurer D, 150% | -12.22 |
| female nonsmoker | 200% | 100% | Reinsurer A, 150% | -7.15 |
| female smoker | 200% | 100% | Reinsurer A, 125% | -0.21 |

Figure 3.4b (appendix 4) shows that there is a dramatic improvement over

**Figure 3.4a - Initial compromise method**

Equivalent rating table

| CEDING COMPANY RATING AND REINSURERS OFFERS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 200% | 150% | 125% | 125% | 225% | 175% |
| Male Smoker | 200% | 200% | 150% | 100% | 100% | 150% | 175% |
| Female Non | 200% | 200% | 150% | 100% | 125% | 225% | 175% |
| Female Smk | 200% | 200% | 125% | 100% | 100% | 150% | 175% |

Profit margins

| 30 YEAR PRESENT VALUE OF PROFIT / PRESENT VALUE OF PREMIUM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Issue Rtg | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 125% | 200% | -2.10% | -1.91% | -3.44% | -4.58% | -3.65% | **-0.35%** |
| Male Smoker | 100% | 200% | -1.39% | -2.62% | -3.34% | -4.45% | **-1.36%** | -3.05% |
| Female Non | 100% | 200% | -2.29% | **-1.30%** | -5.84% | -3.14% | -3.45% | -2.59% |
| Female Smk | 100% | 200% | -0.63% | **0.03** | -14.37% | -3.32% | -1.43% | -1.61% |

| 30 YEAR RETURN ON INVESTMENT USING TARGET SURPLUS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Issue Rtg | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | = offer | 200% | 3.88% | 4.09% | 2.25% | 0.61% | 1.57% | 6.20% |
| Male Smoker | = offer | 200% | 4.13% | 0.95% | 1.35% | &n/a | 3.97% | 1.14% |
| Female Non | = offer | 200% | 3.98% | 5.35% | -5.69% | 2.90% | 2.68% | 3.87% |
| Female Smk | = offer | 200% | 6.38% | 7.20% | #n/a | 0.38% | 4.72% | 4.64% |

'&' Denotes where return on investment was unable to be calculated due to multiple sign changes on profit.

'#' Denotes where return on investment was unable to be calculated due to no sign change on profit (always negative).

Surplus

| 30th YEAR SURPLUS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Issue Rtg | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 125% | 200% | -14.79 | -13.46 | -24.22 | -32.25 | -25.68 | **-2.47** |
| Male Smoker | 100% | 200% | -12.47 | -23.56 | -29.97 | -40.01 | **-12.22** | -27.37 |
| Female Non | 100% | 200% | -12.55 | **-7.15** | -32.02 | -17.23 | -18.93 | -14.21 |
| Female Smk | 100% | 200% | -4.19 | **-0.21** | -95.26 | -21.99 | -9.49 | -10.66 |

Profit margins and surplus were determined using the asset share calculations. With each reinsurer, the calculations used the offered rating as the issue rating and zero retention. For the ceding company, the calculations used the lowest offered rating for each classification and full retention.

the aggressive placement method. The 30$^{th}$ year aggregate surplus improved from a loss of -$39,909 to a loss of -$4,410.

Figure 3.4c (appendix 4) shows that increasing retention to 50% reduces surplus under the initial compromise method. The resulting 30$^{th}$ year aggregate surplus is reduced to -$6,604 from -$4,410 at zero retention.

The initial compromise method does not produce profitable outcomes at either zero or 50% retention. Steps 3 and 4 should therefore be analyzed.

Under steps 3 and 4, the issue rating is increased. However, constraints are set on the increase in the issue rating. The maximum issue rating will be the rating of the reinsurer. This constraint avoids issuing the policy at a higher rating than the reinsurance rating. As mentioned earlier, this avoids straining relations with reinsurers.

Step 3, the "issue rating increase" method, determines the amount of increase in the issue rating necessary to meet the compromise profit goals. Figure 3.5a on the following page shows the issue rating increases necessary to meet the compromise profit goals for each classification with each reinsurer. It shows that the compromise profit goals cannot be met within the issue rating constraint for reinsurers B and C. It also fails the constraint test with reinsurer A for the male nonsmoker, but only by 5% (issue rating = 155% vs offer of 150%). So, for the most part, reinsurers A, D, and E's hypothetical offers allow the ceding company to meet its compromise profit goals within the issue rating constraint. For these reinsurers, the issue ratings needed to meet compromise profit goals are all substantially less than the ceding company rating of 200%.

The lowest issue ratings that can be used are illustrated below, showing how far below the maximum constraint each issue rating is:

| Classification | Reinsurer | Issue rtg necessary | Maximum rtg |
|---|---|---|---|
| male nonsmoker | E | 150% | 175% |
| male smoker | D | 125% | 150% |
| female nonsmoker | A | 125% | 150% |
| female smoker | A | 110% | 125% |

**Figure 3.5a - Issue rating increase method**

Equivalent rating table

| CEDING COMPANY RATING AND REINSURERS OFFERS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 200% | 150% | 125% | 125% | 225% | 175% |
| Male Smoker | 200% | 200% | 150% | 100% | 100% | 150% | 175% |
| Female Non | 200% | 200% | 150% | 100% | 125% | 225% | 175% |
| Female Smk | 200% | 200% | 125% | 100% | 100% | 150% | 175% |

Issue ratings necessary for the ceding to charge the policyholder to meet compromise profit goals.

| CEDING COMPANY ISSUE RATING USING EACH REINSURER | | | | | | |
|---|---|---|---|---|---|---|
| | Actual Rtg | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 155%* | 175%* | 190%* | 175% | **150%** |
| Male Smoker | 200% | 145% | 160%* | 170%* | **125%** | 155% |
| Female Non | 200% | **125%** | 170%* | 150%* | 150% | 145% |
| Female Smk | 200% | **110%** | 325%* | 155%* | 130% | 140% |

'*' Denotes a rating exceeding the reinsurer's offer above.

Profit margins using the issue ratings above

| 30 YEAR PRESENT VALUE OF PROFIT / PRESENT VALUE OF PREMIUM | | | | | | |
|---|---|---|---|---|---|---|
| | Actual Rtg | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 1.25% | 1.72% | 2.07% | 1.54% | **2.23%** |
| Male Smoker | 200% | 0.56% | 0.78% | 0.37% | **0.41%** | 0.74% |
| Female Non | 200% | **1.26%** | 1.15% | 1.83% | 1.55% | 1.89% |
| Female Smk | 200% | **0.76%** | 1.91% | 0.88% | 0.89% | 1.43% |

| 30 YEAR RETURN ON INVESTMENT USING TARGET SURPLUS | | | | | | |
|---|---|---|---|---|---|---|
| | Actual Rtg | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 8.29% | 8.28% | 8.66% | 8.29% | **8.84%** |
| Male Smoker | 200% | 7.64% | 7.39% | 7.34% | **7.94%** | 7.60% |
| Female Non | 200% | **8.53%** | 8.02% | 8.58% | 8.15% | 8.36% |
| Female Smk | 200% | **8.28%** | 8.56% | 8.10% | 8.24% | 8.14% |

Surplus using the issue ratings above

| 30th YEAR SURPLUS | | | | | | |
|---|---|---|---|---|---|---|
| | Actual Rtg | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 9.48 | 13.68 | 16.96 | 12.22 | **16.71** |
| Male Smoker | 200% | 4.99 | 7.75 | 3.75 | **3.87** | 7.31 |
| Female Non | 200% | **7.39** | 7.47 | 11.34 | 9.64 | 11.59 |
| Female Smk | 200% | **5.13** | 17.69 | 6.46 | 6.29 | 10.23 |

Figure 3.5b (appendix 4) shows the resulting profitability when these four cases are hypothetically placed with the above reinsurers. Figure 3.5c (appendix 4) shows how increasing retention worsens the profitability for each classification. $\text{Aggsurplus}_{45,30}$ goes from \$6,621 at zero retention to \$4,425 at 50% retention.

It will not always be the case that profit goals can be met solely through the issue rating increase method. The next step of the method considers using agent commissions as a variable in meeting profit goals.

Step 4, the "reduced commissions" method, determines the increased issue rating necessary to meet compromise profit goals if commissions are paid on the base premium of the policy only. By reducing commission expenses, the issue ratings are reduced substantially from those in step 3. Figure 3.6a on the following page shows the reinsurers offers (maximum constraints) and the issue rating necessary to meet the compromise profit goals under the reduced commissions method. As in step 3 though, neither reinsurer B nor C's offer can meet the compromise goals without the issue rating violating the constraint. However, the offer of reinsurers A, D, and E now all meet the compromise goals without violating the constraint for each classification.

The same reinsurers as in step 3 produce the lowest necessary issue rating. These are shown below, again with their maximum constraints:

| Classification | Reinsurer | Issue rtg necessary | Maximum rtg |
|---|---|---|---|
| male nonsmoker | E | 130% | 175% |
| male smoker | D | 115% | 150% |
| female nonsmoker | A | 115% | 150% |
| female smoker | A | 110% | 125% |

Figures 3.6b (appendix 4) shows the resulting profitability when these four cases are hypothetically placed with the above reinsurers under the reduced commissions method. Again, increasing retention worsens the profitability for each classification. This is shown in figure 3.6c (appendix 4). $\text{Aggsurplus}_{45,30}$ goes from \$5,659 at zero retention to \$3,464 at 50% retention.

**Figure 3.6a - Reduced commissions method**
Equivalent rating table

| CEDING COMPANY RATING AND REINSURERS OFFERS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Actual Rtg | Ceding Co | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 200% | 150% | 125% | 125% | 225% | 175% |
| Male Smoker | 200% | 200% | 150% | 100% | 100% | 150% | 175% |
| Female Non | 200% | 200% | 150% | 100% | 125% | 225% | 175% |
| Female Smk | 200% | 200% | 125% | 100% | 100% | 150% | 175% |

Issue ratings necessary for the ceding to charge the policyholder to meet compromise profit goals.

| CEDING COMPANY ISSUE RATING USING EACH REINSURER | | | | | | |
|---|---|---|---|---|---|---|
| | Actual Rtg | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 135% | 145%* | 155%* | 150% | **130%** |
| Male Smoker | 200% | 130% | 140%* | 145%* | **115%** | 135% |
| Female Non | 200% | **115%** | 145%* | 130%* | 130% | 125% |
| Female Smk | 200% | **110%** | 245%* | 135%* | 120% | 125% |

'*' Denotes a rating exceeding the reinsurer's offer above.

Profit margins using the issue ratings above

| 30 YEAR PRESENT VALUE OF PROFIT / PRESENT VALUE OF PREMIUM | | | | | | |
|---|---|---|---|---|---|---|
| | Actual Rtg | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 1.00% | 1.03% | 1.39% | 1.56% | **1.76%** |
| Male Smoker | 200% | 0.50% | 0.78% | 0.20% | **0.23%** | 0.58% |
| Female Non | 200% | **1.03%** | 1.00% | 1.44% | 1.15% | 1.26% |
| Female Smk | 200% | **1.14%** | 1.48% | 0.73% | .090% | 1.28% |

| 30 YEAR RETURN ON INVESTMENT USING TARGET SURPLUS | | | | | | |
|---|---|---|---|---|---|---|
| | Actual Rtg | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 8.84% | 8.29% | 8.93% | 9.41% | **9.04%** |
| Male Smoker | 200% | 8.09% | 7.78% | 7.61% | **7.90%** | 7.78% |
| Female Non | 200% | **8.63%** | 8.67% | 8.77% | 8.23% | 8.16% |
| Female Smk | 200% | **9.17%** | 9.78% | 8.52% | 8.66% | 8.32% |

Surplus using the issue ratings above

| 30th YEAR SURPLUS | | | | | | |
|---|---|---|---|---|---|---|
| | Actual Rtg | Re A | Re B | Re C | Re D | Re E |
| Male Nonsmk | 200% | 7.22 | 7.61 | 10.58 | 11.67 | **12.56** |
| Male Smoker | 200% | 4.73 | 7.47 | 1.96 | **2.11** | 5.52 |
| Female Non | 200% | **5.90** | 6.15 | 8.54 | 6.84 | 7.36 |
| Female Smk | 200% | **7.72** | 11.99 | 5.18 | 6.24 | 8.92 |

Step 5 is exercised only if the compromise profit goals are not met under any of steps 2, 3, or 4. This step first adjusts the compromise goals downward. Then if no compromise goals can be met, the method proceeds to step 7. Under step 7, the facultative agreements are renegotiated with the reinsurers with which the ceding company cannot meet profit goals. Since the compromise goals are already extremely aggressive, a break even year of 20 or less and a positive 30 year profit margin, the ceding company will probably want to renegotiate facultative agreements with reinsurers B and C. This will benefit both the reinsurers, by making placement with them possible, and the ceding company, by increasing the number of reinsurers which can be realistically considered for placement.

In step 6, the decision must be made as to which of the methods developed in steps 2, 3 or 4 should be used. Since the results in steps 3 and 4 were the only ones that met the compromise profit goals, the ceding company's decision set consists of the issue rating increase and the reduced commissions placement methods.

### 3.4.1 Conclusions

Now that the compromise placement method has been analyzed, the ceding company's decision set under this method will be summarized. If the issue rating increase method is chosen, the reinsurance costs are spread to all parties except the agent. The resulting placement situation will be:

- the ceding company meets its compromise profit goals
- the applicant's rating is reduced
- the agent receives full commissions
- the reinsurer with the lowest rates, not rating, places the case

If the reduced commissions method is chosen, no commissions will be paid on the substandard extra premiums. So this method uses all of the tools available to achieve the compromise profit goals. In other words, it spreads the reinsurance costs to all parties involved. This method's resulting placement situation will be:

- the ceding company meets its compromise profit goals
- the applicant's rating is substantially reduced
- the agent receives the same commissions as those for a standard case
- the reinsurer with the lowest rates, not rating, places the case

Decisions made under the compromise method are subject to company philosophy. Some companies may prefer the simplicity of the initial compromise method. If that were the case here, facultative agreements should be renegotiated with reinsurers B and C. Or, a hybrid of the issue rating increase method and the aggressive placement method could be used, where the lowest YRT offered rates are used and maximum issue rating is automatically used. For example, instead of using the necessary issue rating for the male nonsmoker of 150%, the maximum rating of 175% (reinsurer E) would be used. This is simpler, but less equitable than the compromise method. The ceding company will be more profitable and the agent receives higher commissions, but both are at the expense of the insured's higher issue rating. In addition, without renegotiating facultative agreements with reinsurers B and C, these reinsurers will <u>never</u> place a case. Or, if marketing concerns take priority over profitability, the ceding company may choose to use the aggressive placement method to place the case with the reinsurer offering the lowest rating.

In the illustrations, the issue rating was increased in increments of 5% to demonstrate how sensitive surplus is to changes in the issue rating. It is probably more realistic for a company to use table (25%) increments. Again, this decision is subject to company philosophy.

In summary, the ceding company's philosophy determines which placement method is best. When pricing for the most effective placement method, the aggressive, conservative and compromise methods should be analyzed in that order. This creates a converging pricing process analogous to a binary search. The entire pricing process for substandard/reinsurance business is summarized in a model solution in the next section.

### 3.5 A model solution using the traditional pricing approach

Using the asset share recursive formula and the tools developed in the previous demonstrations, a pricing algorithm will now be given that summarizes the traditional approach.

A. Determine profit objectives and price the product without reinsurance to meet profit objectives.

B. Draft facultative agreements with each reinsurer and obtain the reinsurance rates.

C. Determine "actual ratings" for all classifications being priced. The "ceding company rating" will equal the "actual rating". Using the simplifying assumption that the actual rating is a static pricing variable, determine equivalent rating tables for each reinsurer. These equivalent reinsurance ratings are assumed to be the "offered" ratings by each reinsurer.

D. Using the reinsurers' offered ratings developed in step C, determine the profit outcomes under the aggressive placement method.

E. If the aggressive placement method produces losses, price the conservative placement method to see if profit is attainable with reinsurance. This step, along with step D will determine which reinsurers, if any, are using inverse underwriting. If profit is not attainable, go to step G.

F. If profit is attainable, investigate results under the compromise placement method. Determine compromise profit objectives and spread the reinsurance costs using the compromise placement method. This is where the level of commissions should be decided.

G. If profit is not attainable with reinsurance, go back to step B and consider renegotiating the facultative agreements with reinsurers charging the highest rates.

To see how the algorithm works, each step of the algorithm will be applied to the four policies priced in this section.

A. It was shown that the policies all met the profit goals without reinsurance.

B. The rates were received from the participating reinsurers after the agreements were drawn up.

C. Using the ceding company's average actual rating of 200%, equivalent rating tables were then used to develop the reinsurers' hypothetical offered ratings. The development of these ratings pointed out a wide disparity in rates, especially with reinsurers B and C, because of the number of tables they were able to absorb versus the other reinsurers.

D. After pricing the aggressive placement method, it was found that business placed under this method showed significant losses.

E. The conservative placement method showed that profit was attainable so step G was not necessary.

F. Compromise profit goals were decided once it was discovered that the aggressive placement method produced losses but profit was attainable under the conservative placement method. For the four classifications that were priced, the ceding company's profitable decision set came down to a choice between the issue rating increase method or the reduced commissions method.

G. Though this step was not needed, it should be noted that in the illustrations, none of the cases were placed with the two companies using inverse underwriting (reinsurers B and C). The ceding company should consider renegotiating the facultative agreements with these two reinsurers to maintain good relations. Otherwise these two reinsurers' placement ratios will be low.

### 3.6 The retention tool

With the pricing completed, the placement process will now be addressed. Even though premiums, commissions, and the placement method have been decided, when actual offers are made and accepted on the substandard policies, profitability will not be the same on a case by case basis. One case may have a break even year of 19, while another has a break even year of 14. While this is the case for most products that are priced, it is particularly true for substandard/reinsured products due to the additional variables involved. Wouldn't it be nice to place each case having the same or as close to the same break even year? This is possible, and this section will develop a retention tool that can be used to do just that.

When profitability results are developed at the two ends of the retention spectrum, zero and full retention, intermediate retention percentages will tend toward each spectrum. In fact, an exact linear relationship results if reinsurance expenses are assumed at full retention. Assuming reinsurance expenses at full retention is not an unrealistic assumption because even though a case was "shopped out", it may not be placed i.e. it is fully retained.

To illustrate this linear relationship, assume the hypothetical offers developed in section 3.1 are the actual offers received from the reinsurers. For the issue rating increase method, the per unit surplus$_{45,30}$ at each retention extreme is shown below for each classification. The per unit surplus with 50% retention is then compared to the average surplus of the retention extremes revealing the linear relationship:

| | Per unit surplus at the given retentions | | | |
|---|---|---|---|---|
| Classification | Full | 50% | Zero | Avg of extremes |
| male nonsmoker | 4.39 | 10.55 | 16.71 | 10.55 |
| male smoker | 3.61 | 3.74 | 3.87 | 3.74 |
| female nonsmoker | 2.00 | 4.70 | 7.39 | 4.70 |
| female smoker | 1.15 | 3.14 | 5.13 | 3.14 |

Using this linear relationship, a retention formula can now be developed. The targeted surplus would be defined as follows:

$$\text{targeted surplus}_{x,t} = (X)\ (\text{full retention surplus}_{x,t}) + (1-X)\ (\text{zero retention surplus}_{x,t}),$$

where X is the retention that will meet the targeted surplus. Solving for X, the retention formula becomes

$$X = \frac{\text{targeted surplus}_{x,t} - \text{zero retention surplus}_{x,t}}{\text{full retention surplus}_{x,t} - \text{zero retention surplus}_{x,t}},$$

with the constraints:

1) targeted surplus$_{x,t}$ is between the retention extremes',

2) resulting in $0\% \le X \le 100\%$.

This makes retention a valuable tool in placing a policy. It can be used to precisely meet targeted surplus in a given year. To illustrate, consider the ceding company's placement method decision set: the issue rating increase method and the reduced commissions method. It will be shown that the compromise goal's break even year, 20, can be met by setting the targeted $\text{surplus}_{45,20}$ to zero and solving for X.

To begin, the zero and full retention $\text{surplus}_{45,20}$ must be found. For the issue rating increase method the male nonsmoker's zero and full retention per unit $\text{surplus}_{45,20}$ are \$1.85 and -\$2.20 respectively. Solving for X:

$$X = \frac{(0.00) - (1.85)}{(-2.20) - (1.85)} = 45.68\%.$$

Using a retention of 45.68% in the asset share calculations produces \$0.00 per unit $\text{surplus}_{45,20}$. The following four pages illustrate the effectiveness of the retention tool. Figure 3.7a summarizes the results for each classification using the hypothetical offers. Figure 3.7b shows the yearly progression of per unit surplus for each classification.

Applying the same formula under the reduced commissions method also gives \$0.00 per unit $\text{surplus}_{45,20}$ for each classification. These results are shown in figures 3.8a and b.

It should be noted that it would not be realistic to retain 45.68% of the policy. The exact retention was used in the illustrations to show that the targeted surplus can precisely be met. Rounding to the nearest 5%, or to the more profitable retention extreme could be used instead.

It should also be noted that the zero retention surplus will not always be the higher surplus of the retention extremes. If the aggressive placement method was chosen, it was most often the case that the full retention surplus was better. The conservative placement method had scattered results. So it cannot be assumed that a particular retention extreme will always have better surplus.

So no matter which method the ceding company decides to use, the retention tool can be used to meet surplus goals.

**Figure 3.7a - Issue rating increase method**
Hypothetical placement using lowest issue rating that met compromise profit goals.

| CEDING COMPANY'S PROFIT UNDER HYPOTHETICAL PLACEMENT AT ZERO RETENTION | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Actual Rtg | Issue Rtg | Reinsurance Rtg | Reinsurer | $surplus_{45,20}$ | $pvprofprem_{45}$ | $targsurpROI_{45}$ |
| **Male Nonsmk** | 200% | 150% | 175% | E | **1.85** | 2.23% | 8.84% |
| **Male Smoker** | 200% | 125% | 150% | D | **1.38** | 0.41% | 7.94% |
| Female Non | 200% | 125% | 150% | A | **0.50** | 1.26% | 8.53% |
| Female Smk | 200% | 110% | 125% | A | **0.08** | 0.76% | 8.38% |

| CEDING COMPANY'S PROFIT AT FULL RETENTION | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Actual Rtg | Issue Rtg | Reinsurance Rtg | Reinsurer | $surplus_{45,20}$ | $pvprofprem_{45}$ | $targsurpROI_{45}$ |
| Male Nonsmk | 200% | 150% | N/A | N/A | **-2.20** | 0.59% | 7.39% |
| Male Smoker | 200% | 125% | N/A | N/A | **-0.57** | 0.39% | 7.60% |
| Female Non | 200% | 125% | N/A | N/A | **-3.51** | 0.34% | 7.25% |
| Female Smk | 200% | 110% | N/A | N/A | **-0.08** | 0.17% | 7.27% |

| CEDING COMPANY'S PROFIT AT SPECIFIED RETENTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Actual Rtg | Issue Rtg | Reinsurance Rtg | Reinsurer | **Retention** | $surplus_{45,20}$ | $pvprofprem_{45}$ | $targsurpROI_{45}$ |
| Male Nonsmk | 200% | 150% | 175% | E | 45.68% | **0.00** | 1.48% | 8.23% |
| Male Smoker | 200% | 125% | 150% | D | 70.77% | **0.00** | 0.39% | 7.69% |
| Female Non | 200% | 125% | 150% | A | 12.47% | **0.00** | 1.15% | 8.36% |
| Female Smk | 200% | 110% | 125% | A | 2.86% | **0.00** | 0.74% | 8.34% |

**Figure 3.7b** - Issue rating increase method. Issue rating increased to break even before compromise goal year at zero retention. Retention used to exactly break even in year 20.

| Parameters for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| break even goal: | 20 yrs | 20 yrs | 20 yrs | 20 yrs |
| reinsurer: | E | D | A | A |
| retention: | 45.68% | 70.77% | 12.47% | 2.86% |
| reinsurer rtg: | 175% | 150% | 150% | 125% |
| issue rtg: | 150% | 125% | 125% | 110% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 1.43 | 0.60 | 0.55 | 0.33 |
| $\text{premium}_{45,0}$: | 19.49 | 25.61 | 15.39 | 18.40 |
| policy year(t) | Per unit $\text{surplus}_{45,t}$ | | | |
| 1 | -8.68 | -9.72 | -6.51 | -7.09 |
| 2 | -10.08 | -10.31 | -7.60 | -7.77 |
| 3 | -11.07 | -10.69 | -8.22 | -8.00 |
| 4 | -11.29 | -10.27 | -8.28 | -7.66 |
| 5 | -11.30 | -9.68 | -8.22 | -7.21 |
| 6 | -11.17 | -9.37 | -8.07 | -6.96 |
| 7 | -11.07 | -9.17 | -7.89 | -6.55 |
| 8 | -10.95 | -8.61 | -7.49 | -6.15 |
| 9 | -10.69 | -8.06 | -7.13 | -5.81 |
| 10 | -10.19 | -7.52 | -6.79 | -5.50 |
| 11 | -9.22 | -6.45 | -6.07 | -4.79 |
| 12 | -8.26 | -5.47 | -5.38 | -4.12 |
| 13 | -7.30 | -4.57 | -4.69 | -3.61 |
| 14 | -6.32 | -3.75 | -4.02 | -3.04 |
| 15 | -5.33 | -3.00 | -3.36 | -2.51 |
| 16 | -4.32 | -2.36 | -2.69 | -2.00 |
| 17 | -3.29 | -1.73 | -2.01 | -1.49 |
| 18 | -2.22 | -1.12 | -1.34 | -1.00 |
| 19 | -1.13 | -0.54 | -0.67 | -0.50 |
| 20 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | 1.15 | 0.51 | 0.69 | 0.50 |
| 22 | 2.31 | 0.97 | 1.36 | 0.99 |
| 23 | 3.46 | 1.40 | 2.03 | 1.49 |
| 24 | 4.60 | 1.78 | 2.69 | 1.97 |
| 25 | 5.73 | 2.14 | 3.34 | 2.44 |
| 26 | 6.78 | 2.49 | 3.98 | 2.90 |
| 27 | 7.83 | 2.81 | 4.63 | 3.38 |
| 28 | 8.92 | 3.11 | 5.29 | 3.89 |
| 29 | 10.01 | 3.41 | 5.99 | 4.43 |
| 30 | 11.08 | 3.69 | 6.72 | 5.02 |
| $\text{pvprofprem}_{45}$: | 1.48% | 0.39% | 1.15% | 0.74% |
| $\text{targsurpROI}_{45}$: | 8.23% | 7.69% | 8.36% | 8.34% |

**Figure 3.8a - Reduced commissions method**
Hypothetical placement using lowest issue rating that met compromise profit goals.

| CEDING COMPANY'S PROFIT UNDER HYPOTHETICAL PLACEMENT AT ZERO RETENTION | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Actual Rtg | Issue Rtg | Reinsur-ance Rtg | Reinsurer | $surplus_{45,20}$ | $pvprofprem_{45}$ | $targsurpROI_{45}$ |
| Male Nonsmk | 200% | 130% | 175% | E | **1.58** | 1.76% | 9.04% |
| Male Smoker | 200% | 115% | 150% | D | **1.19** | 0.23% | 7.90% |
| Female Non | 200% | 115% | 150% | A | **0.57** | 1.03% | 8.63% |
| Female Smk | 200% | 110% | 125% | A | **1.60** | 1.14% | 9.17% |

| CEDING COMPANY'S PROFIT AT FULL RETENTION | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Actual Rtg | Issue Rtg | Reinsur-ance Rtg | Reinsurer | $surplus_{45,20}$ | $pvprofprem_{45}$ | $targsurpROI_{45}$ |
| Male Nonsmk | 200% | 130% | N/A | N/A | **-2.47** | 0.03% | 7.15% |
| Male Smoker | 200% | 115% | N/A | N/A | **-0.76** | 0.20% | 7.51% |
| Female Non | 200% | 115% | N/A | N/A | **-3.44** | 0.09% | 7.16% |
| Female Smk | 200% | 110% | N/A | N/A | **-1.19** | 0.55% | 7.97% |

| CEDING COMPANY'S PROFIT AT SPECIFIED RETENTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Actual Rtg | Issue Rtg | Reinsur-ance Rtg | Reinsurer | **Retention** | $surplus_{45,20}$ | $pvprofprem_{45}$ | $targsurpROI_{45}$ |
| Male Nonsmk | 200% | 130% | 175% | E | 39.01% | **0.00** | 1.09% | 8.38% |
| Male Smoker | 200% | 115% | 150% | D | 61.03% | **0.00** | 0.21% | 7.65% |
| Female Non | 200% | 115% | 150% | A | 14.21% | **0.00** | 0.90% | 8.41% |
| Female Smk | 200% | 110% | 125% | A | 57.35% | **0.00** | 0.80% | 8.47% |

**Figure 3.8b** - Reduced commissions method, base commissions only. Issue rating increased to break even before compromise goal year at zero retention. Retention used to exactly break even in year 20.

| Parameters for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| break even goal: | 20 yrs | 20 yrs | 20 yrs | 20 yrs |
| reinsurer: | E | D | A | A |
| retention: | 39.01% | 61.03% | 14.21% | 57.35% |
| reinsurer rtg: | 175% | 150% | 150% | 125% |
| issue rtg: | 130% | 115% | 115% | 110% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 1.43 | 0.60 | 0.55 | 0.33 |
| $premium_{45,0}$: | 19.49 | 25.61 | 15.39 | 18.40 |
| policy year(t) | Per unit $surplus_{45,t}$ | | | |
| 1 | -6.46 | -8.80 | -5.67 | -6.77 |
| 2 | -7.82 | -9.35 | -6.73 | -7.43 |
| 3 | -8.78 | -9.71 | -7.34 | -7.65 |
| 4 | -9.06 | -9.30 | -7.43 | -7.33 |
| 5 | -9.15 | -8.73 | -7.40 | -6.94 |
| 6 | -9.12 | -8.45 | -7.29 | -6.77 |
| 7 | -9.12 | -8.02 | -6.91 | -6.42 |
| 8 | -8.65 | -7.46 | -6.51 | -6.08 |
| 9 | -8.18 | -6.94 | -6.17 | -5.78 |
| 10 | -7.77 | -6.44 | -5.85 | -5.52 |
| 11 | -6.95 | -5.45 | -5.18 | -4.86 |
| 12 | -6.18 | -4.55 | -4.55 | -4.24 |
| 13 | -5.43 | -3.75 | -3.94 | -3.71 |
| 14 | -4.68 | -3.03 | -3.35 | -3.16 |
| 15 | -3.94 | -2.38 | -2.78 | -2.64 |
| 16 | -3.18 | -1.85 | -2.21 | -2.13 |
| 17 | -2.42 | -1.34 | -1.65 | -1.61 |
| 18 | -1.63 | -0.85 | -1.09 | -1.09 |
| 19 | -0.82 | -0.40 | -0.54 | -0.55 |
| 20 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | 0.84 | 0.36 | 0.55 | 0.55 |
| 22 | 1.67 | 0.66 | 1.09 | 1.09 |
| 23 | 2.50 | 0.92 | 1.61 | 1.64 |
| 24 | 3.31 | 1.13 | 2.12 | 2.17 |
| 25 | 4.11 | 1.32 | 2.62 | 2.70 |
| 26 | 4.82 | 1.49 | 3.10 | 3.23 |
| 27 | 5.54 | 1.63 | 3.59 | 3.76 |
| 28 | 6.29 | 1.76 | 4.08 | 4.31 |
| 29 | 7.04 | 1.86 | 4.59 | 4.87 |
| 30 | 7.75 | 1.95 | 5.13 | 5.44 |
| $pvprofprem_{45}$: | 1.09% | 0.21% | 0.90% | 0.80% |
| $targsurpROI_{45}$: | 8.38% | 7.65% | 8.41% | 8.47% |

### 3.7 Use of a computer program

Using the pricing algorithm and retention placement tools can involve an overwhelming number of calculations. The complexity involved in both pricing and placing substandard/reinsured cases necessitates the use of a computer program. Such a program and its uses will be described in this section.

The computer program is simply a version of the asset share program used to price the product. The program should be dynamic in the sense that it allows various input parameters to be used in pricing and sensitivity testing. The input parameters for the program should be:

- Classification: sex, smoking status, issue age, actual rating.
- Placement tools: issue rating, reinsurance rating, reinsurer.
- Commissions.
- Retention.

Tables of each reinsurers' YRT rates must also be incorporated into the program.

For Phase I, pricing the entire block without reinsurance, input the actual rating and 100% retention. Do this for all classifications being priced until the premium structure is finalized.

For Phase II, pricing with reinsurance, continue to use the actual rating, but vary the retention as desired. Input the reinsurer's hypothetical offer, developed using equivalent rating tables. Apply the steps of the pricing algorithm, varying the issue and reinsurance ratings as needed. Do this for each reinsurer for the entire block until the commission structure and the placement method are decided. Apply sensitivity testing by varying the reinsurer's hypothetical rating. This will indicate how close the hypothetical offers must be in order to ensure profitability.

For Phase III, actually placing individual cases after the product has been priced, this same program can be used. The following process should be used:

1. During this phase, unlike when the product was being priced, the actual mortality is not assumed to be known. So as the reinsurers' offers come in, the rates at their offered ratings should be compared to the ceding company's rates. In doing this, make an educated guess as to what the expected mortality is. Use this in the asset share as the actual rating.

2. Input each reinsurer's offered rating, and apply the placement method. If the issue rating increase method is being used, determine which reinsurer's offer requires the lowest issue rating to meet the profit goals.

3. Using the reinsurer producing the best profit, calculate the retention extremes' surplus for the profit goal targeted year. Using the zero and full retention surpluses, solve for retention that will meet the profit goals, subject to the constraints. Input retention to verify results.

There are three strong arguments for using the program to actually place individual policies:

- The cost of creating the program will continue to be recovered by using it after the original pricing is completed.
- Profitability can be assured on every policy based on the pricing assumptions and offered ratings.
- It will allow the ceding company to truly "shop" each policy. The few minutes it takes to pick the reinsurer, the issue rating, and the retention amount will cost much less than placing a policy unwisely.

**3.8 Applying the model solution to other uses of substandard reinsurance**

This section discusses how the pricing algorithm can be used in other areas of the substandard reinsurance market.

Some companies prefer to do their own underwriting and issue on the basis of the "ceding company rating". Any substandard reinsurance from these companies will usually be placed under automatic reinsurance treaties. The pricing algorithm can be used for these automatic agreements as well. The automatic YRT rates must be incorporated into the computer program. Because it is treaty insurance, no facultative methods apply, so the algorithm is reduced to steps A, B, C, part of F, and G.

A. Determine profit objectives and price the product without reinsurance to meet profit objectives.

B. Draft automatic treaties with each reinsurer and obtain the reinsurance rates.

C. Develop rating equivalency tables for each classification.

D. N/A.

E. N/A.

F. The issue rating and reinsurance rating are both set equal to the ceding company's underwritten rating. This is really the "issue rating increase" method (step 3 of the compromise placement algorithm) using the maximum rating possible (issue rating = reinsurance rating). Use the pricing program to determine the profitability. Also determine profitability under the "reduced commissions" method (step 4 of compromise algorithm). If profitability cannot be attained go to step G.

G. Go back to step B and renegotiate the all automatic treaties necessary.

Another method used to reinsure difficult substandard cases is to place them facultatively under automatic agreements. To save on shopping expenses, some ceding companies are now submitting facultative cases to automatic reinsurers before shopping among other outlets. So the shopping expense assumption in the program should be reduced appropriately. However, this is the same as shopping the substandard policy to one reinsurer, so the pricing algorithm still applies.

Another method of transferring substandard risk, but seldom used, is substandard coinsurance. The ceding company transfers the reserve to the reinsurer, is charged premiums, and is given expense allowances to help cover expenses and commissions incurred (Tiller 70-73). The premiums are usually based on the gross premium charged to the policyholder (Tiller 73). The expense allowances are usually proportionate to the gross premium (which includes the substandard extra premium), such as 75% to 85% in the first year and 10% to 15% in renewal years (Tiller 75). The most common use of coinsurance is for term products since they have little or no cash value and minimal investment risk (Tiller 77). Coinsurance involves no YRT rates or shopping. The pricing considerations for coinsurance are the allowances. A computer program similar to the one used for facultative shopping can be used to determine the profitability. To do so, use $(1 - \text{allowance}_{x,s})$ multiplied by the gross premiums as reinsurance premiums. This is a fairly straightforward process.

So the model used to price substandard cases reinsured facultatively on a YRT basis can be used to analyze most any reinsurance agreement.

## 4. A MACRO PRICING APPROACH

Section 3 illustrated a unit-based convergent traditional pricing algorithm that can be effectively used to price substandard/reinsurance. The process will now be taken to a macro level where external effects of particular decisions can be factored into pricing. These effects can be analyzed by moving from a unit-based analysis to a project-based analysis which shows the expected profit on the entire substandard block.

A project-based analysis will be demonstrated in this section using the macro pricing method as described by Shane Chalke[5]. Any adjustments to the model, needed to account for substandard/reinsurance considerations, will be substituted where appropriate. These modifications are discussed below.

### 4.1 Substandard/reinsurance macro pricing considerations

Macro pricing analysis produces to a decision set of possible price structures. Normally, these price structures are a given range of prices, each with a sub-range of commission scales. This range of price structures can be chosen by management provided that they meet profitability constraints. For substandard/reinsurance, the placement methods represent the price structures since the price levels are determined by the expected issue ratings under each placement method. Developing these expected issue ratings introduces some additional subjectivity over that of the traditional pricing model.

The additional subjectivity inherent in macro pricing results from the added assumptions which are made for sales distribution among pricing classifications, sales patterns, and production volume. In addition, the reinsurance element of substandard/reinsurance macro pricing, requires assumptions for the expected issue ratings for each placement method. The

---

5 For a detailed discussion on macro pricing, see Shane Chalke's study note Macro Pricing: Toward a Comprehensive Product Development Process.

expected issue rating depends on the placement distribution among reinsurers, retention amount, and assumed reinsurance rating used under each placement method. Therefore, assumptions for these items must also be made.

Along with the pricing structures, the macro pricing decision set usually includes a decision to not offer the product. Because substandard is a subset of the product, this decision cannot be included in the substandard/ reinsurance decision set. Hence, the objective of substandard/reinsurance macro pricing is to determine the impact of reinsurance. So the decision to not use reinsurance is used in lieu of the decision to not offer the product.

In arriving at the decision set, substandard/reinsurance macro pricing emphasizes two decision points in addition to price and profitability - risk assessment and effective reinsurance placement. This means that the underwriting department must now become involved because these issues are primarily their responsibility. These additional decision points could affect the convergence of the macro pricing algorithm which is dependent on marketing choosing a price/production pair which has acceptable projected profitability. Some definition regarding decision points should help resolve this potential problem. "Open" decision points are normally decided between actuarial and marketing and center around the premium and commission structures. Risk assessment and effective reinsurance placement are not open decision points, but are similar to profitability in that they become design constraints that determine which premium and commission structures will be allowed as open decision points in the decision set. So in addition to profitability, a second overriding determinant is whether or not the price for a particular premium structure compensates the company for the risk involved. A coordinated effort by actuarial and underwriting using sensitivity testing will allow management to determine which price structures will comprise the decision set from which marketing will choose. The second decision point, the effectiveness of reinsurance placement, also becomes a design constraint. This constraint set by underwriting and will remove any placement methods from the decision set which would not be acceptable to participating reinsurers. So, although there are additional decision points to consider for substandard/reinsurance macro pricing, they are not open decision points, and therefore should not affect the algorithm's convergence.

A final consideration for substandard/reinsurance macro pricing is its relationship to the product as a whole. A distinguishing feature of substandard insurance is that it generally represents only a small portion of a product's total block of business. However, substandard macro pricing results do affect the product's total profitability, both independently, as a stand-alone pricing subset, and interdependently, as it affects the standard portion. Because only the stand-alone substandard block will be considered here, it is important to note that included in the product's total profitability should be possible "cross-over" effects that substandard/ reinsurance decisions could have on the standard portion of the block. An example of such an effect would be increased standard production due to utilizing aggressive substandard/reinsurance placement. This could occur for multi-person cases such as employer-provided executive bonus or deferred compensation packages involving both substandard and standard employees. Depending on the company's target market, this effect can range anywhere from negligible to substantial.

### 4.2 Simplifying demonstration assumptions

A complete macro pricing analysis would ultimately result in using a detailed model office projection with cells that vary by issue age, rating, sex, smoking status, price structure, and projected production volume. In keeping with the traditional algorithm's demonstration, this demonstration will macro price issue age 45, actual rating 200% and face amount $200,000.

These will be distributed by sex and smoking status for each price structure at various production levels. This will allow a more explicit demonstration. Assuming the average issue age is 45, the average rating is 200%, the average face amount is $200,000, and that the product has been balanced over these classifications, the results will also be realistic. However, it should be noted that the simplifying assumptions used here are for demonstration purposes only, and that an actual macro pricing process would cover a more extensive level of detail.

Another simplifying assumption that must be made is that of retention. Although the amount of retention could vary significantly among placement methods, it will be assumed that on average, 50% of each policy will be retained within each placement method.

The following section presents a step by step demonstration of the macro pricing algorithm.

### 4.3 Demonstration of the macro pricing algorithm

This section will demonstrate a step-wise progression through the macro pricing algorithm. Two demonstrations will be illustrated throughout the algorithm - one assuming this is a new product, and another assuming it is a replacement product. The reason for demonstrating both a new and replacement product is that different decisions can result. For example, the administrative start-up costs associated with the new product for the compromise placement method may eliminate this as a possible decision. On the other hand, the replacement product's administrative start-up costs may be immaterial if the existing product already has a system set up to handle this placement method. Other differences include sales projection patterns and the decision making process itself, which are described below in their respective steps of the macro pricing algorithm for substandard/reinsurance.

1. <u>Determine competitive focus.</u> The issue here is the ability to place substandard cases without sacrificing risk and profitability. It can be assumed that the competitive focus will be that of a residual effect of the competitive focus of the product as a whole. So it will be assumed that substandard business mirrors standard sales, i.e. assume a proportionate amount of sales.

2. <u>Determine particular design constraints.</u> External constraints limiting product design include administrative, marketing, actuarial, legal, and contractual.

Reinsurance placement will require additional administrative capability, with the compromise placement method needing the most and the aggressive placement method the least. The additional maintenance of appropriate reinsurance data for inclusion in company financial statements must also be considered.

Reinsurance placement also means creating reinsurance treaties, which carries with them additional implications. Drafting of treaties requires input from the actuarial, legal and underwriting departments. The reinsurance treaties themselves may impose placement constraints such as not allowing the ceding company to increase the issue rating above that of the reinsurer's rating.

For a new product, there are usually more constraints than for a replacement product. Totally new reinsurance treaties must be drafted. In addition, it is likely that an administrative system to handle reinsurance for the product does not yet exist.

At this point, none of the decisions in the decision set have been eliminated. It will be assumed that constraints will not be considered until after each decision's projected financial impact has been demonstrated.

3. <u>Develop retail price structure.</u> The retail price structures consist of using no reinsurance, the core placement methods, i.e. aggressive, conservative, and initial compromise, and the issue rating increase placement method. Commissions are not considered in this step of the algorithm, so the reduced commissions placement method is not included as a retail price structure. From this point forward, the "initial" compromise placement method will be referred to as just the compromise place method.

Given the knowledge of the previous sections of this paper, which demonstrate evidence of inverse underwriting by reinsurers B and C, a comprehensive decision set can be constructed. The retail price structures that will be used are listed below:

1. aggressive placement method,
2. aggressive placement method without reinsurers B and C included,
3. compromise placement method,
4. compromise placement method without reinsurers B and C included,
5. minimum issue rating increase placement method,
6. maximum issue rating increase placement method,
7. conservative placement method,
8. no reinsurance (no placement).

Recall that the issue rating increase placement method determines the lowest possible issue rating necessary to be profitable subject to the maximum rating, which is the lesser of the ceding company rating and the reinsurance rating. Since results are measured by profit as premium production increases, it is only fair to give a range of premiums offered by this placement method. The minimum will be quite competitive but relatively unprofitable as production increases. The maximum will be less competitive but more profitable as production increases. This gives the company a more complete basis on which to base its decision.

In price structures 2 and 4, by eliminating reinsurers B and C from the analysis, the aggressive and compromise methods' profitability will be substantially enhanced. It gives the ceding company a means of analyzing the effectiveness of each placement method without inverse underwriting influencing the results. Also, by both including and excluding these two reinsurers, the ceding company will have the opportunity to determine the actual impact of inverse underwriting.

Although some of these decisions would generally be refinements, they are included now so that the algorithm has more potential to converge to an acceptable decision the first time through.

With the retail price structures defined, the premium levels of each structure must now be determined. This is dependent on the expected issue rating of each price structure. The expected issue rating, in turn, depends upon the definition of each retail price structure, i.e. placement method. The expected issue rating of the placement methods are determined using the ceding company rating and the reinsurers' ratings constructed using the equivalent rating tables. These items were discussed earlier in the paper, but will be summarized here for the male nonsmoker. The equivalent ratings represent the reinsurers' expected offered ratings. For the male nonsmoker rated 200% by the ceding company, these are:

| Ceding Company | Reinsurer A | Reinsurer B | Reinsurer C | Reinsurer D | Reinsurer E |
|---|---|---|---|---|---|
| 200% | 150% | 125% | 125% | 225% | 175% |

Given these equivalent ratings, and the retail price structures, the expected issue ratings for each price structure would be defined as follows:

| Retail Price Structure | Issue Rating Definition | Issue Rating |
|---|---|---|
| aggressive | min(150%,125%,125%,225%175%) | 125% |
| aggressive w/o B & C | min(150%,225%175%) | 150% |
| compromise | min(150%,125%,125%,225%175%) | 125% |
| compromise w/o B & C | min(150%,225%175%) | 150% |
| min iss rtg increase | minimum profitable rating | 125% < rtg < 200% |
| max iss rtg increase | min(ceding co, reins rtg) | 125% < rtg < 200% |
| conservative | ceding company rating | 200% |
| no reinsurance | ceding company rating | 200% |

Note that at this point, only a range of issue ratings can be given for the issue rating increase placement methods. This is because these ratings are determined on a case by case basis using the asset share program. This will be determined in a later step of the algorithm. For now, the range that is given is sufficient, as these ratings are to be used for competitive comparisons. The range of the issue rating increase placement method's issue ratings is between the aggressive and no reinsurance issue ratings, so their relative competitiveness will be known. This is true for all of the pricing classifications.

4. <u>Develop competitive comparisons.</u> Using the expected issue ratings from step 3, the resulting premium range of the price structures can be used to determine the competitiveness of the substandard premiums relative to peer companies in the industry. There will be substantially more work involved here if this is a new product. If an existing product is being replaced, maybe all that is needed is a comparison to the existing product premiums.

5. <u>Determine unit-based marginal cost assumptions.</u> Marginal costs are defined as expenses which cannot be eliminated by choosing any of the decisions in the decision set. Unit-based marginal costs apply uniformly to individual policies and will not vary between the new and replacement products. They include normal underwriting and issue costs, mailing and printing costs, production costs for the policy form and related documents, production costs for the policyholder's annual report, commissions on the standard portion of the policy, billing and collection costs, DAC tax, premium tax, reinsurance placement costs, reinsurance annual administrative costs, reinsurance premiums, and shopping costs. These costs are similar to those used in the traditional pricing model. One difference is that fixed costs are implicitly included in the traditional unit-based cost assumptions. So the first step here is to remove fixed costs from these assumptions to arrive at truly marginal assumptions.

Typical of traditional unit-based pricing, fixed costs are spread over the thousands of insurance in force, premium in force, and number of policies in force. This is usually done by charging an average per thousand, percent of premium, and per policy amount to each policy. These averages are arrived at by taking the total amount of fixed costs incurred or expected to be incurred, and allocating it to each of the three categories.

There are two types of fixed costs which are charged to policies: recurring overhead, and project-based costs. In section 3, the traditional pricing method included recurring overhead costs with variable unit-based cost assumptions for the percent of premium and per policy costs. Only the variable amount of these annual policy charges are unit-based marginal costs. Because the fixed amount of these costs represents a general overhead charge which cannot be eliminated using any of the decisions in the decision set, they are non-marginal and are not included in the macro pricing analysis. So the fixed recurring overhead costs must be removed from the per policy and percent of premium traditional unit-based costs to arrive at marginal unit-based costs. Assume 2% of the annual percent of premium represents the recurring overhead charge. Also assume $30 and $15 represent the recurring overhead per policy charges for the first and renewal years respectively. These amounts must then be subtracted from the traditional unit-based cost assumptions shown in appendix 1.

Project-based costs, which are generally start-up in nature, were included in the traditional first year per thousand charge. For pricing, this amount is based on the expected, rather than actual amount of project-based cost, since the amount is unknown until the project is completed. Unlike recurring overhead costs, this amount can vary substantially among the decisions in the decision set and therefore is a marginal expense. However, it is not a unit-based marginal expense as implied by its name, and therefore is not addressed in this step of the algorithm. (Step 9 covers non-unit based marginal cost assumptions.) For now, the amount of traditional project-based cost must be removed from the traditional first year per thousand charge to arrive at a unit-based marginal per thousand cost. Recall that the traditional first year per thousand expense was $1.10. Assume that the marginal costs are only $0.60 of $1.10 and the remaining $0.50 represents project-based costs. Then only $0.60 will be used in the unit-based marginal cost assumptions.

The unit-based marginal costs now consist of only those costs which can vary by production amount. The resulting unit-based marginal profit represents a gross profit which is used to cover project-based costs and overhead. Any remaining profit is the actual net profit of the product. This illustrates a major difference between cost assumptions of macro and traditional pricing. Macro pricing focuses on the use of explicit assumptions, rather than attempting to implicitly spread fixed costs among policies.

Unlike traditional pricing, macro pricing also explicitly recognizes the unit-based marginal cost assumptions that will vary among the price structures. Included are reinsurance placement costs, reinsurance annual administration costs, and shopping costs. The traditional pricing model applied the same reinsurance cost assumptions to each placement method when in reality, these costs will vary.

The macro pricing assumptions for reinsurance placement costs, reinsurance annual administration costs, and shopping costs are shown on an expected average per case basis in figure 4.1. Note that the issue rating increase placement method has significantly higher placement cost assumptions due to the additional effort involved. The conservative and compromise placement methods require more placement effort than the aggressive placement method due to the additional rate analysis. The annual reinsurance administration cost is reduced when the aggressive placement method is used since only one rating is used in annual processing; the other methods require separate issue and reinsurance ratings to be maintained and used in annual processing. Shopping costs will be lowest using the aggressive placement method since it is expected that this placement method will result in the highest amount of placement. These costs will increase with other the placement methods and are the highest under the conservative placement method because of the expected decreased placement. The costs shown in figure 4.1 represent additional per policy expenses. All of these costs are added to the marginal first year per policy cost, and the annual reinsurance administration costs are also added to the marginal renewal year per policy costs.

**Figure 4.1 Unit based marginal reinsurance cost assumptions per case**

| Price Structure | Placement costs | Annual rein admin costs | Shopping costs |
|---|---|---|---|
| aggressive | $25 | $5 | $15 |
| compromise | $40 | $10 | $20 |
| issue rating increase | $70 | $10 | $20 |
| conservative | $40 | $10 | $30 |
| no reinsurance | $0 | $0 | $0 |

Costs which cannot be shown explicitly but can vary significantly by placement method are the reinsurance premiums, which also affect the net premium and DAC tax amounts. The reinsurance premiums are dependent upon the reinsurer being used. As shown in sections 2 and 3, determining which reinsurer has the lowest reinsurance premiums is not straight forward since inverse underwriting might be taking place. The equivalent rating tables developed in section 3 must be used to determine which reinsurers, and at what offers, the business will be placed within each pricing structure. (This is demonstrated in step 7.)

6. <u>Develop wholesale price structures.</u> Wholesale price structures are determined by assuming different levels of commissions for each of the retail

price structures. For demonstration purposes, only two levels will be considered: pay full commissions on the substandard extra premium, or pay no commissions on the substandard extra premium. (Recall that full agent commissions are 50% of first year premium and 4% of renewal premium with equal overrides for the general agent.) Two classes of wholesale price structures result, a full and zero commissions class, each containing the eight retail price structures, for a total of 16 wholesale price structures.

At this point it is necessary to define some terminology. In section 3, paying no commissions on the substandard extra premium for the issue rating increase placement method was called the "reduced commissions placement method". For substandard/reinsurance macro pricing, it is more appropriate to term this structure the "zero commissions issue rating increase wholesale price structure". This will allow both of the wholesale price structure classes to use the retail price structure names.

7. <u>Balance products over various usages.</u> With the price structures and unit-based costs defined, this step now balances the unit profitability over various usages of the substandard block. Components of each of the price structures are altered to arrive at comparable unit profitability by issue age, rating, sex, smoking status, policy size, and premium pattern. The goal here is to refine each price structure into stand-alone workable designs. As mentioned earlier, the distribution will be only by sex and smoking class. The number of rating classifications would normally include a range of expected ratings separated into credibly sized representative cells such as (100%-150%],(150%- 200%],(200%-250%], (250%-300%] and over 300%. For simplicity, it was assumed that all insureds have an actual rating of 200%. As mentioned earlier, it is also assumed that all policies have a face amount of $200,000.

Before balancing the unit profitability, the expected issue rating for the issue rating increase method must first be determined. This was not done for this placement method earlier in the development of the retail price structures for two reasons: the issue rating increase method requires profit analysis in determining the issue rating, and it was not necessary at that time since the range of premiums given by the other price structures included the issue rating increase method's possible premium levels. Also, because the minimum issue rating increase method uses the lowest profitable issue rating, determining the expected issue rating for this method is a balancing process in itself, making it appropriate to defer it until this step of the algorithm. The maximum issue rating increase method's issue rating merely serves as an upper bound for the issue rating under this placement method. As with the other placement methods, the derivation of the male nonsmoker expected issue rating will be illustrated as an example.

Using the traditional asset share unit-based calculations with the marginal cost assumptions developed in step 5, the lowest profitable issue rating using each reinsurer can be determined. These represent the minimum issue rating increase method's expected issue ratings and are shown below for both the full and zero commissions wholesale price structures. The highest allowable issue rating is the minimum of the ceding company's rating (200%) or the reinsurer's rating, and represents the maximum premium structure for this placement method. This issue rating does not vary between the full and zero commissions wholesale price structure.

| Price Structure | Commissions | Reinsurer A | Reinsurer B | Reinsurer C | Reinsurer D | Reinsurer E |
|---|---|---|---|---|---|---|
| Minimum Rtg | Full | 135% | 155% | 170% | 140% | 125% |
| Minimum Rtg | Zero | 125% | 140% | 150% | 130% | 120% |
| Maximum Rtg | Both | 150% | 125% | 125% | 200% | 175% |

In determining the overall expected issue rating for the male nonsmoker, distribution assumptions among the reinsurers must be made. Because the minimum issue rating necessary to be profitable exceeded the maximum allowable issue rating for both reinsurers B and C, no placement will take place with them for this placement method under either of the wholesale price structures. Based on the remaining reinsurer's allowable issue ratings, a distribution of 35% to reinsurer A, 25% to reinsurer D, and 40% to reinsurer E is assumed for both of the minimum wholesale price structures; and a distribution of 60% to reinsurer A, 10% to reinsurer D, and 30% to reinsurer E is assumed for both of the maximum wholesale price structures. The male nonsmoker's expected issue ratings for the issue rating increase placement method can now be determined. For the full commissions minimum issue rating increase placement method, the expected issue rating is:

```
  (issue rating using reinsurer A) x (expected placement with reinsurer A)
+ (issue rating using reinsurer B) x (expected placement with reinsurer B)
+ (issue rating using reinsurer C) x (expected placement with reinsurer C)
+ (issue rating using reinsurer D) x (expected placement with reinsurer D)
+ (issue rating using reinsurer E) x (expected placement with reinsurer E)
= (135%) x (35%)
+ (155%) x (0%)
+ (170%) x (0%)
+ (140%) x (25%)
+ (125%) x (40%)
= 132.25%
```

Similarly, the resulting expected issue ratings for the zero commissions minimum issue rating and both maximum wholesale issue rating increase placement methods are 124.25% and 163.50% respectively.

Note that the minimum issue rating increase placement method has an expected issue rating that varies between the full and zero commissions wholesale price structures. This is a variation to the price structures described in Shane Chalke's study note. This variation could not be avoided due to the nature of this placement method. Because the zero commissions wholesale structure results in a different price level than the full commissions structure, it could have been classified as a retail price structure. But this would then violate the definition of a retail price structure since, as mentioned in the retail price structure step, commissions are not considered. Therefore, it is more appropriate to classify it as a wholesale price structure. Even though this naming variation exists, it will

**Figure 4.2 Expected issue ratings for the wholesale price structures**

| Full commissions on substandard extra premium | | | | |
|---|---|---|---|---|
| Price Structure | Male nonsmoker | Male smoker | Female nonsmoker | Female smoker |
| aggressive | 125% | 100% | 100% | 100% |
| compromise | 125% | 100% | 100% | 100% |
| min iss rtg increase | 132% | 114% | 110% | 100% |
| aggressive w/o B & C | 150% | 150% | 150% | 125% |
| compromise w/o B & C | 150% | 150% | 150% | 125% |
| max iss rtg increase | 164% | 153% | 163% | 138% |
| conservative | 200% | 200% | 200% | 200% |
| no reinsurance | 200% | 200% | 200% | 200% |

| Zero commissions on substandard extra premium | | | | |
|---|---|---|---|---|
| Price Structure | Male nonsmoker | Male smoker | Female nonsmoker | Female smoker |
| aggressive | 125% | 100% | 100% | 100% |
| compromise | 125% | 100% | 100% | 100% |
| min iss rtg increase | 124% | 109% | 108% | 100%* |
| aggressive w/o B & C | 150% | 150% | 150% | 125% |
| compromise w/o B & C | 150% | 150% | 150% | 125% |
| max iss rtg increase | 164% | 153% | 163% | 138% |
| conservative | 200% | 200% | 200% | 200% |
| no reinsurance | 200% | 200% | 200% | 200% |

* This expected issue rating is the same as the full commissions wholesale structure's because it cannot be reduced lower than the already standard (100%) issue rating achieved under the full commissions wholesale structure.

not affect the ultimate decision that is made. The expected issue ratings for the male nonsmoker under each placement method have now been determined.

Applying the same methodology to the other three classifications completes the derivation of the expected issue ratings. The expected issue ratings for all of the wholesale price structures are shown in figure 4.2. The price structures are given in order of increasing expected issue rating, hence, increasing premium level.

In the derivation of the expected issue ratings for the issue rating increase placement method, reinsurance distribution assumptions had to be made. These assumptions must now be made for the other placement methods in order for the unit-based marginal profit to be analyzed for each price structure. The resulting reinsurance placement distribution assumptions for the male nonsmoker are shown in figure 4.3 with the reasoning for each given below.

**Figure 4.3 Assumed reinsurer placement distribution**

| Retail Price Structure | Reinsurer A | Reinsurer B | Reinsurer C | Reinsurer D | Reinsurer E |
|---|---|---|---|---|---|
| aggressive | 0% | 50% | 50% | 0% | 0% |
| aggressive w/o B & C | 100% | n/a | n/a | 0% | 0% |
| compromise | 0% | 0% | 0% | 0% | 100% |
| compromise w/o B & C | 0% | n/a | n/a | 0% | 100% |
| conservative | 0% | 0% | 0% | 0% | 100% |
| min iss rtg increase | 35% | 0% | 0% | 25% | 40% |
| max iss rtg increase | 60% | 0% | 0% | 10% | 30% |
| no reinsurance | n/a | n/a | n/a | n/a | n/a |

The first item to note is that these distributions apply to both the full and zero commission wholesale structures under each placement method. From figure 4.3, it can be seen that under the aggressive placement method, all of the business will be placed with reinsurers B and C simply because they always offer the lowest rating. When reinsurers B and C are not included in the aggressive placement method, reinsurer A would then have the lowest rating and receive the business.

The compromise placement method places the case with the reinsurer with the lowest rates. This was determined to be reinsurer E in section 3. So, as shown in figure 4.3, the compromise placement method places the business with reinsurer E for the male nonsmoker.

Like the compromise method, the conservative method places the case with the reinsurer with the lowest rates (reinsurer E).

As was shown above, the issue rating increase placement method allows placement with all feasible reinsurers. The placement distribution was spread among the reinsurers based on the resulting issue rating necessary to meet the targeted profitability using each reinsurers rates at their offered ratings.

With the reinsurance distribution assumptions defined, the unit-based profitability for each classification under each placement method can now be determined. The present value of marginal profit will be the decision variable for the macro pricing model. To calculate this amount for each price structure based on premium production projections, the present value of profit over the present value of premium (pvprofprem) is needed. Since it will be the only profit measure emphasized in the macro pricing analysis, the target surplus used in section 3 (3% of reserve plus $0.50 per thousand of net amount at risk) will also be included in pvprofprem. Using the reinsurance placement distribution in figure 4.3, $\text{pvprofprem}_{s,c}$ for each classification within each price structure can be calculated with the following formula:

$$\text{pvprofprem}_{s,c} = \sum_{r} (\text{pvprofit}_{s,c,r})\,(\text{dist\%}_{s,c,r}),$$

where $\text{pvprofit}_{s,c,r}$ is the traditional present value of marginal per unit profit calculation for each price structure (s), classification (c), and reinsurer (r). The variable $\text{dist\%}_{s,c,r}$ is the percentage of expected placement with each reinsurer for each price structure's distribution as shown for the male nonsmoker in figure 4.3.

Figure 4.4 shows the resulting present value of marginal per unit profit for each cell. These are given for the two wholesale price structures in order of increasing premium level.

**Figure 4.4 Present value of marginal per unit profit**

| Full commissions on substandard extra premium | | | | |
|---|---|---|---|---|
| Price Structure | Male nonsmoker | Male smoker | Female nonsmoker | Female smoker |
| aggressive | -0.72% | -0.57% | -0.85% | -2.42% |
| compromise | 0.71% | 0.41% | 0.22% | 1.99% |
| min iss rtg increase | 0.37% | 0.50% | 0.12% | 0.55% |
| aggressive w/o B & C | 2.99% | 3.76% | 5.48% | 3.88% |
| compromise w/o B & C | 3.34% | 3.76% | 5.01% | 3.47% |
| max iss rtg increase | 3.43% | 3.13% | 5.13% | 3.52% |
| conservative | 7.53% | 6.25% | 8.48% | 7.87% |
| no reinsurance | 7.87% | 7.22% | 9.41% | 8.75% |

| Zero commissions on substandard extra premium | | | | |
|---|---|---|---|---|
| Price Structure | Male nonsmoker | Male smoker | Female nonsmoker | Female smoker |
| aggressive | 0.06% | -0.57%* | -0.85%* | -2.42%* |
| compromise | 1.96% | 0.41%* | 0.22%* | 1.99%* |
| min iss rtg increase | 0.66% | 0.41% | 0.38% | 0.55% |
| aggressive w/o B & C | 5.25% | 5.18% | 7.54% | 4.73% |
| compromise w/o B & C | 5.60% | 5.18% | 7.07% | 4.32% |
| max iss rtg increase | 6.11% | 4.63% | 8.01% | 4.77% |
| conservative | 11.42% | 8.79% | 12.05% | 10.41% |
| no reinsurance | 11.75% | 9.78% | 12.97% | 11.59% |

* The profit for the zero commissions is the same as the full commission's because the expected issue rating is standard (100%), so there is no substandard extra premium on which to vary commissions.

In balancing the substandard/reinsurance pricing, the goal is to have comparable unit profitability across classifications within each price structure. For the ceding company, the major balance focus is on the no-reinsurance price structure since all of its parameters are within the control of the company. Figure 4.3 shows that the per unit profit for this price structure is consistent among classes, so the balance is at an acceptable level.

On a relative basis, all of the other price structures produce rather consistent profitability among classes. Figure 4.4 shows that, with the exception of the minimum issue rating increase method, there is an increasing progression of profitability as the premium level increases. This is an expected result. It will then be assumed that no further balancing is necessary. This assumption is also based on the fact that "fine tuning" is only done once a price structure has been decided upon, and is a final step of the algorithm.

Finally, it should be noted that these marginal per unit profit results apply to both the new and replacement products. The algorithm can now proceed to step 8.

8. Determine profile of the anticipated book of business. This step develops assumptions concerning the distribution of the substandard business among classes as well as the pattern (not amount) of production over time.

The distribution among underwriting classes can be more objectively estimated when an existing product is being replaced by studying the existing product's distribution. More subjectivity is introduced when projecting the distribution for a new product. Factors to be considered are geographic location of the target market, epidemics such as AIDS, and other items affecting the anticipated growth in the size of the substandard market.

The premium distribution among sex and smoking classes for both the new product and replacement product illustrations will be assumed to be identical and will be as follows:

| | male | female |
|---|---|---|
| nonsmoker | 50% | 25% |
| smoker | 15% | 10% |

It will be assumed that the ceding company expects the product life to be three years. For the new product, introductory factors such as sales force education must be considered in developing the pattern. This can result in a slow first year and a booming second year as the field becomes more familiar with the product. Using year 1 sales as a base, the pattern of anticipated substandard production for the new product will be as follows:

Year 1: 1.00;

Year 2: 2.00 of year 1 volume;

Year 3: 1.50 of year 2 volume.

For the replacement product, an immediate increase in production can be expected since a replacement is usually perceived as an enhancement. This increasing sales pattern is likely to carry over into the second year and taper off in the third year. Using the current sales volume on the existing product as the base, the pattern of anticipated substandard production for the replacement product is assumed to be:

Year 1: 1.25 of current volume;

Year 2: 1.50 of year 1 volume;

Year 3: 1.25 of year 2 volume.

9. <u>Determine non-unit based marginal cost assumptions.</u> These cost assumptions include project-based expenses which can be eliminated through the choice of at least one of the elements of the decision set. For substandard/reinsurance, these are the start-up costs associated with each

placement method. As mentioned in step 5, $0.50 of the $1.10 traditional first year per thousand cost assumption was used to implicitly spread this cost. The traditional pricing method assumed the same amount for each placement method where, as will be shown below, this amount will vary among placement methods, and each placement method's start-up cost will be separately and explicitly considered in the macro pricing method.

Marginal start-up costs for reinsurance placement methods include the drafting of reinsurance agreements and the cost of implementing the administration system. These can vary significantly between the new product and the replacement product depending on whether the existing product has an administration system in place that can be used for the reinsurance placement method being considered.

Figure 4.5 shows the assumed start-up costs for both products under each price structure.

**Figure 4.5 Non-unit based marginal start-up cost assumptions**

| Price Structure | New product | Replacement product |
|---|---|---|
| aggressive | $100,000 | $0 |
| compromise | $145,000 | $45,000 |
| issue rating increase | $175,000 | $75,000 |
| aggressive w/o B $ C | $100,000 | $0 |
| compromise w/o B $ C | $145,000 | $45,000 |
| conservative | $100,000 | $0 |
| no reinsurance | $0 | $0 |

As expected, the new product's start-up costs are higher than the replacement product's costs. The numbers in the table are based on the following assumptions:

1. The new product's cost of drafting reinsurance agreements is $50,000.
2. For the replacement product, the existing product already has an

administrative system that can handle the aggressive and conservative placement methods, so the administrative developmental costs are $0.

3. The new product's marginal administrative developmental cost is $50,000 for the aggressive and conservative placement methods.
4. For both products, the additional administrative developmental costs for the compromise and issue rating increase placement methods is $25,000.
5. For both products, the developmental cost of the computer program to be used to determine placement parameters for the issue rating increase placement method is $50,000.
6. For both products, the developmental cost of the computer program to be used to determine placement parameters for the compromise placement method is $20,000.

10. Develop model office projections. Given the project-based marginal costs, model office projections can now be developed for each price structure for a range of production scenarios. Outlined below is the development of the formula leading to the project-based marginal present value of profit that will be used in the decision process.

The results from step 7 are the starting point of the project-based model office. The first step is to move to an analysis based on profit per dollar of premium paid. The measure $pvprofprem_{s,c}$ can be interpreted as meaning that $1 of annual premium translates to a present value of profit equal to $pvprofprem_{s,c} * \ddot{a}_{x:\overline{30}|}$. The life annuity due ($\ddot{a}_{x:\overline{30}|}$) is taken over the pricing horizon (30 years) and decremented by mortality based on the actual rating (200%), lapses, and the after-tax present value rate of 5.28%.

This value will vary by classification. For issue age 45, the life annuities for each class are:

| | |
|---|---|
| male nonsmoker: | 7.20, |
| male smoker: | 7.06, |
| female nonsmoker: | 7.31, |
| female smoker: | 7.24. |

So, for example, assume $pvprofprem_{s,c}$ is 10% for a price structure for the male nonsmoker. For every $1 of annual premium, the expected present value of profit is 10% x 7.20 = $0.72. The resulting formula for present value of profit per dollar of premium paid is then:

$$pvprofper\$1prem_{s,c} = pvprofprem_{s,c} * \ddot{a}_{x:\overline{30}|}.$$

The next step is to determine the present value of marginal profit per dollar of premium paid for each price structure across classifications using the distribution assumptions ($dist\%_c$) developed in step 8:

$$pvprofper\$1prem_s = \sum_c (pvprofper\$1prem_{s,c})\ (dist\%_c)$$

Since the product life is expected to be three years, the production pattern developed in step 8 must be applied to the first year's projected premium production amount. The result will be three present values of profit, one beginning in issue year 1, the next in issue year 2, and the last in issue year 3. The sum of these three values is then the present value of expected unit based marginal profit per dollar of annual premium:

$$pvunitprofper\$1prem_s = (pvprofper\$1prem_s)\ \sum_{iy} (1 + j_{iy})^{-(iy-1)} \prod_{t=1}^{iy} (pattern_t),$$

where $pattern_t$ is the pattern of premium production for issue years t = 1, 2, and 3 developed in step 8, and $j_{iy}$ is the after-tax present value rate for each issue year (iy). A constant after-tax rate of 5.28% is assumed for each issue year.

In order to arrive at an actual dollar amount of expected present value of profit, the first year premium production must simply be multiplied by $pvunitprofper\$1prem_s$. This now results in the total expected present value of profit before project-based costs. Because the project-based marginal costs are start-up costs (occur at t=0), they are simply subtracted from the total expected unit based marginal profit to arrive at the present value of project based marginal profit for the price structure ($pvprojectprof_s$). The resulting formula is as follows:

$$pvprojectprof_s = (pvunitprofper\$1prem_s)\ (premvolume_s) - projcost_s,$$

where $premvolume_s$ is the projected first year premium production for the price structure (s) and $projcost_s$ is the price structure's start-up costs.

Figure 4.6 on the following page shows $pvunitprofper\$1prem_s$ for each price structure for both the new and replacement products under the two wholesale price structures. As expected, the profit increases as the issue ratings increase, with the exception being the issue rating increase placement method. For the minimum issue rating increase method, the slight increase in the issue rating over that of the compromise method is offset by the additional placement costs, making profitability slightly less. This is also true of the full commissions maximum issue rating increase method, but to a lesser extent.

With the expected present values of unit profit per dollar of premium developed, the model office projections can now be constructed for various production amounts.

The issue rating for each placement method shown in figure 4.6 is the aggregate expected issue rating among pricing classifications. It was determined using the premium distribution percentages among sex and smoking classes as weights within each price structure. These ratings now give marketing the ability to project production on a relative basis, since they already know the competitiveness of the 200% substandard premium.

Assume that the marketing department does not expect to sell more than $1 million dollars of substandard premium. So, project-based model office projections between $0 and $1 million of premium production need to be developed. The resulting $pvprojectprof_s$ is shown in appendix 5 under both wholesale price structures for the new product, and in appendix 6 for the replacement product. These appendices show the expected present values of project-based profit as production increases from $0 to $1 million for each price structure, and are based on the formulas developed above. The analysis of these results is discussed in steps 11 and 12 below.

**Figure 4.6 Present value of marginal unit based profit**

| Full commissions on substandard extra premium | | | |
|---|---|---|---|
| Price Structure | Issue rating | New product | Replacement product |
| aggressive | 113% | -36.30% | -33.31% |
| compromise | 113% | 27.10% | 24.87% |
| min iss rtg increase | 121% | 13.89% | 12.75% |
| aggressive w/o B & C | 148% | 154.56% | 141.86% |
| compromise w/o B & C | 148% | 155.15% | 142.40% |
| max iss rtg increase | 159% | 154.71% | 141.99% |
| no reinsurance | 200% | 307.91% | 282.60% |
| conservative | 200% | 333.63% | 306.21% |

| Zero commissions on substandard extra premium | | | |
|---|---|---|---|
| Price Structure | Issue rating | New product | Replacement product |
| aggressive | 113% | -20.75% | -19.05% |
| compromise | 113% | 52.32% | 48.02% |
| min iss rtg increase | 116% | 21.91% | 20.11% |
| aggressive w/o B & C | 148% | 233.16% | 214.00% |
| compromise w/o B & C | 148% | 233.75% | 214.54% |
| max iss rtg increase | 159% | 252.24% | 231.51% |
| no reinsurance | 200% | 448.39% | 411.53% |
| conservative | 200% | 475.14% | 436.09% |

11. <u>Assemble the price/production graph.</u> From the model office projections just developed in step 10, price/production graphs can be assembled for the two wholesale price structures under the new product and replacement product.

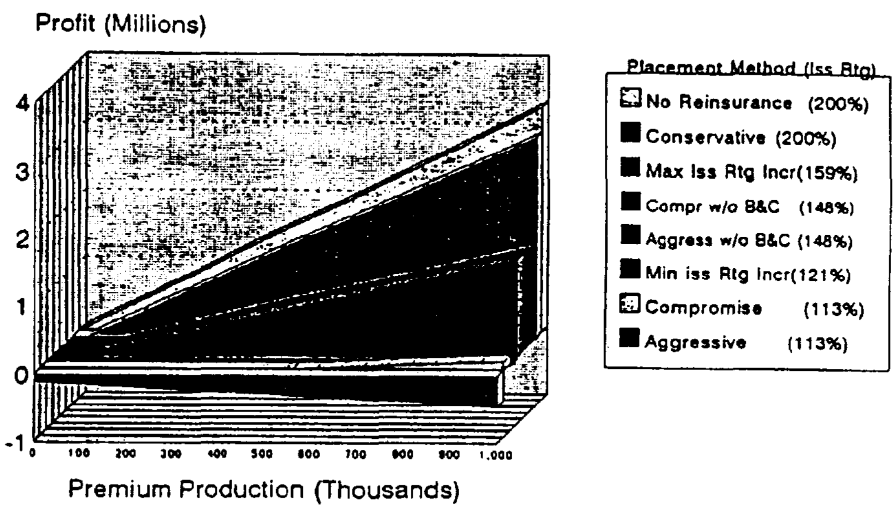
Figure 4.7 on the following page shows the price/production graphs for the new product. The price structures are represented by the x-axis and are shown in order of increasing issue rating. At this point, all 16 price structures make up the decision set for the new product. Not surprisingly, since the aggressive placement method has negative expected profits per dollar of premium paid (shown in figure 4.6), the higher the premium production, the more money the ceding company loses. On the other hand, it appears that there is potential for substantial profit with several of the other price structures under both wholesale structures, beginning with the aggressive placement method without reinsurers B and C, and moving up to the no-reinsurance method.

The price/production graphs for the replacement product are shown in figure 4.8. The profit potential for each price structure is similar to that of the new product's. This is because the only differences between the replacement product and the new product are the start-up costs and premium production pattern assumptions. The sharply increasing premium pattern between years 1 and 2 for the new product make it appear that the new product has more profit potential. This premium pattern is dependent on the first year level of production, however, and it is unlikely that the first year premium production will be as large as the replacement product's first year production. Also, more sales are required to overcome the new product's start-up costs because they are larger than the replacement product's costs. This could be significant for smaller companies.

The graphs developed in step 11 are then presented in the marketing/actuarial/underwriting/management decision meeting, which is the next step of the algorithm.

**Figure 4.7 New product price/production graphs**

## Full Commissions Wholesale Price Structure




## Zero Commissions Wholesale Price Structure

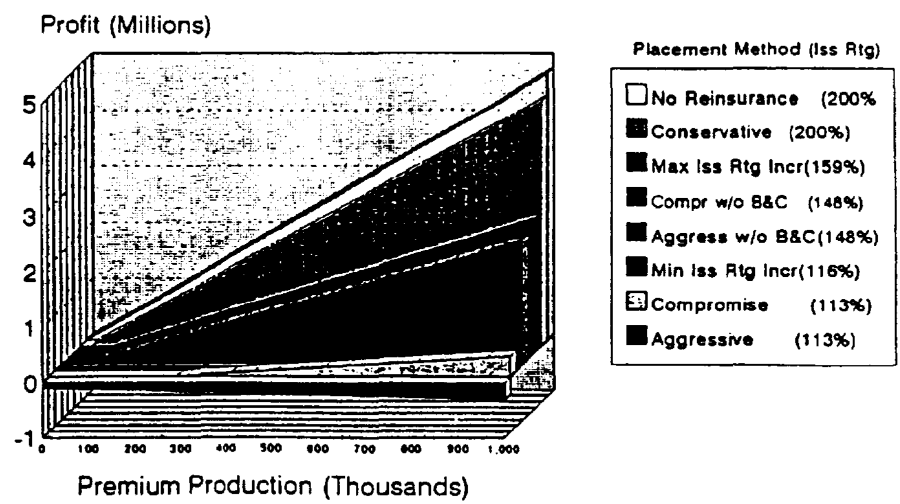
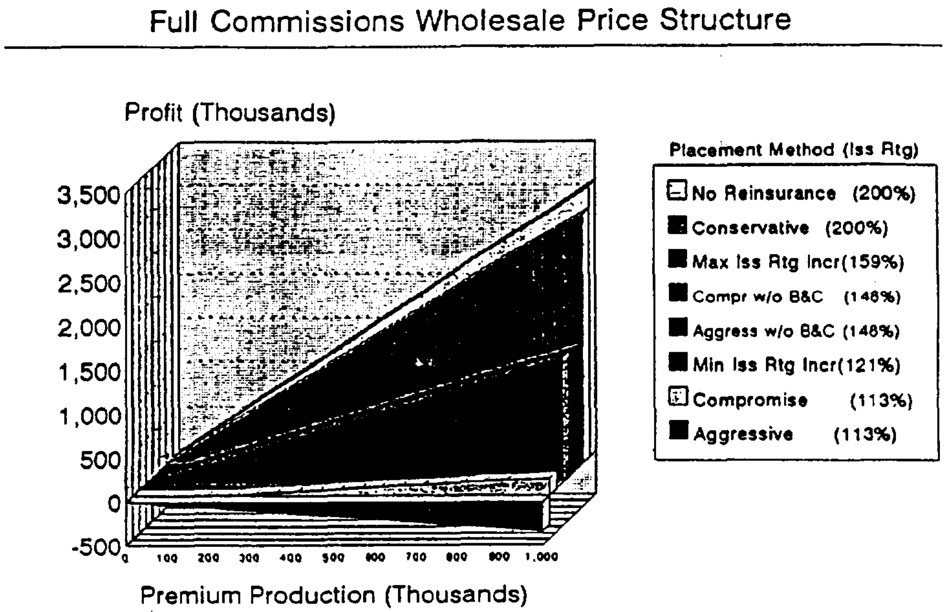
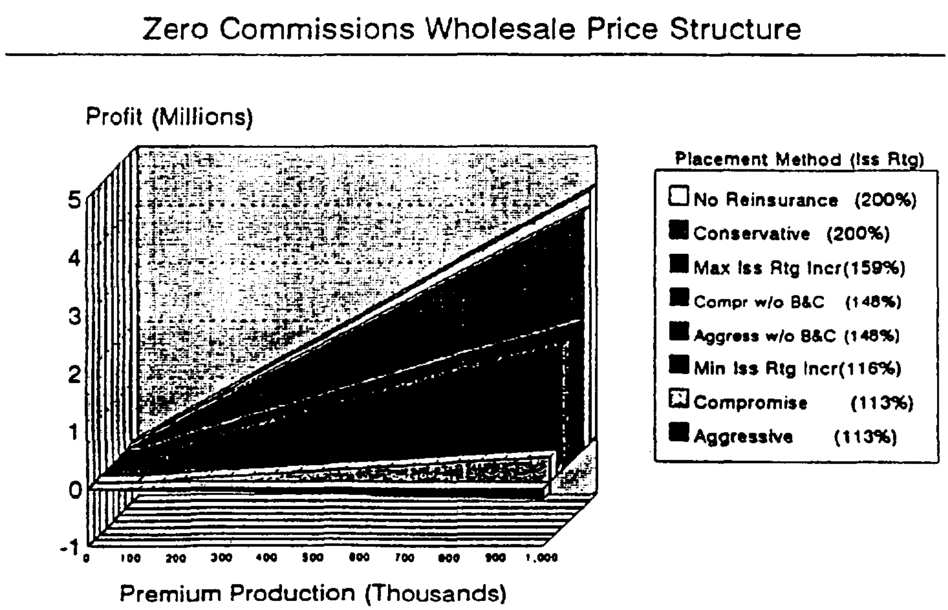


Figure 4.8 Replacement product's price/production graphs



12. Marketing/actuarial/underwriting/management decision meeting. The decision sets for the new and replacement products must now be narrowed to only those decisions that have potential for profit. This will eliminate price structures that exhibited negative profit in the price/production graphs and also price structures with design constraints which inhibit their potential performance.

Although the conservative placement method exhibited high profit per dollar of premium, the underwriting department is almost sure to place design constraints on it due to its potential erosive effect on reinsurance relationships. So, the conservative placement method will not be included in either product's decision set.

For the new product, both wholesale structures under the aggressive placement method are eliminated due to negative profits. With the new product's decision set narrowed, marketing must now specify equal effort price/production pairs. These pairs represent the amount of production that marketing feels can be achieved with an equal amount of effort under each price structure. Assume marketing specifies the equal effort price/production pairs for the remaining price structures shown in figure 4.9 on the following page. Also shown are the accompanying expected profits for each price/production pair. These profit amounts are highlighted in appendix 5 and represent the amount of expected profit, given marketing's production projection for each price structure.

From these price/production pairs, the aggressive and compromise methods without including reinsurers B and C, will result in the highest expected profit. These results demonstrate the effect that inverse underwriting has on these two placement methods. The methods produce the worst profit with reinsurers B and C included, but produce the best profit among the remaining reinsurance placement methods when reinsurers B and C are excluded. If the ceding company chooses the aggressive or compromise method without including reinsurers B and C, it should consider terminating relations with these two reinsurers or renegotiating the reinsurance rates. If the latter option is chosen, additional analysis would be required.

**Figure 4.9 New product's equal effort price/production pairs**

| Price Structure | Commissions | Issue rating | Projected Production | Expected Profit |
|---|---|---|---|---|
| compromise | Full | 113% | 750,000 | 58,215 |
| compromise | Zero | 113% | 700,000 | 221,267 |
| min iss rtg increase | Zero | 116% | 700,000 | -21,618 |
| min iss rtg increase | Full | 121% | 650,000 | -84,724 |
| aggressive w/o B & C | Full | 148% | 400,000 | 518,258 |
| aggressive w/o B & C | Zero | 148% | 300,000 | 599,493 |
| compromise w/o B & C | Full | 148% | 400,000 | 475,596 |
| compromise w/o B & C | Zero | 148% | 300,000 | 556,246 |
| max iss rtg increase | Full | 159% | 300,000 | 289,119 |
| max iss rtg increase | Zero | 159% | 200,000 | 329,489 |
| no reinsurance | Full | 200% | 150,000 | 500,447 |
| no reinsurance | Zero | 200% | 50,000 | 237,571 |

Figure 4.9 also illustrates that insufficient sales will be generated under either of the wholesale minimum issue rating increase placement methods to be profitable. Their maximum premium counterparts would be profitable, but not enough to make them a choice based on expected profits. The full commissions no-reinsurance price structure exhibits high expected profits, but probably not enough to compensate for the additional risk involved (discussed below).

For the replacement product, both wholesale structures under the aggressive placement method are eliminated due to negative profits. This results in the same decision set as that of the new product.

However, the replacement product's decision process is different from that of the new product's. In deciding on a price structure here, management must set a minimum acceptable profit level first. From this level, the minimum amount of production necessary under each price structure can be determined. Then marketing can choose the price/production pair it feels can most easily be met.

Assume management sets the minimum acceptable profit level at $500,000. The resulting minimum production amounts for the remaining price structures in the decision set are shown in figure 4.10 below. These numbers are also highlighted in appendix 6 and were determined by setting $\text{pvprojectprof}_s$ equal to $500,000, and solving for $\text{premvolume}_s$ using the formula given for $\text{pvprojectprof}_s$ in step 10.

**Figure 4.10 Replacement product's required production to produce $500,000 of profit**

| Price Structure | Commissions | Issue rating | Required Production |
|---|---|---|---|
| compromise | Full | 113% | 2,191,544 |
| compromise | Zero | 113% | 1,134,869 |
| min iss rtg increase | Zero | 116% | 2,859,181 |
| min iss rtg increase | Full | 121% | 4,510,842 |
| aggressive w/o B & C | Full | 148% | 352,459 |
| aggressive w/o B & C | Zero | 148% | 233,645 |
| compromise w/o B & C | Full | 148% | 382,734 |
| compromise w/o B & C | Zero | 148% | 254,037 |
| max iss rtg increase | Full | 159% | 404,957 |
| max iss rtg increase | Zero | 159% | 248,368 |
| no reinsurance | Full | 200% | 163,287 |
| no reinsurance | Zero | 200% | 114,656 |

From these minimum production amounts, marketing can immediately dismiss the compromise and minimum issue rating increase placement methods because their required production exceeds the maximum potential sales of $1 million.

Marketing must now decide which of the remaining production amounts can most easily be met given the corresponding price structures.

The remaining price structures are all potential candidates. Which structure is chosen depends on company philosophy. A ceding company which prefers the ease of the aggressive and compromise placement methods may choose one of these if marketing feels the required production can be met. The small amount of production necessary when no reinsurance is used may appeal to other companies. However, two other items must be considered before making the decision. These are discussed below.

Figure 4.10 shows the no-reinsurance price structure requires the least amount of production. Two factors, however, may deem this price structure an unacceptable choice. The first is that it has by far the highest issue rating, which may be unacceptable to marketing. The second is the company's policy concerning the additional risk involved when no reinsurance is used. Ceding companies generally feel that reinsurance is a necessity for substandard risks.

Management should also consider the equity provided by the zero commissions issue rating increase placement method (demonstrated in section 3). It must be remembered that this placement method has a range of possible issue ratings (hence, premiums) that are profitable. Since the maximum premium requires a relatively low amount of production compared to the remaining price structures, a lower issue rating could be used and still meet the minimum acceptable profit level with an increase in production. This makes this placement method very attractive. If marketing feels that the effort required to meet the production for this price structure is not substantially more than any of the other price structures, this placement method could be appealing to management, based on its profit equity among classifications.

13. <u>Final steps.</u> With the price structure decision made, the product design is now refined to achieve a more precise balance. To do so, the pricing actuary more closely analyzes the price structure. After this is complete, the final product detail and filing materials are developed.

It may be that additional analysis is needed. If, for instance, the company chose to renegotiate reinsurance agreements with reinsurers B and C, additional analysis would then be needed. The pricing actuary would substitute the new reinsurance rates into the placement structures and reconstruct the price/production graphs. The process would then continue with step 12.

This analysis made simplifying assumptions which allowed for an explicit illustration. These included the use of an average issue age, average face amount, and average rating. In reality, distribution assumptions should be made for each of these. This will uncover cells that are particularly unprofitable or overly sensitive to certain pricing assumptions and will possibly lead to a more conclusive analysis.

A "cross-over" analysis may also be performed if the company feels that its substandard price structure will significantly affect the performance of the standard portion of the product.

### 4.4 Conclusion

The macro pricing algorithm indeed converged on decision sets for both products that included acceptable decisions. The new product's best decision was either the aggressive or compromise placement methods without including reinsurers B and C. The replacement product had several possible choices that could be chosen depending on company philosophy, but the most equitable decision would be the zero commissions issue rating increase placement method.

It is important to note that these results are very similar to those of the traditional pricing algorithm. In fact, if the decision to not include reinsurers B and C in the aggressive and compromise placement methods were not used, the acceptable decisions would have been the same as those of the traditional pricing algorithm.

## 5. SUMMARY

In the last few years, the substandard reinsurance market, primarily the facultative market, has "tightened up" with respect to underwriting and price. Reinsurers are now more profit-oriented than in the 70's and 80's, a time when they were trying to increase their market share.

In response to the tightened market, ceding companies have sought ways to reduce their reinsurance costs. The prominent method used for placing substandard business is to implement a facultative shopping program. Under this method, the ceding company tries to place a case, using reinsurance, at the most competitive rating.

Caution shoud be exercised, however, when placing reinsurance based on the lowest rating. Some reinsurers may offer competitively low ratings while charging higher underlying mortality rates. These higher mortality rates can significantly impact the profitability of substandard business.

In determining how to place substandard business with a reinsurer, the company should analyze each reinsurer's rates. This should be done during the pricing process when a placement method is being established, as well as after pricing is completed when individual cases are being placed.

The actuarial department can provide valuable profit analysis for the different price/rating methods used by each of the reinsurers. Such analysis can be obtained through a unit-based traditional pricing algorithm, a project-based macro pricing algorithm, or both. The ceding company can then use these analyses to choose the placement method most suitable to its needs.

## 6. SUGGESTIONS FOR FUTURE STUDY

This paper demonstrated the impact of reinsurance on statutory earnings of a participating whole life product using a traditional and macro model. It focused on substandard reinsurance, but both models could easily be modified to analyze the impact of standard reinsurance as well.

The impact of reinsurance on different product lines could also be studied. Products to consider might be individual disability insurance using excess share coinsurance or YRT reinsurance, individual annuity insurance using coinsurance or modified coinsurance, or nonparticipating life insurance using various methods of reinsurance.

Both models developed in this paper were used to analyze traditional proportional reinsurance that is placed on a case by case basis. The traditional model is flexible enough, however, to handle the above reinsurance arrangements as well as quota share and group reinsurance. With the appropriate changes, the model could be also used to analyze nonproportional reinsurance arrangements. These analyses could then be taken to the macro level to examine their project based profitability.

GAAP reserves could be incorporated into the model to determine the impact on Management Based Financial earnings. This gives the actuary another way to analyze profit.

A crucial element to the success of any reinsurance agreement is producing model office projections and monitoring the program to determine whether the projections are being met. The models could be used to produce this projection. Then experience studies, perhaps annually, can be conducted to compare actual results to expected. A case study could be illustrated.

So, although this paper concentrated on analyzing facultative reinsurance, the models employed in these analyses could be used in a wide range of applications.

**Appendix 1**

Full Retention, Male Nonsmoker Age 45

CONSTANT VARIABLES

| Variable | Value | Variable | Value |
|---|---|---|---|
| $taxrate_{x,t}$: | 34% | $DB_{x,t}$: | 1000.00 |
| interest rate: | 8.00% | $expthou_{x,1}$: | 1.10 |
| pv rate: | 5.28% | $expthou_{x,t>1}$: | 0.00 |
| $avgsize_x$: | 200 | $expdeath_t$: | 225.00 |
| std net prem: | 15.88 | $explapse_t$: | 4.00 |
| substd extra: | 4.46 | $expdiv_t$: | 5.00 |
| % prem load: | 10.00% | issue rtg: | 200% |
| policy fee: | 50 | reinsurer: | N/A |
| $premrate_{x,t}$: | 22.60 | reinsurer rtg: | N/A |
| $premium_{45,0}$: | 22.85 | retention: | 100% |
| prem tax rate: | 2.50% | actual rtg: | 200% |

DECREMENTS AND DISCOUNTING

| t | Standard mortality rate | extra mortality rate | $qd_{x,t}$ | $qw_{x,t}$ | $p_{x+t}$ | $l_{x,t}$ | $D_t$ |
|---|---|---|---|---|---|---|---|
| 0 | 0.00062 | 0.00101 | 0.00163 | 15.00% | | | |
| 1 | 0.00090 | 0.00144 | 0.00234 | 12.50% | 0.848 | 0.85 | 0.950 |
| 2 | 0.00121 | 0.00192 | 0.00312 | 10.00% | 0.872 | 0.74 | 0.902 |
| 3 | 0.00143 | 0.00227 | 0.00370 | 9.00% | 0.896 | 0.66 | 0.857 |
| 4 | 0.00162 | 0.00256 | 0.00418 | 8.00% | 0.906 | 0.60 | 0.814 |
| 5 | 0.00179 | 0.00283 | 0.00462 | 7.00% | 0.915 | 0.55 | 0.773 |
| 6 | 0.00194 | 0.00308 | 0.00502 | 5.00% | 0.915 | 0.51 | 0.734 |
| 7 | 0.00210 | 0.00334 | 0.00544 | 5.00% | 0.944 | 0.48 | 0.698 |
| 8 | 0.00230 | 0.00367 | 0.00597 | 5.00% | 0.944 | 0.46 | 0.663 |
| 9 | 0.00255 | 0.00408 | 0.00663 | 5.00% | 0.944 | 0.43 | 0.629 |
| 10 | 0.00294 | 0.00470 | 0.00764 | 5.00% | 0.943 | 0.41 | 0.598 |
| 11 | 0.00339 | 0.00542 | 0.00881 | 5.00% | 0.942 | 0.38 | 0.568 |
| 12 | 0.00390 | 0.00624 | 0.01014 | 5.00% | 0.941 | 0.36 | 0.539 |
| 13 | 0.00449 | 0.00719 | 0.01168 | 5.00% | 0.939 | 0.34 | 0.512 |
| 14 | 0.00517 | 0.00827 | 0.01344 | 5.00% | 0.938 | 0.32 | 0.487 |
| 15 | 0.00595 | 0.00952 | 0.01547 | 5.00% | 0.936 | 0.30 | 0.462 |
| 16 | 0.00672 | 0.01047 | 0.01719 | 5.00% | 0.934 | 0.28 | 0.439 |
| 17 | 0.00758 | 0.01151 | 0.01909 | 5.00% | 0.932 | 0.26 | 0.417 |
| 18 | 0.00852 | 0.01262 | 0.02114 | 5.00% | 0.930 | 0.24 | 0.396 |
| 19 | 0.00956 | 0.01381 | 0.02337 | 5.00% | 0.928 | 0.22 | 0.376 |
| 20 | 0.01073 | 0.01511 | 0.02585 | 5.00% | 0.926 | 0.21 | 0.357 |
| 21 | 0.01202 | 0.01653 | 0.02855 | 5.00% | 0.924 | 0.19 | 0.339 |
| 22 | 0.01348 | 0.01809 | 0.03157 | 5.00% | 0.921 | 0.18 | 0.322 |
| 23 | 0.01511 | 0.01980 | 0.03491 | 5.00% | 0.918 | 0.16 | 0.306 |
| 24 | 0.01664 | 0.02152 | 0.03815 | 5.00% | 0.915 | 0.15 | 0.291 |
| 25 | 0.01831 | 0.02336 | 0.04167 | 5.00% | 0.911 | 0.14 | 0.276 |
| 26 | 0.02011 | 0.02540 | 0.04551 | 5.00% | 0.908 | 0.12 | 0.262 |
| 27 | 0.02204 | 0.02755 | 0.04959 | 5.00% | 0.904 | 0.11 | 0.249 |
| 28 | 0.02413 | 0.02985 | 0.05398 | 5.00% | 0.900 | 0.10 | 0.237 |
| 29 | 0.02641 | 0.03233 | 0.05874 | 5.00% | 0.896 | 0.09 | 0.225 |
| 30 | n/a | n/a | n/a | n/a | 0.891 | 0.08 | 0.214 |

Appendix 1

Full Retention, Male Nonsmoker Age 45

EXPENSES, CASH VALUES AND DIVIDENDS

| $t$ | $premium_{x,t}$ | $exppol_{x,t}$ | $expprem_{x,t}$ | $begexp_{x,t}$ | $endexp_{x,t}$ | $CV_{x,t}$ | $dividend_{x,t}$ |
|---|---|---|---|---|---|---|---|
| 0 | 22.85 | | | | | | |
| 1 | 19.39 | 200 | 1.260 | 31.46 | 0.028 | 0.00 | 0.00 |
| 2 | 16.92 | 25 | 0.188 | 4.24 | 0.023 | 0.00 | 0.00 |
| 3 | 15.17 | 25 | 0.188 | 3.70 | 0.020 | 9.47 | 0.09 |
| 4 | 13.75 | 25 | 0.138 | 2.56 | 0.018 | 22.78 | 0.23 |
| 5 | 12.59 | 25 | 0.138 | 2.32 | 0.016 | 36.60 | 0.37 |
| 6 | 11.65 | 25 | 0.138 | 2.12 | 0.014 | 50.98 | 0.51 |
| 7 | 11.01 | 25 | 0.138 | 1.96 | 0.013 | 65.87 | 0.66 |
| 8 | 10.40 | 25 | 0.138 | 1.86 | 0.012 | 81.27 | 1.63 |
| 9 | 9.82 | 25 | 0.138 | 1.75 | 0.012 | 97.18 | 2.64 |
| 10 | 9.26 | 25 | 0.138 | 1.65 | 0.011 | 113.56 | 3.56 |
| 11 | 8.73 | 25 | 0.055 | 0.79 | 0.010 | 130.40 | 4.34 |
| 12 | 8.22 | 25 | 0.055 | 0.75 | 0.010 | 147.71 | 5.01 |
| 13 | 7.72 | 25 | 0.055 | 0.70 | 0.009 | 165.48 | 5.60 |
| 14 | 7.25 | 25 | 0.055 | 0.66 | 0.009 | 183.74 | 6.10 |
| 15 | 6.79 | 25 | 0.055 | 0.62 | 0.008 | 202.45 | 6.60 |
| 16 | 6.34 | 25 | 0.055 | 0.58 | 0.008 | 221.59 | 7.18 |
| 17 | 5.92 | 25 | 0.055 | 0.54 | 0.007 | 241.15 | 7.75 |
| 18 | 5.51 | 25 | 0.055 | 0.51 | 0.007 | 261.05 | 8.33 |
| 19 | 5.12 | 25 | 0.055 | 0.47 | 0.006 | 281.25 | 8.93 |
| 20 | 4.74 | 25 | 0.055 | 0.44 | 0.006 | 301.68 | 9.57 |
| 21 | 4.38 | 25 | 0.055 | 0.41 | 0.005 | 322.30 | 10.27 |
| 22 | 4.04 | 25 | 0.055 | 0.37 | 0.005 | 343.10 | 11.08 |
| 23 | 3.71 | 25 | 0.055 | 0.35 | 0.004 | 364.07 | 11.94 |
| 24 | 3.39 | 25 | 0.055 | 0.32 | 0.004 | 385.23 | 12.83 |
| 25 | 3.09 | 25 | 0.055 | 0.29 | 0.004 | 406.55 | 13.79 |
| 26 | 2.81 | 25 | 0.055 | 0.26 | 0.003 | 427.97 | 16.53 |
| 27 | 2.54 | 25 | 0.055 | 0.24 | 0.003 | 449.05 | 16.19 |
| 28 | 2.29 | 25 | 0.055 | 0.22 | 0.003 | 470.28 | 17.00 |
| 29 | 2.05 | 25 | 0.055 | 0.20 | 0.002 | 491.19 | 18.30 |
| 30 | n/a | 25 | 0.055 | 0.18 | 0.002 | 511.65 | 19.67 |

Appendix 1

Full Retention, Male Nonsmoker Age 45

DEATH EXPENSES, POLICY BENIFITS, TOTAL EXPENSES, AND INVESTMENT INCOME

| $t$ | $dthexp_{x,t}$ | $deathben_{x,t}$ | $polben_{x,t}$ | $expense_{x,t}$ | $invinc_{x,t}$ |
|---|---|---|---|---|---|
| 0 | | | | | |
| 1 | 0.0018 | 1.64 | 1.64 | 31.49 | -0.75 |
| 2 | 0.0022 | 2.00 | 2.00 | 4.26 | 0.51 |
| 3 | 0.0026 | 2.33 | 3.10 | 3.72 | 1.26 |
| 4 | 0.0028 | 2.47 | 3.98 | 2.58 | 1.99 |
| 5 | 0.0028 | 2.53 | 4.51 | 2.34 | 2.60 |
| 6 | 0.0029 | 2.56 | 4.81 | 2.14 | 3.17 |
| 7 | 0.0029 | 2.57 | 4.59 | 1.98 | 3.70 |
| 8 | 0.0029 | 2.63 | 5.37 | 1.87 | 4.26 |
| 9 | 0.0031 | 2.73 | 6.14 | 1.77 | 4.78 |
| 10 | 0.0032 | 2.86 | 6.82 | 1.67 | 5.24 |
| 11 | 0.0035 | 3.11 | 7.50 | 0.81 | 5.72 |
| 12 | 0.0038 | 3.38 | 8.10 | 0.76 | 6.13 |
| 13 | 0.0041 | 3.66 | 8.63 | 0.72 | 6.49 |
| 14 | 0.0044 | 3.96 | 9.10 | 0.67 | 6.80 |
| 15 | 0.0048 | 4.28 | 9.55 | 0.63 | 7.06 |
| 16 | 0.0052 | 4.61 | 10.00 | 0.59 | 7.28 |
| 17 | 0.0054 | 4.78 | 10.24 | 0.55 | 7.46 |
| 18 | 0.0056 | 4.96 | 10.45 | 0.52 | 7.60 |
| 19 | 0.0057 | 5.11 | 10.60 | 0.48 | 7.72 |
| 20 | 0.0059 | 5.24 | 10.71 | 0.45 | 7.80 |
| 21 | 0.0060 | 5.37 | 10.79 | 0.42 | 7.84 |
| 22 | 0.0062 | 5.48 | 10.84 | 0.39 | 7.86 |
| 23 | 0.0063 | 5.59 | 10.84 | 0.36 | 7.85 |
| 24 | 0.0064 | 5.67 | 10.81 | 0.33 | 7.82 |
| 25 | 0.0064 | 5.67 | 10.66 | 0.30 | 7.77 |
| 26 | 0.0063 | 5.65 | 10.69 | 0.27 | 7.70 |
| 27 | 0.0063 | 5.60 | 10.26 | 0.25 | 7.60 |
| 28 | 0.0062 | 5.52 | 9.93 | 0.23 | 7.51 |
| 29 | 0.0061 | 5.41 | 9.60 | 0.20 | 7.41 |
| 30 | 0.0059 | 5.28 | 9.23 | 0.18 | 7.31 |

Full Retention, Male Nonsmoker Age 45

STATUTORY RESERVES, FEDERALLY PRESCRIBED RESERVES, TAX RESERVES

| t | Standard ${}_{fp}V_{x,t}$ | Substd extra ${}_{fp}V_{x,t}$ | Total ${}_{fp}V_{x,t}$ | Standard $V_{x,t}$ | Substd extra $V_{x,t}$ | Total $V_{x,t}$ | ${}_{tax}V_{x,t}$ |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | 0 |
| 1 | 0.00 | 0.00 | 0.00 | 0.00 | 2.99 | 2.99 | 0.00 |
| 2 | 8.74 | 3.18 | 11.92 | 13.95 | 6.01 | 19.96 | 11.92 |
| 3 | 17.97 | 6.44 | 24.40 | 28.37 | 9.04 | 37.41 | 24.40 |
| 4 | 27.70 | 9.77 | 37.47 | 43.27 | 12.06 | 55.33 | 37.47 |
| 5 | 37.96 | 13.13 | 51.09 | 58.65 | 15.05 | 73.70 | 51.09 |
| 6 | 48.78 | 16.50 | 65.29 | 74.53 | 17.98 | 92.51 | 65.29 |
| 7 | 60.16 | 19.90 | 80.06 | 90.88 | 20.87 | 111.75 | 80.06 |
| 8 | 72.07 | 23.31 | 95.39 | 107.69 | 23.70 | 131.39 | 95.39 |
| 9 | 84.54 | 26.74 | 111.28 | 124.94 | 26.48 | 151.41 | 111.28 |
| 10 | 97.54 | 30.16 | 127.71 | 142.60 | 29.18 | 171.78 | 127.71 |
| 11 | 111.09 | 33.58 | 144.67 | 160.65 | 31.81 | 192.47 | 144.67 |
| 12 | 125.17 | 36.90 | 162.07 | 179.09 | 34.30 | 213.39 | 162.07 |
| 13 | 139.82 | 40.09 | 179.91 | 197.93 | 36.62 | 234.55 | 179.91 |
| 14 | 155.07 | 43.14 | 198.21 | 217.16 | 38.77 | 255.93 | 198.21 |
| 15 | 170.88 | 46.04 | 216.93 | 236.75 | 40.75 | 277.50 | 216.93 |
| 16 | 187.26 | 48.87 | 236.14 | 256.68 | 42.62 | 299.30 | 236.14 |
| 17 | 204.20 | 51.62 | 255.82 | 276.93 | 44.37 | 321.30 | 255.82 |
| 18 | 221.65 | 54.26 | 275.91 | 297.43 | 46.00 | 343.43 | 275.91 |
| 19 | 239.56 | 56.75 | 296.31 | 318.13 | 47.47 | 365.59 | 296.31 |
| 20 | 257.87 | 59.06 | 316.93 | 338.95 | 48.76 | 387.71 | 316.93 |
| 21 | 276.55 | 61.16 | 337.71 | 359.86 | 49.86 | 409.72 | 337.71 |
| 22 | 295.60 | 63.05 | 358.65 | 380.86 | 50.78 | 431.64 | 358.65 |
| 23 | 315.01 | 64.76 | 379.77 | 401.93 | 51.53 | 453.45 | 379.77 |
| 24 | 334.82 | 66.29 | 401.11 | 423.07 | 52.14 | 475.21 | 401.11 |
| 25 | 355.01 | 67.74 | 422.74 | 444.28 | 52.67 | 496.95 | 422.74 |
| 26 | 375.50 | 69.16 | 444.66 | 465.47 | 53.17 | 518.64 | 444.66 |
| 27 | 395.84 | 70.53 | 466.36 | 486.24 | 53.62 | 539.87 | 466.36 |
| 28 | 416.56 | 71.75 | 488.31 | 507.07 | 53.96 | 561.02 | 488.31 |
| 29 | 437.15 | 72.81 | 509.95 | 527.50 | 54.16 | 581.66 | 509.95 |
| 30 | 457.46 | 73.55 | 531.00 | 547.41 | 54.14 | 601.55 | 531.32 |

Appendix 1

Full Retention, Male Nonsmoker Age 45

TAXES, ASSETS, LIABILITIES, SURPLUS*

| t | change in $taxliab_{x,t}$ | $DACtax_{x,t}$ | $taxinc_{x,t}$ | $tax_{x,t}$ | $assets_{x,t}$ | $AS_{x,t}$ | $liab_{x,t}$ | $surplus_{x,t}$ |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | 0 | | 0 | 0 |
| 1 | 0.00 | 1.672 | -9.37 | -3.18 | -7.85 | -9.26 | 2.54 | -10.39 |
| 2 | 8.83 | 1.242 | 6.04 | 2.06 | 3.72 | 5.02 | 14.78 | -11.06 |
| 3 | 7.38 | 0.912 | 4.89 | 1.66 | 13.42 | 20.20 | 24.84 | -11.42 |
| 4 | 6.34 | 0.654 | 4.91 | 1.67 | 22.35 | 37.13 | 33.30 | -10.95 |
| 5 | 5.61 | 0.434 | 4.33 | 1.47 | 30.38 | 55.12 | 40.62 | -10.24 |
| 6 | 5.14 | 0.243 | 3.92 | 1.33 | 37.86 | 74.24 | 47.18 | -9.32 |
| 7 | 5.29 | 0.077 | 3.58 | 1.22 | 45.44 | 94.28 | 53.86 | -8.42 |
| 8 | 4.84 | -0.059 | 3.13 | 1.07 | 52.40 | 115.11 | 59.81 | -7.41 |
| 9 | 4.40 | -0.189 | 2.69 | 0.91 | 58.77 | 136.74 | 65.07 | -6.30 |
| 10 | 3.95 | -0.311 | 2.31 | 0.79 | 64.55 | 159.23 | 69.64 | -5.09 |
| 11 | 3.50 | -0.340 | 2.84 | 0.97 | 70.27 | 183.92 | 73.53 | -3.26 |
| 12 | 3.01 | -0.288 | 2.70 | 0.92 | 75.35 | 209.54 | 76.73 | -1.39 |
| 13 | 2.52 | -0.253 | 2.58 | 0.88 | 79.83 | 236.21 | 79.26 | 0.56 |
| 14 | 2.05 | -0.228 | 2.46 | 0.84 | 83.73 | 264.05 | 81.16 | 2.58 |
| 15 | 1.57 | -0.211 | 2.34 | 0.80 | 87.06 | 293.14 | 82.41 | 4.65 |
| 16 | 1.11 | -0.199 | 2.16 | 0.74 | 89.80 | 323.56 | 83.07 | 6.73 |
| 17 | 0.69 | -0.191 | 2.12 | 0.72 | 92.08 | 355.68 | 83.18 | 8.90 |
| 18 | 0.27 | -0.184 | 2.10 | 0.71 | 93.92 | 389.70 | 82.77 | 11.15 |
| 19 | -0.16 | -0.177 | 2.13 | 0.72 | 95.34 | 425.87 | 81.84 | 13.49 |
| 20 | -0.59 | -0.170 | 2.17 | 0.74 | 96.35 | 464.47 | 80.43 | 15.92 |
| 21 | -1.00 | -0.163 | 2.22 | 0.75 | 96.97 | 505.83 | 78.55 | 18.42 |
| 22 | -1.39 | -0.157 | 2.25 | 0.77 | 97.23 | 550.41 | 76.25 | 20.98 |
| 23 | -1.74 | -0.150 | 2.28 | 0.78 | 97.14 | 598.77 | 73.57 | 23.58 |
| 24 | -2.06 | -0.144 | 2.31 | 0.79 | 96.75 | 651.68 | 70.55 | 26.20 |
| 25 | -2.32 | -0.138 | 2.38 | 0.81 | 96.14 | 710.16 | 67.28 | 28.86 |
| 26 | -2.55 | -0.132 | 2.24 | 0.76 | 95.20 | 774.20 | 63.78 | 31.42 |
| 27 | -2.81 | -0.126 | 2.58 | 0.88 | 94.22 | 847.14 | 60.05 | 34.18 |
| 28 | -2.97 | -0.120 | 2.74 | 0.93 | 93.18 | 930.43 | 56.18 | 36.99 |
| 29 | -3.14 | -0.114 | 2.92 | 0.99 | 92.08 | 1026.12 | 52.19 | 39.88 |
| 30 | -3.27 | -0.108 | 3.10 | 1.05 | 90.96 | 1137.42 | 48.11 | 42.86 |

* $assets_{x,t}$, $liab_{x,t}$, and $surplus_{x,t}$ are per unit issued. $AS_{x,t}$ is per unit in force at the end of the year.

Appendix 1

Full Retention, Male Nonsmoker Age 45

GAIN AND PROFIT

| t | $gain_{x,t}$ | $profit_{x,t}$ | $pvprofit_x$ | $pvprem_x$ | $pvprofprem_{45}$ | |
|---|---|---|---|---|---|---|
| 0 | | | | | n | |
| 1 | -10.39 | -10.39 | -9.87 | 22.85 | 10 | -2.33% |
| 2 | -0.67 | -0.12 | -9.98 | 44.56 | 15 | 1.39% |
| 3 | -0.36 | 0.22 | -9.79 | 62.05 | 20 | 3.39% |
| 4 | 0.47 | 1.07 | -8.91 | 76.54 | 25 | 4.55% |
| 5 | 0.71 | 1.29 | -7.92 | 88.90 | 30 | 5.12% |
| 6 | 0.92 | 1.46 | -6.84 | 99.53 | | |
| 7 | 0.90 | 1.39 | -5.88 | 108.78 | | |
| 8 | 1.01 | 1.46 | -4.91 | 116.91 | | |
| 9 | 1.11 | 1.50 | -3.97 | 124.20 | | |
| 10 | 1.22 | 1.55 | -3.04 | 130.75 | | |
| 11 | 1.82 | 2.09 | -1.85 | 136.62 | | |
| 12 | 1.88 | 2.05 | -0.75 | 141.88 | | |
| 13 | 1.95 | 2.02 | 0.29 | 146.59 | | |
| 14 | 2.01 | 1.98 | 1.25 | 150.80 | | |
| 15 | 2.07 | 1.93 | 2.15 | 154.55 | | |
| 16 | 2.09 | 1.84 | 2.96 | 157.90 | | |
| 17 | 2.17 | 1.81 | 3.71 | 160.88 | | |
| 18 | 2.25 | 1.78 | 4.42 | 163.53 | | |
| 19 | 2.34 | 1.75 | 5.08 | 165.87 | | |
| 20 | 2.43 | 1.72 | 5.69 | 167.94 | | |
| 21 | 2.50 | 1.66 | 6.25 | 169.77 | | |
| 22 | 2.56 | 1.58 | 6.76 | 171.38 | | |
| 23 | 2.59 | 1.49 | 7.22 | 172.79 | | |
| 24 | 2.62 | 1.38 | 7.62 | 174.03 | | |
| 25 | 2.66 | 1.28 | 7.97 | 175.11 | | |
| 26 | 2.56 | 1.04 | 8.25 | 176.04 | | |
| 27 | 2.75 | 1.09 | 8.52 | 176.86 | | |
| 28 | 2.82 | 1.01 | 8.76 | 177.56 | | |
| 29 | 2.89 | 0.93 | 8.97 | 178.16 | | |
| 30 | 2.97 | 0.87 | 9.15 | 178.67 | | |

Appendix 1

Full Retention, Male Nonsmoker Age 45

TARGET SURPLUS RETRUN ON INVESTMENT*

| t | $surplus_{x,t}$ | $gain_{x,t}$ | $profit_{x,t}$ | $pvprofit_x$ | $pvprem_x$ | $targsurpROI_{45}$ |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| 1 | -10.98 | -10.39 | -10.39 | -9.87 | 22.85 | 12.28% |
| 2 | -11.57 | -0.67 | -0.09 | -9.95 | 44.56 | |
| 3 | -12.25 | -0.36 | 0.25 | -9.74 | 62.05 | |
| 4 | -12.05 | 0.47 | 1.12 | -8.83 | 76.54 | |
| 5 | -11.57 | 0.71 | 1.35 | -7.78 | 88.90 | |
| 6 | -10.85 | 0.92 | 1.53 | -6.66 | 99.53 | |
| 7 | -10.13 | 0.90 | 1.47 | -5.64 | 108.78 | |
| 8 | -9.31 | 1.01 | 1.55 | -4.61 | 116.91 | |
| 9 | -8.37 | 1.11 | 1.60 | -3.60 | 124.20 | |
| 10 | -7.68 | 1.22 | 1.66 | -2.61 | 130.75 | |
| 11 | -6.31 | 1.82 | 2.23 | -1.35 | 136.62 | |
| 12 | -4.81 | 1.88 | 2.21 | -0.15 | 141.88 | |
| 13 | -3.17 | 1.95 | 2.20 | 0.97 | 146.59 | |
| 14 | -1.40 | 2.01 | 2.18 | 2.03 | 150.80 | |
| 15 | 0.49 | 2.07 | 2.14 | 3.03 | 154.55 | |
| 16 | 2.45 | 2.09 | 2.06 | 3.93 | 157.90 | |
| 17 | 4.54 | 2.17 | 2.04 | 4.78 | 160.88 | |
| 18 | 6.76 | 2.25 | 2.01 | 5.58 | 163.53 | |
| 19 | 9.12 | 2.34 | 1.98 | 6.32 | 165.87 | |
| 20 | 11.60 | 2.43 | 1.95 | 7.02 | 167.94 | |
| 21 | 14.19 | 2.50 | 1.89 | 7.66 | 169.77 | |
| 22 | 16.86 | 2.56 | 1.81 | 8.24 | 171.38 | |
| 23 | 19.60 | 2.59 | 1.70 | 8.77 | 172.79 | |
| 24 | 22.39 | 2.62 | 1.59 | 9.23 | 174.03 | |
| 25 | 25.24 | 2.66 | 1.48 | 9.64 | 175.11 | |
| 26 | 28.00 | 2.56 | 1.23 | 9.96 | 176.04 | |
| 27 | 30.96 | 2.75 | 1.27 | 10.28 | 176.86 | |
| 28 | 34.00 | 2.82 | 1.18 | 10.56 | 177.56 | |
| 29 | 37.12 | 2.89 | 1.09 | 10.80 | 178.16 | |
| 30 | 40.32 | 2.97 | 1.01 | 11.02 | 178.67 | |

* Target surplus is 3% of reserves held plus 50¢ per thousand of net amount at risk, where net amount at risk is death benefit less cash value. (Note that using cash value rather than reserve results in a more conservative net amount at risk.)

**Appendix 2**

Aggressive Placement Method, Male Nonsmoker Age 45

CONSTANT VARIABLES

| Variable | Value | Variable | Value |
|---|---|---|---|
| $taxrate_{x,t}$: | 34% | $DB_{x,t}$: | 1000.00 |
| interest rate: | 8.00% | $expthou_{x,1}$: | 1.10 |
| pv rate: | 5.28% | $expthou_{x,t>1}$: | 0.00 |
| $avgsize_x$: | 200 | $expdeath_t$: | 225.00 |
| std net prem: | 15.88 | $explapse_t$: | 4.00 |
| substd extra: | 1.20 | $expdiv_t$: | 5.00 |
| % prem load: | 10.00% | issue rtg: | 125% |
| policy fee: | 50 | reinsurer: | C |
| $premrate_{x,t}$: | 18.98 | reinsurer rtg: | 125% |
| $premium_{45,0}$: | 19.23 | retention: | 0% |
| prem tax rate: | 2.50% | actual rtg: | 200% |

DECREMENTS AND DISCOUNTING

| t | Standard mortality rate | extra mortality rate | $qd_{x,t}$ | $qw_{x,t}$ | $p_{x+t}$ | $l_{x,t}$ | $D_t$ |
|---|---|---|---|---|---|---|---|
| 0 | 0.00062 | 0.00101 | 0.00163 | 15.00% | | | |
| 1 | 0.00090 | 0.00144 | 0.00234 | 12.50% | 0.848 | 0.85 | 0.950 |
| 2 | 0.00121 | 0.00192 | 0.00312 | 10.00% | 0.872 | 0.74 | 0.902 |
| 3 | 0.00143 | 0.00227 | 0.00370 | 9.00% | 0.896 | 0.66 | 0.857 |
| 4 | 0.00162 | 0.00256 | 0.00418 | 8.00% | 0.906 | 0.60 | 0.814 |
| 5 | 0.00179 | 0.00283 | 0.00462 | 7.00% | 0.915 | 0.55 | 0.773 |
| 6 | 0.00194 | 0.00308 | 0.00502 | 5.00% | 0.915 | 0.51 | 0.734 |
| 7 | 0.00210 | 0.00334 | 0.00544 | 5.00% | 0.944 | 0.48 | 0.698 |
| 8 | 0.00230 | 0.00367 | 0.00597 | 5.00% | 0.944 | 0.46 | 0.663 |
| 9 | 0.00255 | 0.00408 | 0.00663 | 5.00% | 0.944 | 0.43 | 0.629 |
| 10 | 0.00294 | 0.00470 | 0.00764 | 5.00% | 0.943 | 0.41 | 0.598 |
| 11 | 0.00339 | 0.00542 | 0.00881 | 5.00% | 0.942 | 0.38 | 0.568 |
| 12 | 0.00390 | 0.00624 | 0.01014 | 5.00% | 0.941 | 0.36 | 0.539 |
| 13 | 0.00449 | 0.00719 | 0.01168 | 5.00% | 0.939 | 0.34 | 0.512 |
| 14 | 0.00517 | 0.00827 | 0.01344 | 5.00% | 0.938 | 0.32 | 0.487 |
| 15 | 0.00595 | 0.00952 | 0.01547 | 5.00% | 0.936 | 0.30 | 0.462 |
| 16 | 0.00672 | 0.01047 | 0.01719 | 5.00% | 0.934 | 0.28 | 0.439 |
| 17 | 0.00758 | 0.01151 | 0.01909 | 5.00% | 0.932 | 0.26 | 0.417 |
| 18 | 0.00852 | 0.01262 | 0.02114 | 5.00% | 0.930 | 0.24 | 0.396 |
| 19 | 0.00956 | 0.01381 | 0.02337 | 5.00% | 0.928 | 0.22 | 0.376 |
| 20 | 0.01073 | 0.01511 | 0.02585 | 5.00% | 0.926 | 0.21 | 0.357 |
| 21 | 0.01202 | 0.01653 | 0.02855 | 5.00% | 0.924 | 0.19 | 0.339 |
| 22 | 0.01348 | 0.01809 | 0.03157 | 5.00% | 0.921 | 0.18 | 0.322 |
| 23 | 0.01511 | 0.01980 | 0.03491 | 5.00% | 0.918 | 0.16 | 0.306 |
| 24 | 0.01664 | 0.02152 | 0.03815 | 5.00% | 0.915 | 0.15 | 0.291 |
| 25 | 0.01831 | 0.02336 | 0.04167 | 5.00% | 0.911 | 0.14 | 0.276 |
| 26 | 0.02011 | 0.02540 | 0.04551 | 5.00% | 0.908 | 0.12 | 0.262 |
| 27 | 0.02204 | 0.02755 | 0.04959 | 5.00% | 0.904 | 0.11 | 0.249 |
| 28 | 0.02413 | 0.02985 | 0.05398 | 5.00% | 0.900 | 0.10 | 0.237 |
| 29 | 0.02641 | 0.03233 | 0.05874 | 5.00% | 0.896 | 0.09 | 0.225 |
| 30 | n/a | n/a | n/a | n/a | 0.891 | 0.08 | 0.214 |

Appendix 2

Aggressive Placement Method, Male Nonsmoker Age 45

EXPENSES, CASH VALUES AND DIVIDENDS

| $t$ | $premium_{x,t}$ | $exppol_{x,t}$ | $expprem_{x,t}$ | $begexp_{x,t}$ | $endexp_{x,t}$ | $CV_{x,t}$ | $dividend_{x,t}$ |
|---|---|---|---|---|---|---|---|
| 0 | 19.23 | | | | | | |
| 1 | 16.32 | 220 | 1.260 | 29.04 | 0.028 | 0.00 | 0.00 |
| 2 | 14.24 | 30 | 0.188 | 6.06 | 0.023 | 0.00 | 0.00 |
| 3 | 12.77 | 30 | 0.188 | 5.79 | 0.020 | 9.47 | 0.09 |
| 4 | 11.57 | 30 | 0.138 | 4.90 | 0.018 | 22.78 | 0.23 |
| 5 | 10.60 | 30 | 0.138 | 4.59 | 0.016 | 36.60 | 0.37 |
| 6 | 9.81 | 30 | 0.138 | 4.53 | 0.014 | 50.98 | 0.51 |
| 7 | 9.27 | 30 | 0.138 | 4.59 | 0.013 | 65.87 | 0.66 |
| 8 | 8.75 | 30 | 0.138 | 4.52 | 0.012 | 81.27 | 1.63 |
| 9 | 8.26 | 30 | 0.138 | 4.48 | 0.012 | 97.18 | 2.64 |
| 10 | 7.80 | 30 | 0.138 | 4.49 | 0.011 | 113.56 | 3.56 |
| 11 | 7.35 | 30 | 0.055 | 3.92 | 0.010 | 130.40 | 4.34 |
| 12 | 6.92 | 30 | 0.055 | 4.01 | 0.010 | 147.71 | 5.01 |
| 13 | 6.50 | 30 | 0.055 | 4.17 | 0.009 | 165.48 | 5.60 |
| 14 | 6.10 | 30 | 0.055 | 4.28 | 0.009 | 183.74 | 6.10 |
| 15 | 5.71 | 30 | 0.055 | 4.33 | 0.008 | 202.45 | 6.60 |
| 16 | 5.34 | 30 | 0.055 | 4.42 | 0.008 | 221.59 | 7.18 |
| 17 | 4.98 | 30 | 0.055 | 4.40 | 0.007 | 241.15 | 7.75 |
| 18 | 4.63 | 30 | 0.055 | 4.32 | 0.007 | 261.05 | 8.33 |
| 19 | 4.31 | 30 | 0.055 | 4.23 | 0.006 | 281.25 | 8.93 |
| 20 | 3.99 | 30 | 0.055 | 4.02 | 0.006 | 301.68 | 9.57 |
| 21 | 3.69 | 30 | 0.055 | 3.89 | 0.005 | 322.30 | 10.27 |
| 22 | 3.40 | 30 | 0.055 | 3.77 | 0.005 | 343.10 | 11.08 |
| 23 | 3.12 | 30 | 0.055 | 3.61 | 0.004 | 364.07 | 11.94 |
| 24 | 2.86 | 30 | 0.055 | 3.47 | 0.004 | 385.23 | 12.83 |
| 25 | 2.60 | 30 | 0.055 | 3.30 | 0.004 | 406.55 | 13.79 |
| 26 | 2.36 | 30 | 0.055 | 3.14 | 0.003 | 427.97 | 16.53 |
| 27 | 2.14 | 30 | 0.055 | 2.99 | 0.003 | 449.05 | 16.19 |
| 28 | 1.93 | 30 | 0.055 | 2.83 | 0.003 | 470.28 | 17.00 |
| 29 | 1.73 | 30 | 0.055 | 2.63 | 0.002 | 491.19 | 18.30 |
| 30 | n/a | 30 | 0.055 | 2.43 | 0.002 | 511.65 | 19.67 |

Appendix 2

Aggressive Placement Method, Male Nonsmoker Age 45

DEATH EXPENSES, POLICY BENIFITS, TOTAL EXPENSES, AND INVESTMENT INCOME

| t | $dthexp_{x,t}$ | $deathben_{x,t}$ | $polben_{x,t}$ | $expense_{x,t}$ | $invinc_{x,t}$ |
|---|---|---|---|---|---|
| 0 | | | | | |
| 1 | 0.0018 | 0.01 | 0.01 | 29.07 | -0.79 |
| 2 | 0.0022 | 0.01 | 0.01 | 6.08 | 0.22 |
| 3 | 0.0026 | 0.03 | 0.81 | 5.81 | 0.80 |
| 4 | 0.0028 | 0.07 | 1.58 | 4.92 | 1.34 |
| 5 | 0.0028 | 0.10 | 2.08 | 4.61 | 1.80 |
| 6 | 0.0029 | 0.14 | 2.39 | 4.55 | 2.20 |
| 7 | 0.0029 | 0.18 | 2.19 | 4.60 | 2.56 |
| 8 | 0.0029 | 0.22 | 2.96 | 4.54 | 2.94 |
| 9 | 0.0031 | 0.27 | 3.68 | 4.50 | 3.31 |
| 10 | 0.0032 | 0.33 | 4.29 | 4.50 | 3.62 |
| 11 | 0.0035 | 0.41 | 4.80 | 3.93 | 3.92 |
| 12 | 0.0038 | 0.50 | 5.22 | 4.03 | 4.15 |
| 13 | 0.0041 | 0.61 | 5.58 | 4.18 | 4.32 |
| 14 | 0.0044 | 0.73 | 5.87 | 4.29 | 4.43 |
| 15 | 0.0048 | 0.87 | 6.14 | 4.34 | 4.50 |
| 16 | 0.0052 | 1.02 | 6.41 | 4.43 | 4.52 |
| 17 | 0.0054 | 1.15 | 6.61 | 4.41 | 4.50 |
| 18 | 0.0056 | 1.29 | 6.79 | 4.33 | 4.44 |
| 19 | 0.0057 | 1.43 | 6.93 | 4.24 | 4.35 |
| 20 | 0.0059 | 1.58 | 7.05 | 4.03 | 4.22 |
| 21 | 0.0060 | 1.73 | 7.15 | 3.90 | 4.06 |
| 22 | 0.0062 | 1.88 | 7.23 | 3.78 | 3.86 |
| 23 | 0.0063 | 2.03 | 7.29 | 3.62 | 3.63 |
| 24 | 0.0064 | 2.18 | 7.32 | 3.48 | 3.37 |
| 25 | 0.0064 | 2.30 | 7.29 | 3.31 | 3.08 |
| 26 | 0.0063 | 2.41 | 7.45 | 3.15 | 2.77 |
| 27 | 0.0063 | 2.51 | 7.17 | 3.00 | 2.42 |
| 28 | 0.0062 | 2.59 | 7.00 | 2.84 | 2.05 |
| 29 | 0.0061 | 2.65 | 6.85 | 2.64 | 1.67 |
| 30 | 0.0059 | 2.70 | 6.65 | 2.43 | 1.27 |

Aggressive Placement Method, Male Nonsmoker Age 45

STATUTORY RESERVES, FEDERALLY PRESCRIBED RESERVES, TAX RESERVES

| t | Standard $_{fp}V_{x,t}$ | Substd extra $_{fp}V_{x,t}$ | Total $_{fp}V_{x,t}$ | Standard $V_{x,t}$ | Substd extra $V_{x,t}$ | Total $V_{x,t}$ | $_{tax}V_{x,t}$ |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | 0 |
| 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.84 | 0.84 | 0.00 |
| 2 | 8.74 | 0.88 | 9.62 | 13.95 | 1.69 | 15.64 | 9.62 |
| 3 | 17.97 | 1.78 | 19.74 | 28.37 | 2.54 | 30.91 | 19.74 |
| 4 | 27.70 | 2.70 | 30.40 | 43.27 | 3.40 | 46.67 | 30.40 |
| 5 | 37.96 | 3.64 | 41.60 | 58.65 | 4.25 | 62.90 | 41.60 |
| 6 | 48.78 | 4.58 | 53.37 | 74.53 | 5.09 | 79.62 | 53.37 |
| 7 | 60.16 | 5.54 | 65.70 | 90.88 | 5.92 | 96.80 | 66.53 |
| 8 | 72.07 | 6.51 | 78.58 | 107.69 | 6.74 | 114.43 | 82.90 |
| 9 | 84.54 | 7.48 | 92.02 | 124.94 | 7.54 | 132.48 | 99.81 |
| 10 | 97.54 | 8.46 | 106.01 | 142.60 | 8.34 | 150.93 | 117.12 |
| 11 | 111.09 | 9.44 | 120.53 | 160.65 | 9.11 | 169.76 | 134.74 |
| 12 | 125.17 | 10.41 | 135.58 | 179.09 | 9.85 | 188.94 | 152.72 |
| 13 | 139.82 | 11.34 | 151.16 | 197.93 | 10.54 | 208.47 | 171.08 |
| 14 | 155.07 | 12.24 | 167.31 | 217.16 | 11.20 | 228.35 | 189.85 |
| 15 | 170.88 | 13.11 | 183.99 | 236.75 | 11.81 | 248.56 | 209.05 |
| 16 | 187.26 | 13.96 | 201.23 | 256.68 | 12.39 | 269.07 | 228.77 |
| 17 | 204.20 | 14.80 | 219.00 | 276.93 | 12.94 | 289.87 | 248.89 |
| 18 | 221.65 | 15.61 | 237.26 | 297.43 | 13.46 | 310.89 | 269.38 |
| 19 | 239.56 | 16.38 | 255.95 | 318.13 | 13.94 | 332.06 | 290.18 |
| 20 | 257.87 | 17.11 | 274.99 | 338.95 | 14.36 | 353.31 | 311.25 |
| 21 | 276.55 | 17.79 | 294.34 | 359.86 | 14.74 | 374.60 | 332.57 |
| 22 | 295.60 | 18.41 | 314.01 | 380.86 | 15.07 | 395.93 | 354.17 |
| 23 | 315.01 | 18.99 | 334.00 | 401.93 | 15.35 | 417.28 | 376.01 |
| 24 | 334.82 | 19.52 | 354.34 | 423.07 | 15.59 | 438.66 | 398.06 |
| 25 | 355.01 | 20.03 | 375.03 | 444.28 | 15.81 | 460.09 | 420.34 |
| 26 | 375.50 | 20.53 | 396.03 | 465.47 | 16.02 | 481.49 | 444.50 |
| 27 | 395.84 | 21.02 | 416.85 | 486.24 | 16.21 | 502.46 | 465.23 |
| 28 | 416.56 | 21.46 | 438.02 | 507.07 | 16.37 | 523.44 | 487.28 |
| 29 | 437.15 | 21.86 | 459.00 | 527.50 | 16.49 | 543.98 | 509.48 |
| 30 | 457.46 | 22.16 | 479.62 | 547.41 | 16.53 | 563.95 | 531.32 |

Aggressive Placement Method, Male Nonsmoker Age 45

TAXES, ASSETS, LIABILITIES, SURPLUS

| t | change in $taxliab_{x,t}$ | $DACtax_{x,t}$ | $taxinc_{x,t}$ | $tax_{x,t}$ | $assets_{x,t}$ | $AS_{x,t}$ | $liab_{x,t}$ | $surplus_{x,t}$ |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | 0 | | 0 | 0 |
| 1 | 0.00 | 1.247 | -9.39 | -3.19 | -7.44 | -8.77 | 0.71 | -8.15 |
| 2 | 7.12 | 0.878 | 4.20 | 1.43 | 1.57 | 2.12 | 11.58 | -10.01 |
| 3 | 5.99 | 0.605 | 3.04 | 1.03 | 8.96 | 13.49 | 20.52 | -11.56 |
| 4 | 5.19 | 0.404 | 2.84 | 0.96 | 15.62 | 25.95 | 28.08 | -12.47 |
| 5 | 4.63 | 0.247 | 2.30 | 0.78 | 21.52 | 39.04 | 34.66 | -13.15 |
| 6 | 4.29 | 0.100 | 1.68 | 0.57 | 26.82 | 52.58 | 40.60 | -13.79 |
| 7 | 4.85 | -0.033 | 0.69 | 0.23 | 32.15 | 66.71 | 46.65 | -14.50 |
| 8 | 5.68 | -0.127 | -1.09 | -0.37 | 37.24 | 81.80 | 52.09 | -14.85 |
| 9 | 5.16 | -0.216 | -1.48 | -0.50 | 41.63 | 96.87 | 56.93 | -15.30 |
| 10 | 4.59 | -0.302 | -1.80 | -0.61 | 45.33 | 111.82 | 61.19 | -15.85 |
| 11 | 4.00 | -0.322 | -1.33 | -0.45 | 48.78 | 127.67 | 64.86 | -16.08 |
| 12 | 3.44 | -0.281 | -1.47 | -0.50 | 51.52 | 143.29 | 67.94 | -16.42 |
| 13 | 2.90 | -0.260 | -1.69 | -0.57 | 53.57 | 158.51 | 70.45 | -16.88 |
| 14 | 2.38 | -0.243 | -1.86 | -0.63 | 54.97 | 173.35 | 72.41 | -17.44 |
| 15 | 1.88 | -0.227 | -1.99 | -0.68 | 55.77 | 187.78 | 73.82 | -18.05 |
| 16 | 1.41 | -0.218 | -2.24 | -0.76 | 55.92 | 201.48 | 74.68 | -18.76 |
| 17 | 0.94 | -0.203 | -2.33 | -0.79 | 55.53 | 214.47 | 75.05 | -19.52 |
| 18 | 0.49 | -0.185 | -2.36 | -0.80 | 54.64 | 226.69 | 74.93 | -20.29 |
| 19 | 0.04 | -0.167 | -2.39 | -0.81 | 53.26 | 237.92 | 74.34 | -21.08 |
| 20 | -0.40 | -0.142 | -2.30 | -0.78 | 51.49 | 248.22 | 73.29 | -21.80 |
| 21 | -0.81 | -0.124 | -2.31 | -0.79 | 49.28 | 257.05 | 71.81 | -22.54 |
| 22 | -1.19 | -0.110 | -2.38 | -0.81 | 46.63 | 263.96 | 69.94 | -23.31 |
| 23 | -1.56 | -0.095 | -2.41 | -0.82 | 43.57 | 268.55 | 67.70 | -24.13 |
| 24 | -1.91 | -0.083 | -2.48 | -0.84 | 40.11 | 270.18 | 65.13 | -25.01 |
| 25 | -2.19 | -0.072 | -2.54 | -0.86 | 36.31 | 268.25 | 62.29 | -25.97 |
| 26 | -2.25 | -0.063 | -3.05 | -1.04 | 32.12 | 261.21 | 59.21 | -27.09 |
| 27 | -2.91 | -0.056 | -2.53 | -0.86 | 27.59 | 248.10 | 55.88 | -28.29 |
| 28 | -2.95 | -0.049 | -2.76 | -0.94 | 22.88 | 228.45 | 52.42 | -29.54 |
| 29 | -3.08 | -0.041 | -2.85 | -0.97 | 17.95 | 200.09 | 48.81 | -30.86 |
| 30 | -3.22 | -0.032 | -2.89 | -0.98 | 12.85 | 160.70 | 45.10 | -32.25 |

Appendix 2

Aggressive Placement Method, Male Nonsmoker Age 45

GAIN AND PROFIT

| t | $gain_{x,t}$ | $profit_{x,t}$ | $pvprofit_x$ | $pvprem_x$ | $pvprofprem_{45}$ | |
|---|---|---|---|---|---|---|
| 0 | | | | | n | |
| 1 | -8.15 | -8.15 | -7.74 | 19.23 | 10 | -8.61% |
| 2 | -1.85 | -1.42 | -9.03 | 37.50 | 15 | -6.41% |
| 3 | -1.56 | -1.03 | -9.91 | 52.22 | 20 | -5.51% |
| 4 | -0.90 | -0.29 | -10.15 | 64.42 | 25 | -4.87% |
| 5 | -0.68 | -0.02 | -10.16 | 74.81 | 30 | -4.58% |
| 6 | -0.64 | 0.05 | -10.13 | 83.76 | | |
| 7 | -0.71 | 0.02 | -10.12 | 91.55 | | |
| 8 | -0.35 | 0.41 | -9.84 | 98.39 | | |
| 9 | -0.45 | 0.34 | -9.63 | 104.53 | | |
| 10 | -0.55 | 0.26 | -9.48 | 110.04 | | |
| 11 | -0.23 | 0.61 | -9.13 | 114.98 | | |
| 12 | -0.34 | 0.51 | -8.85 | 119.40 | | |
| 13 | -0.47 | 0.40 | -8.65 | 123.37 | | |
| 14 | -0.56 | 0.33 | -8.49 | 126.91 | | |
| 15 | -0.61 | 0.31 | -8.34 | 130.07 | | |
| 16 | -0.71 | 0.24 | -8.24 | 132.89 | | |
| 17 | -0.76 | 0.23 | -8.14 | 135.40 | | |
| 18 | -0.77 | 0.26 | -8.04 | 137.62 | | |
| 19 | -0.78 | 0.29 | -7.93 | 139.60 | | |
| 20 | -0.73 | 0.39 | -7.79 | 141.34 | | |
| 21 | -0.73 | 0.42 | -7.65 | 142.88 | | |
| 22 | -0.78 | 0.41 | -7.52 | 144.23 | | |
| 23 | -0.82 | 0.41 | -7.39 | 145.42 | | |
| 24 | -0.88 | 0.39 | -7.28 | 146.46 | | |
| 25 | -0.96 | 0.36 | -7.18 | 147.37 | | |
| 26 | -1.12 | 0.25 | -7.11 | 148.16 | | |
| 27 | -1.20 | 0.23 | -7.05 | 148.84 | | |
| 28 | -1.25 | 0.24 | -6.99 | 149.43 | | |
| 29 | -1.32 | 0.24 | -6.94 | 149.94 | | |
| 30 | -1.39 | 0.24 | -6.89 | 150.37 | | |

## Aggressive Placement Method, Male Nonsmoker Age 45

### TARGET SURPLUS RETRUN ON INVESTMENT

| t | $surplus_{x,t}$ | $gain_{x,t}$ | $profit_{x,t}$ | $pvprofit_x$ | $pvprem_x$ | $targsurpROI_{45}$ |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| 1 | -8.68 | -8.15 | -8.15 | -7.74 | 19.23 | 0.61% |
| 2 | -10.40 | -1.85 | -1.39 | -9.00 | 37.50 | |
| 3 | -12.25 | -1.56 | -1.01 | -9.87 | 52.22 | |
| 4 | -13.40 | -0.90 | -0.26 | -10.08 | 64.42 | |
| 5 | -14.28 | -0.68 | 0.03 | -10.05 | 74.81 | |
| 6 | -15.10 | -0.64 | 0.11 | -9.97 | 83.76 | |
| 7 | -15.98 | -0.71 | 0.08 | -9.91 | 91.55 | |
| 8 | -16.51 | -0.35 | 0.49 | -9.59 | 98.39 | |
| 9 | -17.11 | -0.45 | 0.42 | -9.32 | 104.53 | |
| 10 | -18.18 | -0.55 | 0.35 | -9.11 | 110.04 | |
| 11 | -18.85 | -0.23 | 0.73 | -8.69 | 114.98 | |
| 12 | -19.56 | -0.34 | 0.66 | -8.34 | 119.40 | |
| 13 | -20.33 | -0.47 | 0.57 | -8.05 | 123.37 | |
| 14 | -21.14 | -0.56 | 0.52 | -7.80 | 126.91 | |
| 15 | -21.93 | -0.61 | 0.51 | -7.56 | 130.07 | |
| 16 | -22.78 | -0.71 | 0.45 | -7.37 | 132.89 | |
| 17 | -23.62 | -0.76 | 0.44 | -7.18 | 135.40 | |
| 18 | -24.43 | -0.77 | 0.48 | -6.99 | 137.62 | |
| 19 | -25.21 | -0.78 | 0.51 | -6.80 | 139.60 | |
| 20 | -25.89 | -0.73 | 0.61 | -6.59 | 141.34 | |
| 21 | -26.55 | -0.73 | 0.63 | -6.37 | 142.88 | |
| 22 | -27.23 | -0.78 | 0.63 | -6.17 | 144.23 | |
| 23 | -27.91 | -0.82 | 0.62 | -5.98 | 145.42 | |
| 24 | -28.64 | -0.88 | 0.59 | -5.81 | 146.46 | |
| 25 | -29.43 | -0.96 | 0.56 | -5.66 | 147.37 | |
| 26 | -30.36 | -1.12 | 0.44 | -5.54 | 148.16 | |
| 27 | -31.36 | -1.20 | 0.40 | -5.44 | 148.84 | |
| 28 | -32.41 | -1.25 | 0.40 | -5.35 | 149.43 | |
| 29 | -33.51 | -1.32 | 0.39 | -5.26 | 149.94 | |
| 30 | -34.69 | -1.39 | 0.38 | -5.18 | 150.37 | |

Appendix 3

**DAC tax illustration and formula development**

To illustrate the calculation in a simplified example, assume level premiums are charged by the ceding company and reinsurer. Also assume no deaths or lapses. Then the DAC taxable amount and deduction for one policy would be as follows:

| policy year(t) | gross prem | reins prem | $DACtax_t$ | deduction |
|---|---|---|---|---|
| 1 | $110 | $10 | $7.70 | $0.385 |
| 2 | $110 | $10 | $7.70 | $1.155 |
| 3 | $110 | $10 | $7.70 | $1.925 |
| 4 | $110 | $10 | $7.70 | $2.695 |
| 5 | $110 | $10 | $7.70 | $3.465 |
| 6 | $110 | $10 | $7.70 | $4.235 |
| 7 | $110 | $10 | $7.70 | $5.005 |
| 8 | $110 | $10 | $7.70 | $5.775 |
| 9 | $110 | $10 | $7.70 | $6.545 |
| 10 | $110 | $10 | $7.70 | $7.315 |
| 11 | $110 | $10 | $7.70 | $7.700 |
| 12 | $110 | $10 | $7.70 | $7.700 |
| . | . | . | . | . |
| . | . | . | . | . |

Year 1 DAC taxable amount is:

$$DACtax_1 = (\text{gross prem}_1 - \text{reins prem}_1)\ l_{x,0}\ 7.7\%$$
$$= (110 - 10)(1.0)(0.077) = \$7.70.$$

Year 1 deduction is:

$$\text{deduction}_1 = DACtax_1\ \tfrac{1}{2}\ 10\% = (7.70)(\tfrac{1}{2})(0.1) = \$0.385.$$

The net DAC taxable amount for year 1 is:

$$DACtax_{x,1} = DACtax_1 - \text{deduction}_1 = 7.70 - 0.385 = \$7.315.$$

Year 2 DAC taxable amount is:

$$DACtax_2 = (\text{gross prem}_2 - \text{reins prem}_2)\ l_{x,1}\ 7.7\%$$
$$= (110 - 10)(1.0)(0.077) = \$7.70.$$

Year 2 deduction is:

$$\text{deduction}_2 = DACtax_2\ \tfrac{1}{2}\ 10\% + DACtax_1\ 10\%$$
$$= (7.70)(\tfrac{1}{2})(0.1) + (7.70)(0.1) = \$1.155.$$

The net DAC taxable amount for year 2 is:

$$DACtax_{x,2} = DACtax_2 - deduction_2 = 7.70 - 1.155 = \$6.545$$

The net DAC taxable amount in years 3 through 10 decreases by the 10% deduction (\$0.77) and ½ 10% (\$0.385) in year 11. By the eleventh year, the deduction nets out the tax.

This example shows that the premium for this policy that is treated as capital expense is indeed recovered over the 120 month period, which is the intent of the law.

If premiums are level and no decrements are used, the DAC taxable amount calculation is straight forward and changes by a constant amount each year with the exception of years 1 and 11. In the asset share calculations however, the reinsurer's YRT premiums are not level and decrements reduce $l_{x,t}$ each year, making the calculation complex. The formula is as follows:

$$\begin{aligned} DACtax_{x,t} &= (7.7\%)(premium_{x,t} - reinprem_{x,t}) \\ &- (\tfrac{1}{2})(10\%)(7.7\%)(premium_{x,t} - reinprem_{x,t}) \\ &- (7.7\%)(10\%) \sum_{s=1}^{\min(t-1,9)} (premium_{x,t-s} - reinprem_{x,t-s}) \\ &- (\tfrac{1}{2})(10\%)(7.7\%)(premium_{x,t-10} - reinprem_{x,t-10}) \end{aligned}$$

Where $DACtax_{x,t}$ is now the net DAC taxable amount since the deduction is accounted for in the calculation. Because of decrements resulting in less new premium each year, the deductions will begin to outweigh the tax at some point in the asset share calculations. So $DACtax_{x,t}$ will ultimately become a credit.

**Figure 3.2b Aggressive Placement Method**

| Parameters for the asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| reinsurer: | C | C | B | B |
| retention: | 0% | 0% | 0% | 0% |
| reinsurer rtg: | 125% | 100% | 100% | 100% |
| issue rtg: | 125% | 100% | 100% | 100% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 1.20 | 0.00 | 0.00 | 0.00 |
| $premium_{45,1}$: | 19.23 | 25.95 | 14.78 | 18.03 |
| policy year(t) | Per unit $surplus_{45,t}$ | | | |
| 1 | -8.15 | -9.35 | -6.26 | -7.98 |
| 2 | -10.01 | -10.64 | -7.81 | -10.07 |
| 3 | -11.56 | -11.70 | -8.96 | -11.90 |
| 4 | -12.47 | -12.01 | -9.71 | -13.36 |
| 5 | -13.15 | -12.07 | -10.37 | -14.92 |
| 6 | -13.79 | -12.37 | -10.69 | -16.92 |
| 7 | -14.50 | -12.64 | -10.89 | -18.73 |
| 8 | -14.85 | -13.03 | -11.22 | -20.75 |
| 9 | -15.30 | -13.49 | -11.69 | -22.92 |
| 10 | -15.85 | -14.05 | -12.21 | -25.20 |
| 11 | -16.08 | -14.17 | -12.48 | -27.29 |
| 12 | -16.42 | -14.43 | -12.79 | -29.51 |
| 13 | -16.88 | -14.88 | -13.12 | -31.82 |
| 14 | -17.44 | -15.46 | -13.45 | -34.19 |
| 15 | -18.05 | -16.14 | -13.77 | -36.59 |
| 16 | -18.76 | -17.03 | -14.22 | -39.20 |
| 17 | -19.52 | -18.06 | -14.82 | -42.03 |
| 18 | -20.29 | -19.19 | -15.56 | -45.04 |
| 19 | -21.08 | -20.44 | -16.43 | -48.22 |
| 20 | -21.80 | -21.69 | -17.42 | -51.57 |
| 21 | -22.54 | -23.04 | -18.53 | -55.12 |
| 22 | -23.31 | -24.51 | -19.71 | -58.87 |
| 23 | -24.13 | -26.09 | -20.97 | -62.82 |
| 24 | -25.01 | -27.78 | -22.30 | -66.95 |
| 25 | -25.97 | -29.56 | -23.69 | -71.22 |
| 26 | -27.09 | -31.43 | -25.14 | -75.64 |
| 27 | -28.29 | -33.43 | -26.71 | -80.26 |
| 28 | -29.54 | -35.54 | -28.38 | -85.07 |
| 29 | -30.86 | -37.73 | -30.16 | -90.06 |
| 30 | -32.25 | -40.01 | -32.02 | -95.26 |
| $pvprofprem_{45}$: | -4.58% | -4.45% | -5.84% | -14.37% |
| $targsurpROI_{45}$: | 0.61% | &n/a | -5.69% | #n/a |

**Figure 3.2c Aggressive Placement Method**

| Parameters for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| reinsurer: | C | C | B | B |
| retention: | 50% | 50% | 50% | 50% |
| reinsurer rtg: | 125% | 100% | 100% | 100% |
| issue rtg: | 125% | 100% | 100% | 100% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 1.20 | 0.00 | 0.00 | 0.00 |
| $premium_{45,1}$: | 19.23 | 25.95 | 14.78 | 18.03 |
| policy year(t) | Per unit $surplus_{45,t}$ | | | |
| 1 | -7.98 | -9.15 | -6.03 | -7.42 |
| 2 | -9.66 | -10.22 | -7.47 | -8.88 |
| 3 | -11.07 | -11.12 | -8.51 | -10.01 |
| 4 | -11.83 | -11.26 | -9.12 | -10.69 |
| 5 | -12.40 | -11.20 | -9.64 | -11.39 |
| 6 | -12.88 | -11.31 | -9.85 | -12.40 |
| 7 | -13.34 | -11.27 | -9.93 | -13.19 |
| 8 | -13.42 | -11.34 | -10.12 | -14.15 |
| 9 | -13.59 | -11.47 | -10.41 | -15.21 |
| 10 | -13.83 | -11.65 | -10.75 | -16.34 |
| 11 | -13.72 | -11.38 | -10.81 | -17.18 |
| 12 | -13.73 | -11.26 | -10.92 | -18.13 |
| 13 | -13.84 | -11.30 | -11.08 | -19.14 |
| 14 | -14.03 | -11.47 | -11.25 | -20.19 |
| 15 | -14.28 | -11.75 | -11.44 | -21.28 |
| 16 | -14.63 | -12.21 | -11.71 | -22.49 |
| 17 | -15.02 | -12.75 | -12.06 | -23.81 |
| 18 | -15.44 | -13.37 | -12.48 | -25.22 |
| 19 | -15.86 | -14.06 | -12.97 | -26.70 |
| 20 | -16.27 | -14.78 | -13.52 | -28.28 |
| 21 | -16.70 | -15.58 | -14.15 | -29.96 |
| 22 | -17.17 | -16.46 | -14.82 | -31.76 |
| 23 | -17.70 | -17.42 | -15.55 | -33.66 |
| 24 | -18.30 | -18.47 | -16.33 | -35.67 |
| 25 | -18.96 | -19.58 | -17.16 | -37.75 |
| 26 | -19.77 | -20.76 | -18.03 | -39.93 |
| 27 | -20.65 | -22.03 | -18.98 | -42.21 |
| 28 | -21.55 | -23.37 | -20.01 | -44.60 |
| 29 | -22.50 | -24.77 | -21.11 | -47.10 |
| 30 | -23.52 | -26.24 | -22.29 | -49.73 |
| $pvprofprem_{45}$: | -3.34% | -2.92% | -4.06% | -7.50% |
| $targsurpROI_{45}$: | 2.17% | -0.37% | 0.93% | -15.99% |

'&' Denotes where return on investment was unable to be calculated due to multiple sign changes on profit.

'#' Denotes where return on investment was unable to be calculated due to no sign change on profit (always negative).

**Figure 3.3b – Conservative Placement Method**

| Parameters used for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| reinsurer: | E | D | A | A |
| retention: | 0% | 0% | 0% | 0% |
| reinsurer rtg: | 175% | 150% | 150% | 125% |
| issue rtg: | 200% | 200% | 200% | 200% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 4.46 | 3.70 | 3.35 | 3.07 |
| $premium_{45,1}$: | 22.85 | 29.06 | 18.51 | 21.44 |
| policy year(t) | Per unit $surplus_{45,t}$ | | | |
| 1 | -10.33 | -11.81 | -8.43 | -9.20 |
| 2 | -11.33 | -11.57 | -8.88 | -9.16 |
| 3 | -11.76 | -11.00 | -8.82 | -8.63 |
| 4 | -11.25 | -9.50 | -8.08 | -7.39 |
| 5 | -10.48 | -7.77 | -7.15 | -5.99 |
| 6 | -9.51 | -6.29 | -6.09 | -4.75 |
| 7 | -8.59 | -5.21 | -5.26 | -3.88 |
| 8 | -7.57 | -4.05 | -4.40 | -2.97 |
| 9 | -6.47 | -2.77 | -3.45 | -2.00 |
| 10 | -5.28 | -1.41 | -2.39 | -0.92 |
| 11 | -3.39 | 0.72 | -0.77 | 0.76 |
| 12 | -1.39 | 2.92 | 0.94 | 2.51 |
| 13 | 0.75 | 5.19 | 2.74 | 4.30 |
| 14 | 3.03 | 7.56 | 4.66 | 6.29 |
| 15 | 5.46 | 10.00 | 6.68 | 8.35 |
| 16 | 8.02 | 12.46 | 8.86 | 10.51 |
| 17 | 10.72 | 15.01 | 11.14 | 12.76 |
| 18 | 13.53 | 17.58 | 13.50 | 15.09 |
| 19 | 16.47 | 20.17 | 15.93 | 17.51 |
| 20 | 19.51 | 22.75 | 18.43 | 20.00 |
| 21 | 22.65 | 25.33 | 21.04 | 22.58 |
| 22 | 25.88 | 27.90 | 23.71 | 25.25 |
| 23 | 29.20 | 30.48 | 26.47 | 28.02 |
| 24 | 32.60 | 33.06 | 29.11 | 30.86 |
| 25 | 36.08 | 35.68 | 32.23 | 33.80 |
| 26 | 39.48 | 38.34 | 35.23 | 36.83 |
| 27 | 43.10 | 41.05 | 38.33 | 39.98 |
| 28 | 46.80 | 43.81 | 41.56 | 43.26 |
| 29 | 50.55 | 46.64 | 44.95 | 46.72 |
| 30 | 54.36 | 49.54 | 48.51 | 50.36 |
| $pvprofprem_{45}$: | 6.50% | 4.73% | 7.07% | 6.39% |
| $rgsurpROI_{45}$: | 12.94% | 14.15% | 14.22% | 15.00% |

**Figure 3.3c – Conservative Placement Method**

| Parameters for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| reinsurer: | E | D | A | A |
| retention: | 50% | 50% | 50% | 50% |
| reinsurer rtg: | 175% | 150% | 150% | 125% |
| issue rtg: | 200% | 200% | 200% | 200% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 4.46 | 3.70 | 3.35 | 3.07 |
| $premium_{45,1}$: | 22.85 | 29.06 | 18.51 | 21.44 |
| policy year(t) | Per unit $surplus_{45,t}$ | | | |
| 1 | -10.39 | -11.83 | -8.43 | -9.22 |
| 2 | -11.24 | -11.66 | -8.91 | -9.22 |
| 3 | -11.64 | -11.21 | -8.90 | -8.74 |
| 4 | -11.16 | -9.82 | -8.23 | -7.57 |
| 5 | -10.43 | -8.20 | -7.39 | -6.27 |
| 6 | -9.49 | -6.80 | -6.45 | -5.14 |
| 7 | -8.59 | -5.77 | -5.73 | -4.38 |
| 8 | -7.59 | -4.64 | -4.98 | -3.59 |
| 9 | -6.49 | -3.37 | -4.15 | -2.71 |
| 10 | -5.30 | -1.98 | -3.21 | -1.73 |
| 11 | -3.46 | 0.16 | -1.72 | -0.14 |
| 12 | -1.52 | 2.36 | -0.14 | 1.52 |
| 13 | 0.51 | 4.61 | 1.52 | 3.27 |
| 14 | 2.64 | 6.92 | 3.30 | 5.18 |
| 15 | 4.88 | 9.29 | 5.19 | 7.18 |
| 16 | 7.20 | 11.67 | 7.24 | 9.28 |
| 17 | 9.62 | 14.14 | 9.40 | 11.47 |
| 18 | 12.14 | 16.65 | 11.65 | 13.76 |
| 19 | 14.76 | 19.20 | 14.00 | 16.14 |
| 20 | 17.48 | 21.77 | 16.43 | 18.60 |
| 21 | 20.29 | 24.37 | 18.95 | 21.15 |
| 22 | 23.17 | 26.99 | 21.55 | 23.79 |
| 23 | 26.11 | 29.63 | 24.25 | 26.51 |
| 24 | 29.11 | 32.30 | 27.03 | 29.32 |
| 25 | 32.16 | 35.01 | 29.89 | 32.21 |
| 26 | 35.13 | 37.76 | 32.85 | 35.20 |
| 27 | 38.30 | 40.57 | 35.89 | 38.29 |
| 28 | 41.53 | 43.44 | 39.06 | 41.51 |
| 29 | 44.84 | 46.39 | 42.36 | 44.86 |
| 30 | 48.21 | 49.41 | 45.81 | 48.37 |
| $pvprofprem_{45}$: | 5.76% | 4.72% | 6.67% | 6.14% |
| $targsurpROI_{45}$: | 12.55% | 13.84% | 13.65% | 14.48% |

**Figure 3.4b – Initial Compromise Method**

| Parameters for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| reinsurer: | E | D | A | A |
| retention: | 0% | 0% | 0% | 0% |
| reinsurer rtg: | 175% | 150% | 150% | 125% |
| issue rtg: | 125% | 100% | 100% | 100% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 1.20 | 0.00 | 0.00 | 0.00 |
| $\text{premium}_{45,1}$: | 19.23 | 24.95 | 14.78 | 18.00 |
| policy year(t) | Per unit $\text{surplus}_{45,t}$ | | | |
| 1 | -7.68 | -8.89 | -5.78 | -6.80 |
| 2 | -9.49 | -9.64 | -7.07 | -7.58 |
| 3 | -10.80 | -10.11 | -7.90 | -7.89 |
| 4 | -11.36 | -9.86 | -8.22 | -7.65 |
| 5 | -11.74 | -9.46 | -8.44 | -7.31 |
| 6 | -11.99 | -9.22 | -8.30 | -7.09 |
| 7 | -12.16 | -8.78 | -8.04 | -6.64 |
| 8 | -11.96 | -8.48 | -7.84 | -6.32 |
| 9 | -11.82 | -8.25 | -7.72 | -6.07 |
| 10 | -11.76 | -8.12 | -7.65 | -5.87 |
| 11 | -11.24 | -7.50 | -7.25 | -5.28 |
| 12 | -10.77 | -6.98 | -6.90 | -4.75 |
| 13 | -10.31 | -6.56 | -6.60 | -4.39 |
| 14 | -9.84 | -6.21 | -6.34 | -3.98 |
| 15 | -9.36 | -5.95 | -6.13 | -3.63 |
| 16 | -8.85 | -5.81 | -5.96 | -3.31 |
| 17 | -8.33 | -5.71 | -5.82 | -3.01 |
| 18 | -7.79 | -5.69 | -5.71 | -2.73 |
| 19 | -7.24 | -5.75 | -5.64 | -2.45 |
| 20 | -6.69 | -5.92 | -5.61 | -2.20 |
| 21 | -6.15 | -6.20 | -5.58 | -1.95 |
| 22 | -5.61 | -6.58 | -5.61 | -1.71 |
| 23 | -5.10 | -7.06 | -5.68 | -1.49 |
| 24 | -4.60 | -7.63 | -5.79 | -1.29 |
| 25 | -4.12 | -8.25 | -5.95 | -1.12 |
| 26 | -3.75 | -8.93 | -6.14 | -0.96 |
| 27 | -3.39 | -9.66 | -6.37 | -0.80 |
| 28 | -3.03 | -10.46 | -6.62 | -0.62 |
| 29 | -2.71 | -11.31 | -6.89 | -0.43 |
| 30 | -2.47 | -12.22 | -7.15 | -0.21 |
| $\text{pvprofprem}_{45}$: | -0.35% | -1.36% | -1.30% | -0.00% |
| $\text{targsurpROI}_{45}$: | 6.20% | 3.97% | 5.35% | 7.20% |

**Figure 3.4c – Initial Compromise Method**

| Parameters for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| reinsurer: | E | D | A | A |
| retention: | 50% | 50% | 50% | 50% |
| reinsurer rtg: | 175% | 150% | 150% | 125% |
| issue rtg: | 125% | 100% | 100% | 100% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 1.20 | 0.00 | 0.00 | 0.00 |
| $\text{premium}_{45,1}$: | 19.23 | 24.95 | 14.78 | 18.00 |
| policy year(t) | Per unit $\text{surplus}_{45,t}$ | | | |
| 1 | -7.74 | -8.91 | -5.78 | -6.84 |
| 2 | -9.40 | -9.72 | -7.10 | -7.64 |
| 3 | -10.69 | -10.32 | -7.98 | -8.00 |
| 4 | -11.28 | -10.18 | -8.37 | -7.83 |
| 5 | -11.69 | -9.89 | -8.68 | -7.59 |
| 6 | -11.98 | -9.74 | -8.66 | -7.49 |
| 7 | -12.17 | -9.35 | -8.51 | -7.15 |
| 8 | -11.98 | -9.07 | -8.43 | -6.93 |
| 9 | -11.84 | -8.84 | -8.42 | -6.7[illegible] |
| 10 | -11.78 | -8.69 | -8.47 | -6.68 |
| 11 | -11.30 | -8.06 | -8.20 | -6.18 |
| 12 | -10.90 | -7.54 | -7.98 | -5.75 |
| 13 | -10.55 | -7.14 | -7.82 | -5.42 |
| 14 | -10.23 | -6.85 | -7.70 | -5.09 |
| 15 | -9.94 | -6.66 | -7.62 | -4.81 |
| 16 | -9.68 | -6.60 | -7.57 | -4.55 |
| 17 | -9.43 | -6.58 | -7.55 | -4.30 |
| 18 | -9.18 | -6.62 | -7.55 | -4.06 |
| 19 | -8.95 | -6.72 | -7.57 | -3.82 |
| 20 | -8.72 | -6.90 | -7.61 | -3.59 |
| 21 | -8.51 | -7.16 | -7.67 | -3.37 |
| 22 | -8.32 | -7.49 | -7.77 | -3.17 |
| 23 | -8.18 | -7.91 | -7.90 | -2.99 |
| 24 | -8.09 | -8.39 | -8.07 | -2.84 |
| 25 | -8.04 | -8.93 | -8.28 | -2.70 |
| 26 | -8.10 | -9.51 | -8.53 | -2.59 |
| 27 | -8.20 | -10.14 | -8.81 | -2.48 |
| 28 | -8.30 | -10.83 | -9.13 | -2.38 |
| 29 | -8.43 | -11.56 | -9.47 | -2.29 |
| 30 | -8.63 | -12.34 | -9.85 | -2.20 |
| $\text{pvprofprem}_{45}$: | -1.23% | -1.37% | -1.80% | -0.33% |
| $\text{targsurpROI}_{45}$: | 5.17% | 4.06% | 4.64% | 6.62 |

**Figure 3.5b** - Issue rating increase method. Issue rating increased to break even before compromise goal year.

| Parameters for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| break even goal: | 20 yrs | 20 yrs | 20 yrs | 20 yrs |
| reinsurer: | E | D | A | A |
| retention: | 0% | 0% | 0% | 0% |
| reinsurer rtg: | 175% | 150% | 150% | 125% |
| issue rtg: | 150% | 125% | 125% | 110% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 2.34 | 0.98 | 0.90 | 0.33 |
| $premium_{45,1}$: | 20.49 | 26.04 | 15.78 | 18.40 |
| policy year(t) | Per unit $surplus_{45,t}$ | | | |
| 1 | -8.62 | -9.68 | -6.51 | -7.09 |
| 2 | -10.16 | -10.18 | -7.59 | -7.77 |
| 3 | -11.17 | -10.39 | -8.20 | -7.99 |
| 4 | -11.37 | -9.82 | -8.24 | -7.65 |
| 5 | -11.35 | -9.08 | -8.16 | -7.20 |
| 6 | -11.18 | -8.64 | -7.98 | -6.94 |
| 7 | -11.07 | -8.37 | -7.77 | -6.52 |
| 8 | -10.94 | -7.78 | -7.34 | -6.11 |
| 9 | -10.66 | -7.22 | -6.96 | -5.76 |
| 10 | -10.17 | -6.72 | -6.58 | -5.46 |
| 11 | -9.16 | -5.67 | -5.84 | -4.74 |
| 12 | -8.13 | -4.68 | -5.11 | -4.06 |
| 13 | -7.08 | -3.74 | -4.39 | -3.55 |
| 14 | -5.97 | -2.85 | -3.68 | -2.98 |
| 15 | -4.80 | -2.00 | -2.99 | -2.45 |
| 16 | -3.57 | -1.24 | -2.28 | -1.93 |
| 17 | -2.28 | -0.50 | -1.58 | -1.42 |
| 18 | -0.96 | 0.19 | -0.88 | -0.92 |
| 19 | 0.43 | 0.82 | -0.19 | -0.42 |
| 20 | 1.85 | 1.38 | 0.50 | 0.08 |
| 21 | 3.30 | 1.86 | 1.21 | 0.58 |
| 22 | 4.78 | 2.26 | 1.90 | 1.08 |
| 23 | 6.28 | 2.59 | 2.58 | 1.57 |
| 24 | 7.79 | 2.86 | 3.26 | 2.06 |
| 25 | 9.31 | 3.10 | 3.92 | 2.53 |
| 26 | 10.76 | 3.31 | 4.58 | 3.00 |
| 27 | 12.22 | 3.49 | 5.24 | 3.48 |
| 28 | 13.73 | 3.64 | 5.92 | 3.99 |
| 29 | 15.24 | 3.76 | 6.63 | 4.54 |
| 30 | 16.71 | 3.87 | 7.39 | 5.13 |
| $pvprofprem_{45}$: | 2.23% | 0.41% | 1.26% | 0.76% |
| $targsurpROI_{45}$: | 8.84% | 7.94% | 8.53% | 8.38% |

**Figure 3.5c** - Issue rating increase method. Issue rating used to break even before compromise goal year at zero retention.

| Parameters for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| break even goal: | 20 yrs | 20 yrs | 20 yrs | 20 yrs |
| reinsurer: | E | D | A | A |
| retention: | 50% | 50% | 50% | 50% |
| reinsurer rtg: | 175% | 150% | 150% | 125% |
| issue rtg: | 150% | 125% | 125% | 110% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 2.34 | 0.98 | 0.90 | 0.33 |
| $premium_{45,1}$: | 20.49 | 26.04 | 15.78 | 18.40 |
| policy year(t) | Per unit $surplus_{45,t}$ | | | |
| 1 | -8.68 | -9.71 | -6.51 | -7.11 |
| 2 | -10.07 | -10.27 | -7.62 | -7.83 |
| 3 | -11.06 | -10.60 | -8.28 | -8.10 |
| 4 | -11.28 | -10.14 | -8.39 | -7.83 |
| 5 | -11.30 | -9.50 | -8.40 | -7.47 |
| 6 | -11.17 | -9.15 | -8.34 | -7.34 |
| 7 | -11.07 | -8.94 | -8.24 | -7.03 |
| 8 | -10.96 | -8.37 | -7.93 | -6.73 |
| 9 | -10.69 | -7.81 | -7.66 | -6.48 |
| 10 | -10.19 | -7.28 | -7.40 | -6.26 |
| 11 | -9.22 | -6.22 | -6.78 | -5.64 |
| 12 | -8.27 | -5.23 | -6.19 | -5.06 |
| 13 | -7.32 | -4.33 | -5.61 | -4.58 |
| 14 | -6.36 | -3.48 | -5.04 | -4.09 |
| 15 | -5.38 | -2.71 | -4.47 | -3.62 |
| 16 | -4.39 | -2.03 | -3.90 | -3.17 |
| 17 | -3.38 | -1.37 | -3.32 | -2.71 |
| 18 | -2.34 | -0.74 | -2.72 | -2.26 |
| 19 | -1.27 | -0.14 | -2.12 | -1.79 |
| 20 | -0.17 | 0.41 | -1.51 | -1.32 |
| 21 | 0.96 | 0.91 | -0.88 | -0.85 |
| 22 | 2.07 | 1.35 | -0.26 | -0.39 |
| 23 | 3.19 | 1.75 | 0.36 | 0.07 |
| 24 | 4.30 | 2.10 | 0.97 | 0.51 |
| 25 | 5.39 | 2.42 | 1.58 | 0.94 |
| 26 | 6.40 | 2.73 | 2.19 | 1.37 |
| 27 | 7.41 | 3.01 | 2.80 | 1.80 |
| 28 | 8.47 | 3.27 | 3.41 | 2.24 |
| 29 | 9.52 | 3.51 | 4.05 | 2.68 |
| 30 | 10.56 | 3.74 | 4.70 | 3.14 |
| $pvprofprem_{45}$: | 1.41% | 0.40% | 0.80% | 0.46% |
| $targsurpROI_{45}$: | 8.17% | 7.76% | 7.87% | 7.81% |

**Figure 3.6b** - Reduced commissions method, base commissions only. Issue rating increased to break even before compromise goal year.

| Parameters for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| break even goal: | 20 yrs | 20 yrs | 20 yrs | 20 yrs |
| reinsurer: | E | D | A | A |
| retention: | 0% | 0% | 0% | 0% |
| reinsurer rtg: | 175% | 150% | 150% | 125% |
| issue rtg: | 130% | 115% | 115% | 110% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 1.43 | 0.60 | 0.55 | 0.33 |
| $premium_{45,1}$: | 19.49 | 25.61 | 15.39 | 18.40 |
| policy year(t) | Per unit $surplus_{45,t}$ | | | |
| 1 | -6.41 | -8.76 | -5.67 | -6.75 |
| 2 | -7.89 | -9.25 | -6.72 | -7.36 |
| 3 | -8.87 | -9.45 | -7.32 | -7.53 |
| 4 | -9.13 | -8.91 | -7.39 | -7.13 |
| 5 | -9.19 | -8.21 | -7.33 | -6.62 |
| 6 | -9.13 | -7.82 | -7.19 | -6.31 |
| 7 | -9.11 | -7.33 | -6.77 | -5.84 |
| 8 | -8.63 | -6.75 | -6.34 | -5.37 |
| 9 | -8.16 | -6.21 | -5.97 | -4.97 |
| 10 | -7.75 | -5.75 | -5.61 | -4.60 |
| 11 | -6.91 | -4.78 | -4.92 | -3.82 |
| 12 | -6.08 | -3.87 | -4.25 | -3.10 |
| 13 | -5.24 | -3.04 | -3.59 | -2.53 |
| 14 | -4.39 | -2.25 | -2.97 | -1.89 |
| 15 | -3.49 | -1.52 | -2.36 | -1.29 |
| 16 | -2.54 | -0.89 | -1.75 | -0.71 |
| 17 | -1.56 | -0.28 | -1.15 | -0.13 |
| 18 | -0.54 | 0.28 | -0.57 | 0.44 |
| 19 | 0.51 | 0.78 | 0.01 | 1.02 |
| 20 | 1.58 | 1.19 | 0.57 | 1.60 |
| 21 | 2.68 | 1.52 | 1.15 | 2.19 |
| 22 | 3.79 | 1.77 | 1.70 | 2.77 |
| 23 | 4.91 | 1.95 | 2.24 | 3.36 |
| 24 | 6.03 | 2.07 | 2.77 | 3.94 |
| 25 | 7.16 | 2.14 | 3.28 | 4.52 |
| 26 | 8.22 | 2.19 | 3.78 | 5.09 |
| 27 | 9.29 | 2.22 | 4.28 | 5.69 |
| 28 | 10.40 | 2.21 | 4.79 | 6.32 |
| 29 | 11.50 | 2.17 | 5.33 | 7.00 |
| 30 | 12.56 | 2.11 | 5.90 | 7.72 |
| $pvprofprem_{45}$: | 1.76% | 0.23% | 1.03% | 1.14% |
| $targsurpROI_{45}$: | 9.04% | 7.90% | 8.63% | 9.17% |

**Figure 3.6c** - Reduced commissions method, base commissic only. Issue rating used to break even before compromise goal year at zero retention.

| Parameters for asset share calculations | | | | |
|---|---|---|---|---|
| sex: | male | male | female | female |
| smoking status: | nonsmoker | smoker | nonsmoker | smoker |
| break even goal: | 20 yrs | 20 yrs | 20 yrs | 20 yrs |
| reinsurer: | E | D | A | A |
| retention: | 50% | 50% | 50% | 50% |
| reinsurer rtg: | 175% | 150% | 150% | 125% |
| issue rtg: | 130% | 115% | 115% | 110% |
| actual rtg: | 200% | 200% | 200% | 200% |
| std net prem: | 15.88 | 22.23 | 13.08 | 16.00 |
| substd extra: | 1.43 | 0.60 | 0.55 | 0.33 |
| $premium_{45,1}$: | 19.49 | 25.61 | 15.39 | 18.40 |
| policy year(t) | Per unit $surplus_{45,t}$ | | | |
| 1 | -6.48 | -8.79 | -5.67 | -6.77 |
| 2 | -7.80 | -9.33 | -6.76 | -7.42 |
| 3 | -8.76 | -9.66 | -7.40 | -7.64 |
| 4 | -9.04 | -9.23 | -7.54 | -7.31 |
| 5 | -9.14 | -8.64 | -7.58 | -6.90 |
| 6 | -9.11 | -8.34 | -7.55 | -6.71 |
| 7 | -9.12 | -7.89 | -7.24 | -6.3[illegible] |
| 8 | -8.65 | -7.33 | -6.93 | -5.99 |
| 9 | -8.19 | -6.81 | -6.67 | -5.68 |
| 10 | -7.77 | -6.32 | -6.43 | -5.40 |
| 11 | -6.97 | -5.33 | -5.86 | -4.72 |
| 12 | -6.21 | -4.43 | -5.32 | -4.09 |
| 13 | -5.48 | -3.62 | -4.81 | -3.56 |
| 14 | -4.77 | -2.89 | -4.32 | -3.00 |
| 15 | -4.06 | -2.23 | -3.84 | -2.47 |
| 16 | -3.37 | -1.68 | -3.37 | -1.95 |
| 17 | -2.66 | -1.14 | -2.89 | -1.42 |
| 18 | -1.94 | -0.65 | -2.41 | -0.89 |
| 19 | -1.20 | -0.19 | -1.92 | -0.34 |
| 20 | -0.44 | 0.22 | -1.44 | 0.20 |
| 21 | 0.32 | 0.57 | -0.94 | 0.76 |
| 22 | 1.08 | 0.86 | -0.46 | 1.31 |
| 23 | 1.82 | 1.11 | 0.02 | 1.86 |
| 24 | 2.54 | 1.30 | 0.49 | 2.40 |
| 25 | 3.25 | 1.47 | 0.94 | 2.93 |
| 26 | 3.87 | 1.62 | 1.39 | 3.47 |
| 27 | 4.48 | 1.74 | 1.84 | 4.01 |
| 28 | 5.13 | 1.84 | 2.29 | 4.57 |
| 29 | 5.78 | 1.92 | 2.74 | 5.14 |
| 30 | 6.40 | 1.98 | 3.20 | 5.73 |
| $pvprofprem_{45}$: | 0.90% | 0.21% | 0.56% | 0.87 |
| $targsurpROI_{45}$: | 8.18% | 7.69% | 7.88% | 8.55% |

Appendix 5

## Macro Pricing Model Office Projections

New product price/production - Full commissions on extra premium

| Price structure: | AGG | COMP | ISS MIN | AGG-B&C | COMP-B&C | ISS MAX | CONSERV | NO REINS |
|---|---|---|---|---|---|---|---|---|
| Issue Rating: | 113% | 113% | 121% | 148% | 148% | 159% | 200% | 200% |
| Start-up costs: | 100000 | 145000 | 175000 | 100000 | 145000 | 175000 | 100000 | 0 |
| $pvunitprofper\$1prem_s$: | -36.30% | 27.10% | 13.89% | 154.56% | 155.15% | 154.71% | 307.91% | 333.63% |
| Premium Production | Present value of project-based profit as production increases ($pvprojectprof_s$) | | | | | | | |
| 0 | -100000 | -145000 | -175000 | -100000 | -145000 | -175000 | -100000 | 0 |
| 50000 | -118148 | -131452 | -168056 | -22718 | -67426 | -97647 | 53955 | 166816 |
| 100000 | -136295 | -117905 | -161111 | 54565 | 10149 | -20294 | 207910 | 333631 |
| 150000 | -154443 | -104357 | -154167 | 131847 | 87723 | 57059 | 361865 | 500447 |
| 200000 | -172590 | -90809 | -147223 | 209129 | 165298 | 134412 | 515820 | 667263 |
| 250000 | -190738 | -77262 | -140278 | 286412 | 242872 | 211766 | 669775 | 834078 |
| 300000 | -208885 | -63714 | -133334 | 363694 | 320447 | 289119 | 823730 | 1000894 |
| 350000 | -227033 | -50166 | -126390 | 440976 | 398021 | 366472 | 977685 | 1167710 |
| 400000 | -245180 | -36618 | -119445 | 518258 | 475596 | 443825 | 1131640 | 1334525 |
| 450000 | -263328 | -23071 | -112501 | 595541 | 553170 | 521178 | 1285595 | 1501341 |
| 500000 | -281475 | -9523 | -105557 | 672823 | 630745 | 598531 | 1439549 | 1668157 |
| 550000 | -299623 | 4025 | -98613 | 750105 | 708319 | 675884 | 1593504 | 1834972 |
| 600000 | -317771 | 17572 | -91668 | 827388 | 785894 | 753237 | 1747459 | 2001788 |
| 650000 | -335918 | 31120 | -84724 | 904670 | 863468 | 830590 | 1901414 | 2168604 |
| 700000 | -354066 | 44668 | -77780 | 981952 | 941043 | 907943 | 2055369 | 2335419 |
| 750000 | -372213 | 58215 | -70835 | 1059235 | 1018617 | 985297 | 2209324 | 2502235 |
| 800000 | -390361 | 71763 | -63891 | 1136517 | 1096192 | 1062650 | 2363279 | 2669051 |
| 850000 | -408508 | 85311 | -56947 | 1213799 | 1173766 | 1140003 | 2517234 | 2835866 |
| 900000 | -426656 | 98859 | -50002 | 1291081 | 1251341 | 1217356 | 2671189 | 3002682 |
| 950000 | -444803 | 112406 | -43058 | 1368364 | 1328915 | 1294709 | 2825144 | 3169498 |
| 1000000 | -462951 | 125954 | -36114 | 1445646 | 1406490 | 1372062 | 2979099 | 3336313 |

Appendix 5

## Macro Pricing Model Office Projections

New product price/production - Zero commissions on extra premium

| Price structure: / Issue Rating: / Start-up costs: / pvunitprofper$1prem$_s$: | AGG | COMP | ISS MIN | AGG-B&C | COMP-B&C | ISS MAX | CONSERV | NO REINS |
|---|---|---|---|---|---|---|---|---|
| Price structure: | 113% | 113% | 116% | 148% | 148% | 159% | 200% | 200% |
| Issue Rating: / Start-up costs: | 100000 | 145000 | 175000 | 100000 | 145000 | 175000 | 100000 | 0 |
| pvunitprofper$1prem$_s$: | -20.75% | 52.32% | 21.91% | 233.16% | 233.75% | 252.24% | 448.39% | 475.14% |
| Premium Production | Present value of project-based profit as production increases (pvprojectprof$_s$) | | | | | | | |
| 0 | -100000 | -145000 | -175000 | -100000 | -145000 | -175000 | -100000 | 0 |
| 50000 | -110377 | -118838 | -164044 | 16582 | -28126 | -48878 | 124194 | 237571 |
| 100000 | -120754 | -92676 | -153088 | 133164 | 88749 | 77245 | 348388 | 475141 |
| 150000 | -131132 | -66514 | -142133 | 249747 | 205623 | 203367 | 572582 | 712712 |
| 200000 | -141509 | -40352 | -131177 | 366329 | 322498 | 329489 | 796775 | 950282 |
| 250000 | -151886 | -14190 | -120221 | 482911 | 439372 | 455612 | 1020969 | 1187853 |
| 300000 | -162263 | 11972 | -109265 | 599493 | 556246 | 581734 | 1245163 | 1425424 |
| 350000 | -172640 | 38134 | -98309 | 716075 | 673121 | 707856 | 1469357 | 1662994 |
| 400000 | -183017 | 64296 | -87353 | 832658 | 789995 | 833979 | 1693551 | 1900565 |
| 450000 | -193395 | 90457 | -76398 | 949240 | 906869 | 960101 | 1917745 | 2138136 |
| 500000 | -203772 | 116619 | -65442 | 1065822 | 1023744 | 1086224 | 2141938 | 2375706 |
| 550000 | -214149 | 142781 | -54486 | 1182404 | 1140618 | 1212346 | 2366132 | 2613277 |
| 600000 | -224526 | 168943 | -43530 | 1298986 | 1257493 | 1338468 | 2590326 | 2850847 |
| 650000 | -234903 | 195105 | -32574 | 1415569 | 1374367 | 1464591 | 2814520 | 3088418 |
| 700000 | -245280 | 221267 | -21618 | 1532151 | 1491241 | 1590713 | 3038714 | 3325989 |
| 750000 | -255658 | 247429 | -10663 | 1648733 | 1608116 | 1716835 | 3262908 | 3563559 |
| 800000 | -266035 | 273591 | 293 | 1765315 | 1724990 | 1842958 | 3487101 | 3801130 |
| 850000 | -276412 | 299753 | 11249 | 1881897 | 1841865 | 1969080 | 3711295 | 4038701 |
| 900000 | -286789 | 325915 | 22205 | 1998480 | 1958739 | 2095202 | 3935489 | 4276271 |
| 950000 | -297166 | 352077 | 33161 | 2115062 | 2075613 | 2221325 | 4159683 | 4513842 |
| 1000000 | -307543 | 378239 | 44117 | 2231644 | 2192488 | 2347447 | 4383877 | 4751412 |

Appendix 6

**Macro Pricing Model Office Projections**

Replacement product price/production - Full commissions on extra premium

| Price structure: | AGG | COMP | ISS MIN | AGG-B&C | COMP-B&C | ISS MAX | CONSERV | NO REINS |
|---|---|---|---|---|---|---|---|---|
| Issue Rating: | 113% | 113% | 121% | 148% | 148% | 159% | 200% | 200% |
| Start-up costs: | 0 | 45000 | 75000 | 0 | 45000 | 75000 | 0 | 0 |
| $pvunitprofper\$1prem_s$: | -33.31% | 24.87% | 12.75% | 141.86% | 142.40% | 141.99% | 282.60% | 306.21% |
| Premium Production | Present value of project-based profit as production increases ($pvprojectprof_s$) | | | | | | | |
| 0 | 0 | -45000 | -75000 | 0 | -45000 | -75000 | 0 | 0 |
| 50000 | -16656 | -32566 | -68626 | 70930 | 26198 | -4005 | 141301 | 153104 |
| 100000 | -33312 | -20132 | -62253 | 141860 | 97397 | 66990 | 282602 | 306209 |
| 150000 | -49968 | -7698 | -55879 | 212790 | 168595 | 137985 | 423902 | 459313 |
| 200000 | -66624 | 4737 | -49506 | 283721 | 239793 | 208981 | 565203 | 612418 |
| 250000 | -83280 | 17171 | -43132 | 354651 | 310992 | 279976 | 706504 | 765522 |
| 300000 | -99936 | 29605 | -36759 | 425581 | 382190 | 350971 | 847805 | 918626 |
| 350000 | -116591 | 42039 | -30385 | 496511 | 453388 | 421966 | 989105 | 1071731 |
| 400000 | -133247 | 54473 | -24012 | 567441 | 524587 | 492961 | 1130406 | 1224835 |
| 450000 | -149903 | 66907 | -17638 | 638371 | 595785 | 563956 | 1271707 | 1377940 |
| 500000 | -166559 | 79342 | -11265 | 709302 | 666983 | 634951 | 1413008 | 1531044 |
| 550000 | -183215 | 91776 | -4891 | 780232 | 738182 | 705947 | 1554308 | 1684148 |
| 600000 | -199871 | 104210 | 1482 | 851162 | 809380 | 776942 | 1695609 | 1837253 |
| 650000 | -216527 | 116644 | 7856 | 922092 | 880578 | 847937 | 1836910 | 1990357 |
| 700000 | -233183 | 129078 | 14229 | 993022 | 951777 | 918932 | 1978211 | 2143462 |
| 750000 | -249839 | 141512 | 20603 | 1063952 | 1022975 | 989927 | 2119511 | 2296566 |
| 800000 | -266495 | 153946 | 26977 | 1134882 | 1094173 | 1060922 | 2260812 | 2449670 |
| 850000 | -283151 | 166381 | 33350 | 1205813 | 1165372 | 1131917 | 2402113 | 2602775 |
| 900000 | -299807 | 178815 | 39724 | 1276743 | 1236570 | 1202912 | 2543414 | 2755879 |
| 950000 | -316463 | 191249 | 46097 | 1347673 | 1307768 | 1273908 | 2684714 | 2908984 |
| 1000000 | -333118 | 203683 | 52471 | 1418603 | 1378967 | 1344903 | 2826015 | 3062088 |
| Amount of production necessary to meet $500,000 of profit: | n/a | 2191544 | 4510842 | 352459 | 382734 | 404957 | n/a | 163287 |

Appendix 6

## Macro Pricing Model Office Projections

Replacement product price/production - Zero commissions on extra premium

| Price structure: | AGG | COMP | ISS MIN | AGG-B&C | COMP-B&C | ISS MAX | CONSERV | NO REINS |
|---|---|---|---|---|---|---|---|---|
| Issue Rating: | 113% | 113% | 116% | 148% | 148% | 159% | 200% | 200% |
| Start-up costs: | 0 | 45000 | 75000 | 0 | 45000 | 75000 | 0 | 0 |
| $pvunitprofper\$1prem_s$: | -19.05% | 48.02% | 20.11% | 214.00% | 214.54% | 231.51% | 411.53% | 436.09% |
| Premium Production | Present value of project-based profit as production increases ($pvprojectprof_s$) | | | | | | | |
| 0 | 0 | -45000 | -75000 | 0 | -45000 | -75000 | 0 | 0 |
| 50000 | -9524 | -20988 | -64945 | 107000 | 62268 | 40756 | 205766 | 218044 |
| 100000 | -19048 | 3023 | -54889 | 214000 | 169536 | 156512 | 411533 | 436087 |
| 150000 | -28573 | 27035 | -44834 | 320999 | 276804 | 272268 | 617299 | 654131 |
| 200000 | -38097 | 51046 | -34779 | 427999 | 384072 | 388023 | 823066 | 872175 |
| 250000 | -47621 | 75058 | -24723 | 534999 | 491340 | 503779 | 1028832 | 1090219 |
| 300000 | -57145 | 99069 | -14668 | 641999 | 598608 | 619535 | 1234599 | 1308262 |
| 350000 | -66670 | 123081 | -4613 | 748999 | 705876 | 735291 | 1440365 | 1526306 |
| 400000 | -76194 | 147093 | 5443 | 855999 | 813144 | 851047 | 1646131 | 1744350 |
| 450000 | -85718 | 171104 | 15498 | 962998 | 920412 | 966803 | 1851898 | 1962394 |
| 500000 | -95242 | 195116 | 25553 | 1069998 | 1027680 | 1082558 | 2057664 | 2180437 |
| 550000 | -104767 | 219127 | 35609 | 1176998 | 1134948 | 1198314 | 2263431 | 2398481 |
| 600000 | -114291 | 243139 | 45664 | 1283998 | 1242216 | 1314070 | 2469197 | 2616525 |
| 650000 | -123815 | 267151 | 55719 | 1390998 | 1349484 | 1429826 | 2674964 | 2834568 |
| 700000 | -133339 | 291162 | 65775 | 1497998 | 1456752 | 1545582 | 2880730 | 3052612 |
| 750000 | -142863 | 315174 | 75830 | 1604997 | 1564020 | 1661338 | 3086496 | 3270656 |
| 800000 | -152388 | 339185 | 85885 | 1711997 | 1671288 | 1777093 | 3292263 | 3488700 |
| 850000 | -161912 | 363197 | 95941 | 1818997 | 1778556 | 1892849 | 3498029 | 3706743 |
| 900000 | -171436 | 387208 | 105996 | 1925997 | 1885824 | 2008605 | 3703796 | 3924787 |
| 950000 | -180960 | 411220 | 116051 | 2032997 | 1993092 | 2124361 | 3909562 | 4142831 |
| 1000000 | -190485 | 435232 | 126107 | 2139997 | 2100360 | 2240117 | 4115329 | 4360874 |
| Amount of production necessary to meet \$500,000 of profit: | n/a | 1134869 | 2859181 | 233645 | 254037 | 248368 | n/a | 114656 |

## 6. REFERENCES


[1] Atkinson, David B. Introduction to pricing and Asset Shares. SN 210-25-90, Schaumburg, Illinois: Society of Actuaries, 1990.

[2] Atkinson, David B. Pricing Individual Life Insurance. SN 340-32-89, Schaumburg, Illinois: Society of Actuaries, 1989.

[3] American Council of Life Insurance, Report of the Industry Advisory Committee to the Life Risk Based Capital Working Group. Washington DC: American Council of Life Insurance, 1991.

[4] Barken, Norman. "Special Risk is Alive and Well Among the Professionals." Broker World Apr. 1990, 72-78, 116.

[5] Black, Kenneth Jr. and Harold Skipper, Jr. Life Insurance (11th ed.). Englewood Cliffs, New Jersey: Prentice-Hall, 1987.

[6] Bowers, N L., H. Gerber, J. Hickman, D. Jones, and C. Nesbitt. Acturarial Mathematics, Itasca, Illinois: Society of Actuaries, 1986.

[7] Brockett, Patrick L., Robert C. Witt, and Paul R. Aird. "An Overview of Reinsurance and the Reinsurance Markets." Journal of Insurance Regulation 1990. 432-454.

[8] Chalke, Shane A. Macro Pricing: Toward a Comprehensive Product Development Process. SN 210-26-90, Schaumburg, Illinois: Society of Actuaries, 1990.

[9] Chalke, Shane A. "Macro Pricing: A Comprehensive Product Development Process." Transactions of the Society of Actuaries, XLIII, 137-230, Schaumburg, Illinois: Society of Actuaries, 1991.

[10] Crosson, Cynthia. "Reinsurers Pulling Back On Large, Impaired Cases." National Underwriter November 5, 1990, 33.

[11] Deloitte & Touche. Internal Revenue Code Volume 1, Illinois: Commerce Clearing House, Inc., December 1991.

[12] DuBois, Franklin S. Jr. "Reinsurance Provides You with Your Own Shopping Cart." LIMRA's Marketfacts Nov/Dec. 1989, 7-8, 14-15.

[13] Freedman, Marian. "Adapting to a Changing Terrain." Best's Review Sep. 1991, 50-58.

[14] Hug, Mark Anthony. "Reinsurance from the Ceding Company's View." Record - Society of Actuaries, 15, 707-734, Schaumburg, Illinois: Society of Actuaries, 1989.

[15] Kolodney, Joseph F., Alexander Reinsurance Intermediary, Connecticut is acknowledged for his contributions.

[16] Mosca, Mark. "Evolution Ahead For Reinsurance Market In 1990's." National Underwriter June 11, 1990, S38-S41.

[17] Moylan, Martin J. "When Business Gets Too Risky, Reinsurance Comes Into Play", Minneapolis-St Paul City Business July 16, 1990: 13-14.

[18] Nodulman, Norman B. Expense Analysis. SN 340-30-91, Schaumburg, Illinois: Society of Acturies, 1991.

[19] Pfeifer, Timothy C., Milliman & Robertson, Chicago and Editor of SOA Product Development Section Newsletter is acknowledged for his contributions.

[21] Riehm, Thomas P. "Risk Selection is the key to the Elderly Market." National Underwriter November 9, 1992, 38-40.

[21] Society of Actuaries. Introduction to Reinsurance. SN 340-26-84, Schaumburg, Illinois: Society of Actuaries, 1984.

[22] Society of Actuaries. RISK-BASED CAPITAL: IS YOUR COMPANY READY?. SN 443-80-93, Schaumburg, Illinois: Society of Actuaries, 1993.

[23] Society of Actuaries. Target-surplus Formulas Take Center Stage as Financial Drama Unfolds. SN 443-26-92, Schaumburg, Illinois: Society of Actuaries, 1992.

[24] Thoen, Larry, Minnesota Mutual Life Insurance Company, St. Paul, Minnesota, is acknowledged for his contributions.

[25] Tiller, John E. Jr. and Denise Fagerberg. Life, Health, and Annuity Reinsurance. Winsted, Connecticut: Actex, 1990.

[26] Velazquez, Philip A. North American Reassurance Co, New York is acknowledged for his contributions.

[27] West, Thomas M. "Primary writers and reinsurance: Sharing challanges of the 1990's." The Actuary Apr. 1990, 12-13.

[28] Woodman, Harry A. Extra Premiums on Life Insurance Substandard Risks. SN 441-33-89, Schaumburg, Illinois: Society of Actuaries, 1989. (also his contributions)