The Actuary's Role in Transfer Pricing

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Abstract
When related parties enter into cross border intercompany reinsurance, most countries require that the intercompany pricing be consistent with an "arm's-length standard". An arm's-length standard is an internationally accepted concept that the price of a transaction needs to be reasonably consistent with what would have been negotiated between unrelated parties. In the U.S., regulations governing the intercompany prices are in the Internal Revenue Code ("IRC") Section 482 and Treasury Regulations promulgated thereunder. The analysis and documentation surrounding these regulations is referred to as transfer pricing analysis. Actuaries often play a key role in creating transfer pricing documentation since it requires an in depth knowledge of reinsurance pricing and a fundamental understanding of the reinsurance market. In this paper, we will provide an overview of transfer pricing regulations and acceptable documentation. Further, we will explore and demonstrate the methods that are commonly used to support the pricing of such transactions, which include Return on Economic Capital, Market Based, Expected Profits, Rate-on-Line and Contract Comparison. We will also give practical examples and provide considerations for the actuary performing these analyses.

Keywords. Reinsurance, Transfer Pricing, Tax

1. INTRODUCTION

The property and casualty insurance industry increasingly operates on a global level. As part of an overall global business strategy, many companies utilize intercompany reinsurance to manage risk and capital more effectively while ultimately improving profitability. Accordingly, taxing authorities in many jurisdictions are focusing on and challenging more and more the pricing associated with these related party transactions (i.e., transfer pricing).

A common circumstance arises for U.S. domiciled insurance companies that have affiliates in jurisdictions such as Bermuda that have no corporate taxes. In such cases, the Internal Revenue Service (IRS), the U.S.' taxing authority, may challenge the U.S. company with regard to its pricing of reinsurance ceded to such an affiliate, with the concern that the U.S. company is paying reinsurance premiums that are greater than what might be observed between unrelated parties. Since the companies are affiliated, the IRS may take the view that the ceding company has an incentive to pay excessive premium for the risk being reinsured, because it reduces the U.S. taxable income and thus the tax obligation.

Taxing authorities in many jurisdictions have regulations that guide companies on how to appropriately develop evidence for the pricing of intercompany transactions. Typically, such

guidance requires that the pricing be consistent with that which would be charged between unrelated parties; this is sometimes referred to as the "arms-length standard." While transfer pricing applies not only to reinsurance but to all intercompany transactions, demonstrating that pricing is arms-length is often more challenging for reinsurance as it does not have a listed market price. As a result, actuaries often play a key role in creating transfer pricing documentation since it requires an in-depth knowledge of reinsurance pricing and a fundamental understanding of the reinsurance market.

However, relatively few actuaries perform transfer pricing analyses or are even aware of the regulatory need for such analyses. In this paper, we will provide a high level overview of transfer pricing regulations and acceptable documentation. Further, we will explore and demonstrate the methods that are commonly used to support the pricing of such transactions, which include Return on Economic Capital, Market Based, Expected Profits, Rate-on-Line and Contract Comparison. We will also give practical examples and provide considerations for the actuary performing these analyses.

1.1 Research Context

Although no specific papers addressing the role of actuaries in transfer pricing have been published, the general concepts are covered to a certain degree by other authors, notably Rodney Kreps in "Investment Equivalent Insurance Pricing" and Lee R Steeneck in "Loss Portfolios: Financial Reinsurance."

1.2 Objective

The objective of this paper is to provide education and support to actuaries when performing transfer pricing analyses, including practical examples of several methods that are commonly used in such circumstances.

1.3 Outline

The remainder of the paper proceeds as follows:

Section 2: Background and Current Tax Regulations

Section 3: Types of Methods

Section 4: Methodology and Examples

Section 5: Potential Issues and Variations

Section 6: Conclusions

2. BACKGROUND AND CURRENT TAX REGULATIONS

Many multinational companies use intercompany reinsurance as a key component of their business strategy and often need to consider certain country-specific regulations when dealing with cross-border transactions. When related parties enter into reinsurance contracts, most countries require that pricing of these intercompany transactions be consistent with an arm's-length standard. An arm's-length standard is an internationally accepted concept requiring the price of a transaction to be reasonably consistent with the price that unrelated parties would have negotiated.

In the U.S., regulations governing intercompany reinsurance transaction pricing may be found in Internal Revenue Code ("IRC") Section 482 and Treasury Regulations promulgated thereunder, as well as a penalty provision prescribed in IRC Section 6662. However, these regulations do not prescribe a particular method for determining the pricing of such a transaction. To avoid the risk of penalties resulting from the IRS disagreeing with the intercompany reinsurance pricing and imposing an adjustment, a taxpayer must prepare and maintain documentation to substantiate its pricing of an intercompany transaction by the time it files its tax return. Section 6662 requires documentation including, but not limited to, the following:

- An overview of the taxpayer's business,
- A description of the intercompany transaction(s),
- Selection of the method used to demonstrate that the pricing is consistent with an arm's-length transaction, and
- An analysis to substantiate the intercompany pricing.

Taxing authorities in many jurisdictions outside the U.S. have similar transfer pricing requirements. Since no two reinsurance contracts are identical, demonstrating arms-length intercompany contract pricing can be challenging. Nevertheless, the documentation and judgments made therein should support the intercompany pricing because taxing authorities will heavily scrutinize the documentation, and the level of scrutiny will increase as the

transaction decreases the entity's tax obligation.

2.1 Definition of "Price" for a Reinsurance Contract

For excess of loss reinsurance contracts, "price" is commonly expressed as the contract premium. In some cases it is expressed as a percentage of underlying subject premium, but, effectively, the price is still the final premium. However, on a quota share contract, the determination of price arises in effect from the ceding commission. Since premiums and losses covered under quota share percentages are determined as a contractually stated proportion of the underlying reinsured contracts, the contractual commissions are the actual determinant of the contract pricing. The higher the expected ceding commission, the lower the effective price of the contract.

3. TYPES OF METHODS

The approaches that actuaries typically use to determine the price of intercompany reinsurance contracts fall into four general categories of methods:

1. Capital Based
2. Market Based
3. Contract Comparison (including Rate on Line)
4. Expected Profits

As a starting point, for transfer pricing purposes it is helpful to evaluate a reinsurance contract in the same manner that a pricing actuary in an actuarial department would price a reinsurance contract. However, the approaches used for transfer pricing support may be different from traditional pricing approaches. The actuary is trying to determine a reasonable market price and may operate at a different level of detail than the company pricing actuaries (level of detail and breadth of methods used may be more or less). Also the transfer pricing actuary may derive a range of acceptable prices, the width of which would vary depending on the type of business and the uncertainty in the market. There are also specific company considerations that may alter the price of the reinsurance contract. For example, a company may place more value on a contract because it contains a certain class of business that balances its portfolio. In addition, some of the methods used are hybrid

methods, utilizing market data, company data and specific contract data and generally do not fit squarely into one of the four approaches.

3.1 Capital Based Methods

The most commonly used and most complicated approaches are capital based methods, whereby price is determined based on economic variables and a theoretical construct, described below. The basic components that determine the price are:

1. Expected amount of covered losses, discounted to present value
2. Internal expenses
3. Cost of capital that the assuming company would maintain over time for the risk inherent in the contract.

Capital Based methods require an estimate of capital associated with the policy as well an estimate of what investors demand as a return on that capital. This class of methods is useful for both excess of loss and quota share contracts. It tends to be an especially useful method for evaluating lines of business where the pricing tends to be highly dependent on the uncertainty and duration of the cash flows. For portfolios of business that may be evaluated in a loss portfolio transfer or a commutation, variations of this method are almost exclusively used as the other methods described herein are often not applicable.

There are various approaches in which the capital required by the assuming company is estimated. Some common ways to determine capital are:

1. A solvency ratio, for example the 99.5^{th} percentile of the loss distribution, with further consideration given to diversification within the reinsurer's portfolio of business.
2. Observed leverage ratios in the property/casualty insurance sector, comprised of premium to surplus and/or reserve to surplus ratios.
3. Based on a risk-based capital (RBC) prescribed ratio applied to premiums and estimated unpaid claims, which vary by line of business.
4. An allocation of total company capital.

The principal advantage of capital based methods is that they are generally the most consistent with common actuarial pricing approaches. Capital based methods directly

consider the distribution of expected losses, expected payment pattern, cost of capital, and profitability targets to estimate price.

Nevertheless, there are potential limitations with this approach. In applying this method, there are numerous assumptions required, notably the selections of a capital requirement and an appropriate return on capital are othen be subjective, particularly if the assuming company does not provide reinsurance to unrelated parties. These assumptions may be made and the overall model may lack real market significance and may not reflect changes in cycle or market forces that drive price. As such, these methods are often not the primary methods used for coverages that cover predictable and more homogeneous exposures.

As an additional consideration, if the assuming company writes reinsurance to unrelated parties, it is helpful to demonstrate to taxing authorities that key assumptions used in the pricing (i.e., required capital, expected return, etc.) are the same between third party contracts and intercompany contracts.

3.2 Market Based Methods

Market based methods essentially amount to industry comparisons of commonly used market benchmarks, such as combined ratios from publicly available information. Combined ratios are most commonly applicable for quota share contracts, as excess of loss contracts are typically more difficult to determine market benchmarks for. Considering the impact of the time value of money can be a challenging nuance of this method.

This method is typically performed on a line of business level, such as commercial auto liability, or at times by general class of business, such as Reinsurance Type B. This may be a higher or different level of aggregation than typically used by reinsurance pricing actuaries.

The principle advantage of these types of methods is simplicity. They also reflect current market conditions and have "real world" significance. They are easy to explain to others and defendable. Additionally, they do not require assumptions regarding capital requirements and expected return on capital.

A disadvantage to these methods is that they may not reflect the nuances of a particular contract, and as such the more uncertainty and/or the longer the payout of claims, the less reasonable these methods are for transfer pricing. These methods will therefore work best for short tail contracts, where price and contract features are more homogenous in the

market.

3.3 Contract Comparison Methods

In determining an arms-length price, an actuary may leverage insights gained from the pricing of contracts with unrelated parties. This may include directly comparing the pricing for similarly reinsured business, indirect comparisons, and an approach we refer to as "the rate-on-line method." Rate-on-line is defined as the price of a layer divided by the width of the layer. In application, this method leverages information regarding rates-on-line from externally placed reinsurance to estimate rates-on-line on other layers being reinsured between related parties for the same underlying business.

An important advantage to these methods is that they directly or indirectly provide evidence that the pricing is consistent with actual contracts between unrelated parties.

A disadvantage to these methods might be that they don't consider a broader market or economic perspective or unique contract features because they are focused on just a few contracts.

These methods can work equally well for both quota share and excess of loss contracts, for various levels of risk.

3.4 Expected Profit Methods

The expected profit method is used for straight quota share contracts only, and it compares the expected profit of the assuming company to the expected profit of the ceding company. All else equal, taxing authorities may expect that the ceding and assuming companies share profits consistent with their proportional share as contractually set under the contract. Oftentimes, in our experience, we have found that the ceding company retains somewhat more of its proportional share as this entity typically owns and controls the business and would tend to negotiate a somewhat greater share in the open market.

An advantage to this method is its logical appeal and simplicity. However, there are several disadvantages. One, apart from acquisition expenses, it is not clear how the assuming company's operating expenses are considered. Two, it is not clear if the equivalence of profit is performed before or after income taxes. The application of this method can yield significantly different results depending on how these assumptions are

set.

4. METHODOLOGY AND EXAMPLES

This section will present individual methods within the classes listed above and give examples of the application for each method. The examples are meant to provide simple illustrations as to how the methods could be applied in practice, and in certain cases we used simplifying assumptions for ease of the illustration. In practice, the methods used to support transfer pricing of reinsurance contracts should strive to be reasonable from an actuarial perspective, yet understandable to taxing authorities. In striking this balance, the methods used are often less sophisticated than those used to price reinsurance transactions in the open market.

To illustrate these methods, we perform the methods with a sample quota share contract, a sample aggregate excess of loss contract and/or a sample property excess contract.

4.1 Contracts

4.1.1 The Quota Share Contract

Assume you have the following quota share contract:

1. Underlying Subject Premium = 100,000
2. Percent Ceded = 50%
3. Actual Ceding Commission = 25.0%
4. Lines of Business = Other Liability Occurrence
5. Acquisition costs = 25% or $25,000
6. Assuming Company expense ratio = 2%
7. Ceding Company is U.S. based with a tax rate of 35%
8. Assuming Company is domiciled in Bermuda and pays no corporate taxes.

Historical Data is given as follows:

Calendar Year	Earned Premium	Paid Loss and Expense	Caried Ultimate	Loss Ratio
2004	$ 238,416	$ 118,942	$ 132,090	55.4%
2005	233,273	120,946	132,616	56.9%
2006	246,685	109,425	126,153	51.1%
2007	201,719	110,161	133,728	66.3%
2008	140,162	67,477	91,263	65.1%
2009	97,008	44,881	75,019	77.3%
2010	86,469	30,429	67,909	78.5%
2011	72,845	25,854	61,078	83.8%
2012	66,176	6,339	44,688	67.5%
2013	53,467	2,685	45,257	84.6%
	$ 1,436,220	$ 637,139	$ 909,801	63.3%
		Coefficient of Variation of Loss Ratio		19.0%

4.1.2 The Aggregate Excess of Loss Contract

Assume that the underlying business above had an aggregate excess cover written for losses between a 72.5% and 92.5% loss ratio. Also assume the price of the contract is 6.75% of underlying subject premium. All other info between the two parties is the same.

4.1.3 The Property Excess of Loss Contract

Assume this is a property excess of loss contract covering the layer from $25 million excess of $40 million. The ceding company reinsures layers up through $40 million with third party reinsurers. The current data available is as follows:

Layer	Premium Charged 2013
10 M xs 15 M	$ 4,875,000
10 M xs 25 M	1,100,000
5 M X 35 M	300,000

All other company information is as above. The contract has been priced at $1,027,000.

4.2 Return on Economic Capital Method (ROEC Method)

The ROEC method is a common variation of a capital based method, where an estimate of the premium is made considering commissions paid to the ceding insurer, an estimate of losses that will be covered under the contract, and an estimated return on economic capital that is commensurate with the assuming company's target rate of return or opportunity cost of capital.

Economic capital is a theoretical construct representing the amount of capital an assuming company would need to dedicate to a specific block of business in order to maintain solvency a high percentage of the time. For purposes of our illustrations, we assumed that the assuming company would price these agreements based on dedicating capital that would result in 99.5^{th} percentile of certainty that it would be sufficient to cover the uncertainties under the transaction, as this percentage is one we commonly observe being applied in practice. The assuming company must hold this amount of capital over the life of the contract and therefore will incur an opportunity cost of maintaining this capital rather than investing it in other investments. The opportunity cost, along with the total value of losses, is considered as part of the cost of assuming business.

There are several alternatives that can be used to the way we derive economic capital, and we list some of the alternatives below:

1. Using industry or target premium to surplus or reserve to surplus ratios to determine capital (this method will be illustrated below).

2. Using RBC ratios or other industry benchmark ratios to determine capital.
3. Using an allocation of total company capital.

The advantage to the way we will illustrate the capital requirement is that it is relatively easy to calculate. A transfer pricing review might offer several alternative versions of this method to illustrate the range of prices in which a reasonable arms-length price might fall.

Since the amount of premium is dependent on the overall capital charge over the life of the contract and since the overall level of capital required is dependent on how much premium is received, the determination of premium is made through an iterative process. When a reinsurance contract is written, the expected outcome is that premium will cover the losses associated with the contract. However, there is a reasonable probability that the actual losses under the contract will exceed the consideration, creating the need for required capital. However, the more adequate the premium, the less need for capital; therefore, the amount of capital required is dependent on premium charged.

We will illustrate this method for our quota share and aggregate excess of loss methods since the data and information provided lends well for pricing those contracts. It should be noted however, that industry data specific to type of business can replace many of the components in our analysis, where needed.

4.2.1 General Formula

The general premium formula employed in the ROEC method is:

Premium = Discounted value of losses plus expenses plus the discounted cost of capital over the life of the contract.

4.2.2 Considerations and Assumptions

The following components are determined to perform the ROEC method:

1. *Total Variability and Expected Distribution of Losses* - A first step in this approach is to estimate the expected losses, as well as the potential variability of such losses. The greater the variability, the more economic capital the assuming company would need to maintain and thus the greater the premium. To estimate variability, losses might be modeled using lognormal distributions and a selected coefficient of variation (CV). Using historical data above, selection might be presented as follows:

Calendar Year	Earned Premium	Paid Loss and Expense	Caried Ultimate	Loss Ratio
2004	$ 238,416	$ 118,942	$ 132,090	55.4%
2005	233,273	120,946	132,616	56.9%
2006	246,685	109,425	126,153	51.1%
2007	201,719	110,161	133,728	66.3%
2008	140,162	67,477	91,263	65.1%
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2011	72,845	25,854	61,078	83.8%
2012	66,176	6,339	44,688	67.5%
2013	53,467	2,685	45,257	84.6%
	$ 1,436,220	$ 637,139	$ 909,801	63.3%
			(a) Coefficient of Variation of Loss Ratio	19.0%
			Parameter Risk Load as a % of Variance	50.0%
			(b) Final CV	23.2%

Where (a) = Standard Deviation of the loss ratio column divided by the weighted average (63.35%) of that column and (b) = square root ((a)^2 x (1+ Parameter Risk Load)) since in our experience parameter loads are more commonly applied to variance rather than standard deviation. The parameter risk load is selected judgmentally based on industry norms. Note for simplicity this example does not include enhancement such as on-leveling of premium and loss trends. The

appropriate CV is a matter of judgment and the Actuaries best judgment with regards to the appropriate data and final selection.

In addition for contracts with more than one line of business, the distribution of the aggregate business should consider correlations among the lines of business. A full review of appropriate modeling of losses is beyond the scope of this paper.

The higher the selected CV, the higher the need for capital, and therefore the higher the capital charge and the higher the premium (or lower the commission for a quota share contract).

2. *Solvency Standard* - Our example uses the 99.5th percentile of the above distribution to determine total capital needs. In another words, we assume that the reinsurer's risk appetite is such that no more than a one in 200 chance of ruin is acceptable. The selected percentile is an assumption that can be varied.

3. *Time Value of Money* - This approach considers the time value of money on the premium and economic capital. Accordingly, the U. S. Treasury security interest rates when the contract would have been priced are commonly used in practice. A good resource can be found at http://www.treasury.gov. We used the treasury yield curve to match cash flows to the appropriate risk free interest rates.

4. *Capital Charge* – In this context, the capital charge in essence reflects the amount of return expected above the risk free rate which is commensurate with the risks of writing this type of reinsurance. Note that because of the nature of the way we perform our calculations, we assume a pre-tax rate.

   This assumption may be benchmarked using the reinsurers own recent experience or using industry data. It is a very subjective assumption, and as such it may be useful to calculate premiums using a range of estimates based on a range of capital charges. The rates we have observed in the industry have varied widely, albeit more recently we have observed rates between 4% and 10%. For purposes of our illustrations, we used a charge of 5%.

5. *Expected Payout Pattern of Losses* – For our example, we used the payout pattern implied by the historical data and smoothed the tail. This pattern is important as it determines how long capital will need to be held. To the extent that losses are not yet paid, uncertainty remains and capital must be held. The longer the payout pattern, the longer the need for capital and the higher the capital charge. A higher capital charge will increase premium; however, the longer payout pattern will decrease the discounted value of the losses.

6. *Expected Loss Ratio on Underlying Business* – This estimate will be determined by available data and underwriting expectations. We judgmentally selected a loss ratio of 70% based on recent years' experience in our example.

7. *Diversification Benefit* – The actuary should also consider a diversification benefit present to the assuming company in adding the contract to its portfolio of business. In some cases, this is not relevant as the assuming company may write no other business besides a contract from its affiliate. Or conversely, the assuming company may write a highly diversified portfolio, and thus the contract may require significantly less capital due to diversification. This also tends to be an assumption that requires significant judgment.

   Suppose in the case of our other liability quota share contract, the reinsurer writes mostly property business for the rest of its book. In such a case, it would be logical to assume that the contract will not require as much additional capital. If the history is as follows, we might assign a diversification benefit around 87%

Calendar Year	Other Liability Loss Ratio	Property Loss Ratio	Weighted	Portfolio
2004	55.4%	74.0%		
2005	56.9%	64.7%		
2006	51.1%	85.0%		
2007	66.3%	84.7%		
2008	65.1%	85.1%		
2009	77.3%	83.8%		
2010	78.5%	75.3%		
2011	83.8%	73.5%		
2012	67.5%	68.0%		
2013	84.6%	70.0%		
	63.3%	76.9%		
Select Loss Ratio	70.0%	68.0%	68.8%	68.8%
CV of Loss Ratio	19.0%	10.1%		
Parameter Risk Load (% of Variance)	50.0%	50.0%		
Correlation				-13.9%
Weights	40.0%	60.0%		
Final CV	23.2%	12.3%		11.0%
99.5th Percentile	123.1%	92.6%	104.8%	90.8%
Diversifications Benefit				86.7%

The weighted column simply weights the 99.5th percentile loss ratio by the 40/60 weights which would be derived from expected losses (in the year the contract is priced for). The portfolio column uses the portfolio variance formula:

$$\sigma_T^2 = w_A^2\sigma_A^2 + w_B^2\sigma_B^2 + 2w_A w_B \sigma_A \sigma_B \rho_{AB}$$

In the formula above, Rho, shown in the formula as (ϱ), is the correlation observed between lines. (Note this is used for simplicity and to show the effect of such a correlation. While we have observed diversification benefits on multi-line portfolios it is beyond the scope of this paper to explore the best ways to estimate correlation. The actuary should use their best judgment and for purposes of demonstrating to IRS, keep it simple and well documented.) The diversification benefit of 86.7% is derived by taking the 99.5th percentile

based on the portfolio CV and dividing it by the 104.8% which is based on a weighted average and therefore would assume 100% correlation. The capital required for this contract therefore is reduced to 86.7% of original capital requirement.

4.2.3 Results – Quota Share Contract

The following table is an illustration of the application of the ROEC method performed for the quota share contract, considering the assumptions as described in this section. A more detailed version of this exhibit is presented in Exhibit 1.

Calendar Year	Paid Loss (%)	Duration Matched Rate (%)	Discount Factor To Time Zero	Disc. Percent Paid	Percent Outs.	Disc. Percent Outs.	Disc. Outs. Loss	Needed Capital	Capital Charge at 5.00%	Disc. Capital Charge
			1.000		100.00	92.00	32,200	13,321		
2014	5.93	0.10	1.000	5.93	94.07	86.11	30,140	13,009	329	329
2015	8.25	0.26	0.996	8.22	85.81	78.15	27,351	11,648	650	648
2016	28.14	0.58	0.986	27.74	57.67	50.84	17,794	6,933	582	574
2017	2.48	1.02	0.965	2.39	55.19	49.45	17,306	7,057	347	335
2018	15.02	1.51	0.935	14.04	40.17	36.02	12,608	5,154	353	330
2019	14.11	1.93	0.900	12.71	26.06	23.29	8,152	3,301	258	232
2020	8.44	2.28	0.864	7.29	17.62	15.83	5,541	2,277	165	143
2021	4.36	2.55	0.828	3.61	13.26	12.16	4,255	1,844	114	94
2022	4.46	2.75	0.794	3.54	8.80	8.21	2,874	1,300	92	73
2023	3.80	2.94	0.759	2.88	5.00	4.79	1,677	806	65	49
2024	5.00	3.07	0.728	3.64	0.00	0.00	0	0	40	29

Total Charge	2,836
Economic Premium	35,751
Nominal Premium	50,000
Implied Commission	28.50%

Note the initial level of needed capital is determined as the 99.5th percentile (including diversification benefit) of discounted outstanding loss minus the total economic premium (nominal premium less ceding commission). As time progresses, the capital becomes the 99.5th percentile of the remaining outstanding loss minus the nominal held reserves at each point in time. In our example, we assumed a proportional relationship between capital and reserves overtime. Although the actuary can model this more scientifically, we feel this is

adequate for transfer pricing documentation purposes. Another simplifying assumptions is that the payout pattern at the 99.5th percentile and the expected value are the same. Although it is possible to conceive two very different patterns, we feel using one pattern is suitable for transfer pricing purposes. In essence you are providing a corroborative range around price.

The economic premium must also equal the (discounted losses plus the cost of capital)/(1- the reinsurer expense ratio of 2%). Since the amount of capital depends on economic premium, the economic premium must be calculated iteratively. Commission is then determined by comparing the economic premium with the nominal premium.

4.2.4 Aggregate Excess of Loss Contract

For the aggregate excess of loss contract over the same book of business, we simply apply that same lognormal loss distribution to the layer of the contract. For this we use the Mean Excess Value (MEV) function of the lognormal distribution:

$$e(x) = \frac{\exp\left(\mu + \frac{\sigma^2}{2}\right)\left\{1 - \Phi\left(\frac{\ln x - \mu - \sigma^2}{\sigma}\right)\right\}}{\left\{1 - \Phi\left(\frac{\ln x - \mu}{\sigma}\right)\right\}} - x$$

Therefore, expected value in layer = MEV (attachment point or 72.5% loss ratio) x probability that losses are above 72.5% loss ratio – MEV (limit or 92.5% loss ratio) x probability that losses are above 92.5% loss ratio. In this case, the expected value of the layer as a percentage of subject premium is 4.3%. The 99.5th percentile of the underlying losses cover the whole layer and therefore the 99.5th percentile of the aggregate contract is 20% of the underlying premium.

The following are the results of applying the ROEC method for this contract. More detail is displayed in Exhibit 2..

Calendar Year	Paid Loss (%)	Duration Matched Rate (%)	Discount Factor To Time Zero	Disc. Percent Paid	Percent Outs.	Disc. Percent Outs.	Disc. Outs. Loss	Needed Capital	Capital Charge at 5.00%	Disc. Capital Charge
			1.000		100.00	89.48	3,876	10,466		
2014	-	0.10	1.000	-	100.00	89.52	3,878	13,573	258	258
2015	5.93	0.26	0.996	5.91	94.07	83.89	3,634	12,703	679	676
2016	8.25	0.58	0.986	8.13	85.81	76.53	3,315	11,589	635	626
2017	28.14	1.02	0.965	27.16	57.67	50.03	2,167	7,507	579	559
2018	2.48	1.51	0.935	2.32	55.19	49.16	2,129	7,441	375	351
2019	15.02	1.93	0.900	13.52	40.17	36.02	1,560	5,464	372	335
2020	14.11	2.28	0.864	12.19	26.06	23.43	1,015	3,557	273	236
2021	8.44	2.55	0.828	6.99	17.62	16.01	693	2,438	178	147
2022	4.36	2.75	0.794	3.47	13.26	12.32	534	1,890	122	97
2023	4.46	2.94	0.759	3.39	8.80	8.43	365	1,306	95	72
2024	8.80	3.07	0.728	6.40	0.00	0.00	0	0	65	47
								Total Charge		3,405
								Economic Premium		7,430
								Nominal Premium		100,000

Note that we did not recalculate a diversification benefit for this contract. It is often more challenging to estimate correlation reliably on an aggregate excess contract versus a portfolio of relatively homogeneous first dollar claims. Nevertheless, such correlation should still be considered to the extent the actuary believes it is meaningful to the estimates.

4.3 Leverage Ratio Method (LR Method)

This method is essentially identical to the ROEC method, except that capital is determined by observing premium and reserves to surplus ratios in the property/casualty insurance industry. While less "actuarial" than the ROEC method, the LR Method has an advantage of simplicity in that the approach is essentially the same but there are fewer assumptions surrounding required capital that need to be made. Instead, required capital is estimated at the property/casualty insurance sector level considering broader industry statistics. However, as a disadvantage, in cases where the assuming entities in the industry

have significant risks beyond underwriting, such as significant reserve uncertainty, using the leverage ratio method alone may not produce a reasonable estimate.

For this reason, we use this method on the quota share contract only, as industry aggregate leverage ratios may not fit an aggregate excess contract. In lieu of using ratios for the industry as a whole, we may consider ratios for companies that are similar to the assuming company or that reinsure predominantly the lines of business covered by the contract. For this illustration, we used the industry as a whole and ratios of net premium plus reserves divided by average surplus averaged to approximately 1.8 over the latest 5 calendar years.

This method also has to be solved iteratively as initial capital is determined based on initial premium and total premium must also equal discounted losses plus capital charge plus expenses. These are our results for the quota share contract:

Calendar Year	Paid Loss (%)	Duration Matched Rate (%)	Discount Factor To Time Zero	Disc. Percent Paid	Percent Outs.	Disc. Percent Outs.	Disc. Outs. Loss	Needed Capital	Capital Charge at 5.00%	Disc. Capital Charge
			1.000		100.00	92.00	32,200	20,635		
2014	5.93	0.10	1.000	5.93	94.07	86.11	30,140	18,291	510	509
2015	8.25	0.26	0.996	8.22	85.81	78.15	27,351	16,686	915	911
2016	28.14	0.58	0.986	27.74	57.67	50.84	17,794	11,214	834	822
2017	2.48	1.02	0.965	2.39	55.19	49.45	17,306	10,732	561	541
2018	15.02	1.51	0.935	14.04	40.17	36.02	12,608	7,812	537	502
2019	14.11	1.93	0.900	12.71	26.06	23.29	8,152	5,068	391	352
2020	8.44	2.28	0.864	7.29	17.62	15.83	5,541	3,427	253	219
2021	4.36	2.55	0.828	3.61	13.26	12.16	4,255	2,578	171	142
2022	4.46	2.75	0.794	3.54	8.80	8.21	2,874	1,711	129	102
2023	3.80	2.94	0.759	2.88	5.00	4.79	1,677	972	86	65
2024	5.00	3.07	0.728	3.64	0.00	0.00	0	0	49	35

Total Charge	4,201
Economic Premium	37,144
Nominal Premium	50,000
Implied Commission	25.71%

Further detail can be found in Exhibit 3.

4.4 Other Capital Based Methods

There are multiple alternatives to calculation of capital such as using RBC ratios or allocation of total company capital. Such methods would be applied in an identical manner as the ROEC, except with a different amount for required capital.

The application of these methods is from the perspective of the assuming company and how much capital the company is expected to hold against the contract at a given point in time. The cost of such capital then becomes part of our calculation of premium. An alternative method would be to calculate returns form the point of view of the investor and recreate financial statements to derive when capital has to be invested and released. The cash flows are then discounted at the investor's required rate of return and the premium can be set such that the net present value to the investor is zero. We have not illustrated this alternative approach; however, in our experience the results tend to be substantially the same as those produced by the ROEC method.

4.5 Market Combined Ratio Method

The market combined ratio method compares the expected combined ratios using industry benchmarks to that expected to be generated by the reinsurance contract being evaluated. The source of industry benchmarks is typically aggregate industry data, refined by line of business as applicable. This method is most commonly used for quota share contracts, as it is typically easier to obtain industry benchmarks.

Below are the results of an illustration using industry combined ratios. In this illustration, the industry combined ratios were lower than we observed in the data for our sample contract. Our sample contract has a loss ratio of 70% and actual ceding commission of 25%. The indicated commission for this method would be the commission that sets the combined ratio equal to that reported by the industry for the coverage type and selected group of accident years:

	Industry Other Liability Combined Ratio (%)
Lower Quartile	61.0
Median	74.3
Upper Quartile	86.8
Contract Expected Combined Ratio	95.0
Equalizing Commission	
Lower Quartile	(9.0)
Median	4.3
Upper Quartile	16.8

Based on this data, for the other liability line of business as a whole, we might conclude that our contract is providing reinsurance to risks that are less variable than the broader industry since the expected combined ratio for our sample contract is much higher. Generally, the market combined ratio method works well with shorter tail and less varied lines such as nonstandard personal auto or accident and health quota share. In such cases, using sector combined ratios provides reinsurance pricing estimates that are consistent with observed industry practice, and such estimates tend to be greater than estimates based on methods that derive rates based on perceived uncertainty.

4.6 Indirect Industry Comparison Method

Indirect comparison methods often tend to equalize the playing field depending on the amount of uncertainty present in the contract. For this approach, we measure the risk of the contract by its CV. All else equal, a reinsurer should expect to receive a greater risk margin for increased uncertainty - the greater the uncertainty, the lower the expected combined ratio. While we acknowledge that many other factors and nuances in pricing, this method merely shows that a contract is in line with industry risk / price relationships in general and can be a useful tool in demonstrating fair pricing.

The indirect industry comparison method may be applied using aggregate industry data for combined ratios over, for example, a 5 to 10 year period. For each company that is included in the comparison, we can calculate the standard deviation of those reported combined ratios and the current combined ratio. By doing this for a group of companies for lines of business related to the contract we can establish a relationship between risk and price.

Our analysis of industry data for other liability revealed the following average combined ratios (%):

CV greater than 1.0	56.7
CV greater than .5 and less than 1.0	73.2
CV greater than .25 and less than .5	86.4
CV less than .25	100.6

In our illustration, the CV for the quota share contract is 23.2% and the CV of the aggregate excess contract is 170.3%. The combined ratios at current prices are 95% and 64.2% respectively. In addition to evaluating at averages by industry band, a line could be fit to individual CV data points to provide another estimate of combined ratios. So in this case, for the aggregate excess contract, the CV of 170.3% is fitted to a combined ratio of 63.6% which compares well with the priced combined ratio of 64.2%. For the quota share contract, the fitted price of 92.7% also compares well with the expected combined ratio of 95.%. The last to columns display what the price would have been for expected combined ratio to match the fitted. This is illustrated in the table below:

	Contract CV	Fitted Combined Ratio (%)	Expected Combined Ratio (%)	Implied Comission at Fitted Combined Ratio	Implied Price at Fitted Combined Ratio
Aggregate Excess Fitted Value	170.3%	63.6	64.2		6.8
Quota Share	23.2%	92.7	95.0	22.7	

4.7 Contract Comparison Method

An analysis of other contracts that are written or entered into by either the ceding or assuming company can be relevant to preparing support in a transfer pricing analysis, and both ceded and assumed contracts are considered as long as they were entered into between unrelated parties. Tax experts often consider comparable contracts to be the strongest support when evidencing transfer pricing. Unfortunately, in most cases, the pricing in one reinsurance contract is not directly comparable to the pricing in another, particularly for excess of loss contracts.

Another area that the actuary may want to investigate is pricing practices of the reinsurer. If third parties are all priced using the same ROEC method or the same table of underwriting benchmarks, it is important that the intercompany contract follow the same set of rules.

Lastly, the Indirect Industry Comparison Method can be used on third party contracts in which the ceding company and assuming company are engaged. The following table shows what a typical comparison of existing contracts might look like:

Third Party Reinsured	Contract Type	Coefficient of Variation	Expected Combined Ratio	Margin
Company A	All Lines QS	16.5%	95.5%	4.5%
Company B	Marine QS	16.0%	96.0%	4.0%
Company C	Property Catastrophe QS	58.7%	66.8%	33.2%
Company D	General Liability & Liquor Liability QS	16.4%	94.0%	6.0%
Company E	Property QS	16.7%	100.0%	0.0%
Company F	Workers' Compensation XOL	76.9%	90.4%	9.6%
Company 5	Auto QS Retro Reinsurance	11.9%	97.0%	3.0%
Company H	Workers' Compensation XOL	26.3%	91.9%	8.1%
Company I	Medical Professional Liability Clash XOL	60.0%	73.0%	27.0%
Company J	Property Catastrophe Retrocession	125.0%	68.4%	31.6%
	Minimum	11.9%	66.8%	0.0%
	Maximum	125.0%	100.0%	33.2%

Qualitatively, we can say that our current other liability contracts are in line with existing contracts in terms of the relationship of risk to price.

4.8 Rate on Line Method (ROL Method)

In the absence of sufficient data to conduct other methods, as in the case of the sample property excess contract, it is often useful to use a ROL method. ROL is defined as the price of a reinsurance layer divided by the width of that layer. The premise of this method is that as the attachment point of the insurance layer increases, the rate on line should decrease, since the frequency of losses decreases. To the extent the ceding company has entered into contracts with unrelated parties for certain layers of coverage, the rates on line observed can be leveraged to estimate a range of rates on line for a layer of coverage written between related parties.

The following is an illustration of an application of the Rate on Line Method. There are various considerations that may impact the evaluation of the results, such as expense ratios and margin requirements – these are typically considered in developing a range.

Layer	Premium Charged 2013	Width Of Layer	Charged Rate on Line	Low Selected ROL	High Selected ROL	Low Premium	High Premium
10 M xs 15 M	$ 4,875,000	10,000,000	48.8%				
10 M xs 25 M	1,100,000	10,000,000	11.0%				
5 M xs 35 M	300,000	5,000,000	6.0%				
25 M xs 40M		25,000,000		3.0%	5.0%	$ 750,000	$ 1,250,000

4.9 Expected Profits Method

The expected profits method is applicable for traditional quota share contracts. The basic premise of this method is that all else being equal, the ceding company and the assuming company should receive their proportionate share of expected profits. Note for simplicity, we did this on a nominal basis. The following displays our analysis.

	Ceding Company	Assuming Company
Premium	50,000	50,000
Expenses	(25,000)	(1,000)
Expected Commission	12,500	(12,500)
Expected Losses	(35,000)	(35,000)
Margin	5.0%	3.0%
After Tax Margin	3.3%	3.0%
Equalizing Commission		
Before Tax	24.0%	
After Tax	24.8%	
Commission at 24.8%	12,424	(12,424)
Margin	4.8%	3.2%
After Tax Margin	3.2%	3.2%

There are several key assumptions in the analysis that require judgment. First, for both the ceding and assuming companies, the expenses applicable to performing this exercise needs to be estimated. For the reinsurer, expenses should be the nominal amount to write the contract. Taxation also needs to be considered. If the balancing of profits is performed on an after-tax basis, then in effect the ceding company is receiving a share of the tax benefit from the transaction and reducing the estimated price. In practice, we observe both to determine the fairness of a contract.

5. POTENTIAL ISSUES AND VARIATIONS

During the course of performing transfer pricing analyses, there are several challenges that may arise.

5.1 Loss Portfolio Transfers

Transfer pricing applies to loss portfolio transfers (LPT) between related parties, even though for U.S. statutory purposes company management may be tempted to book the transaction at book value to ensure the transaction is surplus neutral. This may not produce results that are consistent with transfer pricing approaches. For LPTs, the ROEC method generally works very well since it

captures the risk specific to the transfer and the unique payment patterns that may arise. Other methods described herein are generally less appropriate.

The trade-off between cost of capital and discount in the losses will be important in determining if price should be greater than, equal to or less than book value. Because of the inherent uncertainty in pricing such a transaction, it is also useful to vary assumptions such as capital charge and capital requirement to derive a range in price.

5.2 Captive Reinsurance Companies

The arms-length principle and pricing approaches described herein are equally applicable for pricing business ceded to affiliated captive reinsurance companies. However, there may be additional considerations that arise with captive reinsurance companies, such as:

1. The capital held in the captive may be much less than required under an economic capital analysis.
2. Internal expenses for captives are generally much lower than other reinsurance companies.
3. Captives may be subject to different tax laws, depending on the jurisdiction.

Accordingly, when performing transfer pricing on captive reinsurance transactions, the actuary should modify the methods appropriately.

5.3 Limited Industry Data

,Because of their multi-jurisdictional nature of transactions, transfer pricing engagements may involve classes of business not typically covered by industry sources such as Best's or SNL financials, which deal with statutory lines of business.

However, the principle of the relationship between risk and price is the same as are the economic principles above. In this case, methods like the indirect industry method and contract comparison methods can be very useful. Also, the actuary can find Schedule P lines that are very similar to foreign business.

5.4 Multiple Jurisdiction and Contracts

For some cross-border reinsurance contracts, there are multiple jurisdictions that may be impacted. In these cases, each taxing authority involved in tested transactions will have an interest in the fairness of price, and in particular an interest in not unfairly losing tax revenue. Several points are important to note in this situation:

1. Each intercompany contract should be fairly priced on its own. For example, it is generally not appropriate to have an excessively priced contract be offset with an underpriced one. Taxing authorities may only focus on the excessively priced contract.
2. A jurisdiction may be a country or a state, depending on the tax laws. It is important to have a comprehensive understanding of the tax treatment for each entity. Companies that are locating in certain jurisdictions may be taxed in another region, depending on the relevant corporate and tax laws.
3. Pricing methodologies between transactions in the group should use consistent methodology. This is similar to the assertion that pricing assumptions must be consistent with the company's pricing of third party transactions.

5.5 Taxing Authority Challenges

Taxing authorities, such as the IRS in the U.S., may challenge transfer pricing documentation and assess the company for the difference between what it considers to be an appropriate price and the actual price charged multiplied by the tax rate. The IRS may challenge assumptions or a certain methodology. For example, for a given transaction between affiliates, if the IRS determines that premiums paid from

the U.S. to the Bermuda affiliate were excessive, it would assess the company for additional taxes. In addition, if the company did not maintain transfer pricing documentation, there would be an additional penalty assessed. As such, documentation of the assumptions and methodologies that were used to support the transfer pricing provide "penalty protection" for the U.S. taxpayer.

6. CONCLUSIONS

Transfer pricing is of increasing importance for many companies that operate internationally. Taxing authorities are focusing to a greater extent on intercompany agreements, including related party reinsurance contracts. Many casualty actuaries have an effective blend of reinsurance pricing training and experience, as well as broader reinsurance market insights and access to industry data to support transfer pricing evaluations on these contracts.

The methods to fairly price reinsurance contracts are not limited to what is presented in this paper. However, we believe that this paper provides useful descriptions and illustrations for an actuary conducting transfer pricing work in coordination with tax professionals.

The Appendix contains a summary of our illustrations as well as a sample presentation of results.

Appendix A

Exhibits are contained in Appendix A which show further details of examples provided in this paper.

5. REFERENCES

[1] Sample Industry Data from SNL Financials 2011 – 2013 Data.

Biography(ies) of the Author(s)

Lynne Bloom, FCAS, MAAA, is a Director at PwC in Philadelphia, PA. She has a B.B.A. in Finance from the Wharton Business School at the University of Pennsylvania. She is a Fellow of the CAS and a Member of the American Academy of Actuaries. Lynne is the chairman of the CAS Research Oversight Committee and Vice President of CAMAR.

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Appendix A

Summary of Indications

	Quota Share Commission	Aggregate Excess Rate	Property Excess Premium
ROEC	28.5%	7.4%	
LR	25.7%		
Market Combined Ratio Median	4.3%		
Market Combined Ratio Upper	16.8%		
Indirect Industry	22.7%	6.8%	
Rate On Line Low			$ 750,000
Rate On Line High			$ 1,250,000
Expected profits	24.8%		
Actual	25.0%	6.8%	$ 1,027,000

Appendix A

Exhibit 1

Return on Economic Capital Method - Quota Share

(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)	(10)	(11)	(12)
Calendar Year	Paid Duration	Paid Loss (%)	Duration Matched Rate (%)	Discount Factor To Time Zero	Disc. Percent Paid	Net Premium paid in	Percent Outs.	Disc. Percent Outs.	Disc. Outs. Loss	Needed Capital	Capital Charge at 5.00%	Disc. Capital Charge
				1.000		35,751	100.00	92.00	32,200	13,321		
2014	0.500	5.93	0.10	1.000	5.93	-	94.07	86.11	30,140	13,009	329	329
2015	1.500	8.25	0.26	0.996	8.22		85.81	78.15	27,351	11,648	650	648
2016	2.500	28.14	0.58	0.986	27.74		57.67	50.84	17,794	6,933	582	574
2017	3.500	2.48	1.02	0.965	2.39		55.19	49.45	17,306	7,057	347	335
2018	4.500	15.02	1.51	0.935	14.04		40.17	36.02	12,608	5,154	353	330
2019	5.500	14.11	1.93	0.900	12.71		26.06	23.29	8,152	3,301	258	232
2020	6.500	8.44	2.28	0.864	7.29		17.62	15.83	5,541	2,277	165	143
2021	7.500	4.36	2.55	0.828	3.61		13.26	12.16	4,255	1,844	114	94
2022	8.500	4.46	2.75	0.794	3.54		8.80	8.21	2,874	1,300	92	73
2023	9.500	3.80	2.94	0.759	2.88		5.00	4.79	1,677	806	65	49
2024	10.500	5.00	3.07	0.728	3.64		0.00	0.00	0	0	40	29

(a) Total Charge	2,836
(b) Economic Premium	35,751
(c) Nominal Premium	50,000
(d) Implied Commission	28.50%

Calculations

(5) 1/(1+(4)/100)^(2)
(6) (3) x (5)
(7) 100 - Cumulative of (3)
(8) Sumproduct of future (3) and (5) divided by current (5)
(9) (8) x (c) x Expected loss Ratio of 70%
(10) Initial Value: (9) x Loss ratio of 123.1 (99.5th percentile) / Expected Loss Ratio of 70.0 x Diversification Benefit of 86.7% - (b)
(b) represents premium and therefore held unearned premium at time contract is written
Subsequent Values subtract Nominal Loss reserves held at each point in time = (7) x (c) x Expected loss Ratio of 70%
(11) Previous (10) x capital charge of 5%
(12) (11) x (5)
(a) Sum of (12)
(b) Solved iteratively such that it is equal to [(a) plus initial value of (9)]/(1-expense ratio of 2%]
(d) 1 - (b)/(c)

Appendix A

Exhibit 2

Return on Economic Capital Method - Aggregate Excess

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Calendar Year	Paid Duration	Paid Loss (%)	Duration Matched Rate (%)	Discount Factor To Time Zero	Disc. Percent Paid	Percent Outs.	Disc. Percent Outs.	Disc. Outs. Loss	Needed Capital	Capital Charge at 5.00%	Disc. Capital Charge
	-			1.000		100.00	89.48	3,876	10,466		
2014	0.500	-	0.10	1.000	-	100.00	89.52	3,878	13,573	258	258
2015	1.500	5.93	0.26	0.996	5.91	94.07	83.89	3,634	12,703	679	676
2016	2.500	8.25	0.58	0.986	8.13	85.81	76.53	3,315	11,589	635	626
2017	3.500	28.14	1.02	0.965	27.16	57.67	50.03	2,167	7,507	579	559
2018	4.500	2.48	1.51	0.935	2.32	55.19	49.16	2,129	7,441	375	351
2019	5.500	15.02	1.93	0.900	13.52	40.17	36.02	1,560	5,464	372	335
2020	6.500	14.11	2.28	0.864	12.19	26.06	23.43	1,015	3,557	273	236
2021	7.500	8.44	2.55	0.828	6.99	17.62	16.01	693	2,438	178	147
2022	8.500	4.36	2.75	0.794	3.47	13.26	12.32	534	1,890	122	97
2023	9.500	4.46	2.94	0.759	3.39	8.80	8.43	365	1,306	95	72
2024	10.500	8.80	3.07	0.728	6.40	0.00	0.00	0	0	65	47

(a) Total Charge	3,405
(b) Economic Premium	7,430
(c) Nominal Premium	100,000
(d) Rate	7.43%

Calculations

(5) 1/(1+(4)/100)^(2)

(6) (3) x (5)

(7) 100 - Cumulative of (3)

(8) Sumproduct of future (3) and (5) divided by current (5)

(9) (8) x Expected cost of Layer of 4.3% x (c)

(10) Initial Value: (9) x 20% of (c) (99.5th percentile) x initial value of (8)/100 - (b)
(b) represents premium and therefore held unearned premium at time contract is written
Subsequent Values subtract Nominal Loss reserves held at each point in time = 4.3% x (7)

(11) Previous (10) x capital charge of 5%

(12) (11) x (5)

(a) Sum of (12)

(b) Solved iteratively such that it is equal to [(a) plus initial value of (9)]/(1-expense ratio of 2%]

(d) (b)/(c)

Exhibit 3

Leverage Ratio Method - Quota Share

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Calendar Year	Paid Duration	Paid Loss (%)	Duration Matched Rate (%)	Discount Factor To Time Zero	Disc. Percent Paid	Percent Outs.	Disc. Percent Outs.	Disc. Outs. Loss	Needed Capital	Capital Charge at 5.00%	Disc. Capital Charge
	-			1.000		100.00	92.00	32,200	20,635		
2014	0.500	5.93	0.10	1.000	5.93	94.07	86.11	30,140	18,291	510	509
2015	1.500	8.25	0.26	0.996	8.22	85.81	78.15	27,351	16,686	915	911
2016	2.500	28.14	0.58	0.986	27.74	57.67	50.84	17,794	11,214	834	822
2017	3.500	2.48	1.02	0.965	2.39	55.19	49.45	17,306	10,732	561	541
2018	4.500	15.02	1.51	0.935	14.04	40.17	36.02	12,608	7,812	537	502
2019	5.500	14.11	1.93	0.900	12.71	26.06	23.29	8,152	5,068	391	352
2020	6.500	8.44	2.28	0.864	7.29	17.62	15.83	5,541	3,427	253	219
2021	7.500	4.36	2.55	0.828	3.61	13.26	12.16	4,255	2,578	171	142
2022	8.500	4.46	2.75	0.794	3.54	8.80	8.21	2,874	1,711	129	102
2023	9.500	3.80	2.94	0.759	2.88	5.00	4.79	1,677	972	86	65
2024	10.500	5.00	3.07	0.728	3.64	0.00	0.00	0	0	49	35

(a) Total Charge	4,201
(b) Economic Premium	37,144
(c) Nominal Premium	50,000
(d) Implied Commission	25.71%

Calculations

(5) 1/(1+(4)/100)^(2)

(6) (3) x (5)

(7) 100 - Cumulative of (3)

(8) Sumproduct of future (3) and (5) divided by current (5)

(9) (8) x (c) x Expected loss Ratio of 70%

(10) Initial Value: (b) / 1.8

(b) represents premium and therefore held unearned premium at time contract is written

Subsequent Values use Nominal Loss reserves held at each point in time = (7) x (c) x Expected loss Ratio of 70% / 1.8

(11) Previous (10) x capital charge of 5%

(12) (11) x (5)

(a) Sum of (12)

(b) Solved iteratively such that it is equal to [(a) plus initial value of (9)]/(1-expense ratio of 2%]

(d) 1 - (b)/(c)