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A Step by Step Guide to Designing Insurance Rating Models

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Introduction

The objective of this note is to present an introduction to the basic concepts of insurance rating and the fundamentals principles of benchmark rating.

In practice, there are two main methods of calculating insurance premiums:

1) **Benchmarking or exposure rating:** this typically occurs when the premium is calculated using a series of factors or a rating matrix where appropriate factors for each risk are selected based on information provided by the policyholder. These factors (also known as rating factors) would generally be the same for all risks with the same risk profile or characteristics.

   Benchmark rating (also known as exposure rating) could be done in two steps: the first step may be based on factual and objective information that generates a benchmark price, average price or automatically calculated price (note this may also be referred to as "model price"). This first step is a starting point in the rating process and may not require any underwriting, just data entry (input) and the result is the benchmark price or premium. The idea is that at this point the answer given by the rating model should be the same for everyone using the rating model.

   The second step is where the less objective characteristics or factors are looked at on a risk by risk basis. This is where underwriting takes place and where usually judgment, risk selection and risk appetite are considered. Factors that may be considered in this second step may include risk management, health and safety and prior claims experience to mention a few. In practice, this second step widely varies by class of business and it could be referred as underwriting debits and credits, loads and discounts, soft factors, etc. The resulting premium after allowing for these factors is the technical price.

   Factors considered in the technical price should be such that they are independent of market conditions, these should represent a view as objective as possible of the risk profile.

   The state of the market determines the market price for each risk. The market price should be compared to the technical price and a business decision is made as to whether the market price is acceptable relative to the technical price indicated by the rating model.

   One of the most important things in benchmark rating is to keep track of the benchmark or model premium, the technical premium and the market premium. Ultimately it is the market price that will determine the profitability of a portfolio, but knowing the technical and benchmark price will allow you to review the rating model over time.

2) **Experience rating:** in this case the premium is derived using claims experience (with various adjustments such as claims inflation) of the risk being priced and nothing else. In this case a loss cost rate per unit of exposure is derived and then loaded for expenses, commissions, risk load and profit margin.

   The focus of this note is to provide a step by step guide to designing consistent benchmarking models even when sufficient data are not available to derive the corresponding factors.

1 Basic Definitions

In principle, the price or premium for an insurance policy is no different to the price of any other product: the final price paid by the buyer includes production costs, distribution costs, commissions for sales and a profit margin.

The key difference between insurance pricing and any other product is that the final "production" cost (claims costs) of the product being sold (a promise to indemnity the policyholder in case of loss) is not known at the time of selling the product.

Insurance rates are calculated based on ***estimates*** of ***average*** future claim costs per policy or per unit of exposure (see definition below). Note two key words in this definition: estimates and averages. Estimates are just an indication of what is expected to happen; the true costs for policies written in a given year will be unknown until all claims are reported, settled and paid (which for some classes of business can take a long time). The true cost will be different to the estimated cost. Average cost per policy or per unit of exposure is usually calculated among risks and between years. Therefore, the average may never happen. Think of a situation where a risk has 2 out of 3 years with no claims a one year there is a claim for 120,000. The average cost for this policy is 40,000, but we have not had a year with claims worth 40,000.

This brings us to an important warning: in insurance rating it is important to keep a clear distinction between ***precision and accuracy***. Given some data or a rating model we can ***precisely*** (to as many decimal places as required) calculate the average cost per policy and the corresponding premium. However, we cannot ***accurately*** calculate the average cost per policy or per unit of exposure because the accuracy depending on knowing the exact cost of the product being sold, but in insurance this happens many years after the sale.

The life of a policy starts at the time of rating and once the premium is agreed you need to know what portion of that premium needs to be set aside to cover future claims. This proportion of premium is simply the loss ratio agreed within the insurance company for the year and for that class of business. If the loss ratio for 2010 has been agreed at 65%, then 65% of the premium for each policy will be set aside as a reserve for future claims.

When developing a benchmark rating model, you need to consider two main factors that impact average claim costs and therefore premiums:

1) Characteristics of the insured such as size, territory, type of business (if a company), risk profile and any other variable that has a relationship to the potential for claims.

2) Insurance product being sold: policy coverage, what "triggers" claims, coverage purchased and any exclusions.

Identifying relevant factors in 1) and 2) above is the first step towards understanding what variables should be included in the rating model.

Before we start discussion how to develop rating models, we need to introduce a few basic definitions:

Rating or risk variables: these are all the variables that have a relationship to potential for claims within a class of business. Each variable typically includes several categories or values and each category or value has associated a numeric rating factor that is used to calculate the benchmark premium.

For example, in homeowners insurance some of the risk variables may be: sum insured, location or postcode, type of property, size of property and type of occupancy. The sum insured can take any numeric value, whereas type of property may include the following categories: flat, terraced house, end of terrace, semi-detached, detached, etc. Each category will have associated a factor that will be applied in order to calculate the premium for a particular policyholder.

Exposure base: an exposure is the basic unit of risk to which the insurance rate applies. This could be any unit or measurement but ideally should be related to the loss potential for a given class of business. Among all the rating or risk variables we need to isolate the one that provides the highest relationship to: likelihood of claiming, frequency of claims and size of loss. The exposure base will vary by class of business. Some examples include:

- Motor insurance – Car/year
- Marine hull – ship/year
- Property – insured value or sum insurance
- Employer's liability – payroll
- General liability – turnover or sales
- Professional liability – fee income

Ideally, the chosen exposure unit or base should be:

- **Reasonable:** it should a reasonable proxy for expected losses
- **Easy to determine and verify:** if the ideal exposure base cannot be verified or is not provided by the policyholder then it is of no practical use.
- **Responsive to change:** an ideal exposure base should respond to changes such as inflation.

For each class of business, the exposure base used may not be the variable most related to claims experience, but historical use of such exposure base makes it difficult to change. For example, in products liability turnover or sales has been used as the exposure base. However, the number of products may be more related to the potential for claim than the price of the each product.

Exposure base is not the true underlying exposure to losses. This depends on many (usually unobservable) factors that interact with each other in a complex way.

Notation:

- E = number of units of exposure
- Claim (C): is a demand for payment due to an insured event
- Frequency (f): the number of claims per unit of exposure = $C \div E$
- Losses (L): are total insured losses across all claims

- LAE or cost: loss adjustment expense
  - ALAE (Allocated Loss Adjustment Expenses) are costs allocated to a specific claims
  - ULAE (Unallocated Loss Adjustment Expenses) are costs not allocated to a specific claim but part of general expenses
- Severity(S): average cost per claim = L÷C
- Pure premium (P) or loss cost or claim cost: insured loss per unit of exposure = L÷E

How are premium rates calculated?

In theory premium rates should be derived from claims experience and exposure information. In order to do this we require a few years of claims experience and exposure base. The first step in deriving premium rates (premium per unit of exposure) is to estimate the pure premium or loss cost rate or average claim cost per unit of exposure.

The pure premium is derived as the ratio of losses or claim costs divided by the number of exposure units. Experience rating techniques are used by actuaries in order to estimate pure premium or loss cost rates and this is outside the scope of this note.

As discussed earlier, the pure premium or loss cost rate is the equivalent of "production costs" in the price of any product. To go from pure premium or loss cost to a premium rate, we need to add commissions, expenses and profit in order to arrive at a premium rate. In addition to these components insurance premium rates may also include a risk or contingent load. This load is included in order to build a safety factor for when the actual claim cost is higher than the estimated claim cost.

In insurance rating all other loads are usually expressed as a percentage of the final premium rate. For example, commissions may be 15% of premium, expenses 10% and profit load may be 10%.

Notation:

P = pure premium or loss cost rate
V = variable expenses such as commission
F = fixed expenses such as overhead costs
Q = risk or contingency load
U = underwriting profit load

V, F, Q and U are expressed as a percentage of the final premium rate (R). Thus, the final premium rate must be such that is sufficient to cover all costs and loads:

$$R = P + V * R + F * R + Q * R + U * R$$

Alternatively, the premium rate after subtracting commissions, expenses, risk and profit load should be sufficient to cover claim costs

$$R - V * R - F * R - Q * R - U * R = P$$

Which is equivalent to

$$R * (1 - V - F - Q - U) = P$$

Finally, the premium rate is simply the pure premium or loss cost rate divided by 1 minus all costs included risks and profit loads:

$$R = \frac{P}{(1 - V - F - Q - U)}$$

Note: one of the most common pitfalls in practice when going from loss cost rate to premium rate is to load the loss cost rate for expenses, commissions and profit as R=P*(1+V+F+Q+U). This approach does not work because when the premium is calculated by loading, when we subtract all costs to the resulting premium, the result is not the loss cost is actually less than the loss cost. Thus, we would be left with less than we need to cover claims.

Exercise: assume loss cost is 100, commissions of 15% of premium, expenses 10%of premium, risk load 5% of premium and underwriting profit 10% of premium. Calculate the premium rate with both approaches: 1) grossing up the premium by (1-V-F-Q-U) and 2) loading by (1+V+F+Q+U). Compare your answers and calculate in each case how much is left when you subtract from each of the corresponding premiums commissions, expenses, risk and profit loads.

Another basic definition that plays an important role in rating is the ***expected*** loss ratio. This is simply defined as expected claims divided by premium. In this definition we use the word expected because remember that at the time of pricing, the pure premium or loss cost is simply an estimate of what we expect to happen.

$$Expected\ Loss\ Ratio = ELR = \frac{Loss\ cost}{Premium\ Rate} = \frac{P}{R}$$

Thus, to derive premium rates it is sufficient to know the pure premium or loss cost and the expected loss ratio. Why?

This brings us to the last basic definition.

Target or adequate loss ratio: Is the loss ratio supported by your desired level of underwriting profit load and used when deriving premium rates from loss experience. This could the plan loss ratio, a long/short term average loss ratio or simply what you are targeting for the following year.

For example, if your desired profit load is 10% of gross premium, 5% risk load, fixed expenses at 8% of gross premium, and 15% for commission and variable expenses, each unit of premium

leaves us with 100%-10%-5%-8%-15% = 62% to pay for losses and claims allocated expenses. This is the target loss ratio (T). In formula we have

$$T = 100\% - V - F - Q - U$$

In practice, we either decide what loss ratio we expect to write the business at or what level of underwriting profit we require. Having one of these figures the other one can easily be estimated.

Note that we already saw the target loss ratio formula above when deriving premium rates. We discussed above that the premium rate was simply the pure premium or loss cost rate divided by the factor (1-V-F-Q-U). Thus, premium rates are derived by dividing or grossing up the pure premium or loss cost rates by the target loss ratio. Rates that are derived using the target loss ratio are known as ***technical rates,*** and these were briefly mentioned in the introduction.

To summarise this section, in a benchmark rating model there is an implicit assumption that the technical premium calculated by the model, based on underwriter's input and judgment, will support a certain loss ratio and therefore a certain level of underwriting profit. However, the actual premium charged (market price), which may be different to the technical price, will determine the actual loss ratio for the portfolio.

2 Designing Benchmark Rating Models

Before we start to go over the steps and considerations of the design of a rating model, we need to understand what rating models are and what they are not.

Benchmark rating models are also known as rating plans, benchmark models, pricing tools or manual rates. Benchmark rating models do not necessarily relate to having an IT tool that produces all calculations and gives the final answer. You could have a perfectly consistent and actuarially sound rating model in paper or in a booklet, which has been the case until a few years ago. However, with new reporting requirements (internal and external), the impending arrival of Solvency II and the need for data, most rating models today have been implemented in an IT platform sometimes integrates with other internal systems.

What is a rating model?

A rating model should represent the structure and relationships (either actual or assumed) between all the risk variables and characteristics of the insured and how these risk variables relate to the potential for losses. Risk factors within a rating model simply represent (actual or assumed) differences in expected loss costs.

For example, in a motor insurance rating model there may a risk factor for gender, where male has a factor of 1.0 and female a factor of 0.75. These values actually mean that the base rate has been derived for male (thus a factor of 1.0) and that on average, female drivers have 25% lower loss cost than male.

The structure of the rating model includes a series of risk variables (numeric or categorical) and within each variable we have the possible values or categories that the variable can take. Within each risk variable, there will be a category with a factor of 1.0 (called the base category). When a rating model is constructed, only those risk variables that are believed to have a relationship to the loss potential should be considered for premium calculation purposes. There may other inputs that are recorded for data capture only but these may not affect the final premium.

For example, if motor insurance companies did not believe that the model and year of the car had any impact on the loss cost, they may still want to capture this information but this would not affect the price.

If we do not have any data to derive rates, how do we know which risk factors to include?
This is a common question. A consistent and sound rating model could still be put in place with no data. To start with, the rating model will reflect underwriters' ***assumptions and perceptions*** about the class of business based on their experience and judgment. At this point the rating model will be an assumption and the data capture together with the claims experience over time, will allow actuaries and underwriters to validate (or disprove) the assumptions made. Therefore, to start with, the real value of a rating model is to capture the relevant data to derive technical rates overtime.

The second key consideration needed when designing a rating model is the need for ***consistency***. A rating model is consistent if given a fixed set of inputs; every user gets the same answer up a certain point of the rating process. Consistency is required at least up to the point before the application of soft or underwriting factors.

Consistency will ensure that benchmark premiums have been calculated under the same assumptions for all risks within a portfolio. Consistency together with data capture will provide the required information to derive technical rates and to consistently monitor market rates against benchmarks.

2.1 Designing a rating model: steps and considerations

Benchmark rating models widely vary depending on the class of business. However, in the next pages we present a set of steps of considerations that will guide you in identifying those risk factors and variables that you may need to include in your rating model in order to achieve consistency. Remember that at the onset a rating model is simply an assumption and all assumptions are right until evidence proves otherwise.

2.1.1 Exposure base

The first step is to identify an appropriate exposure unit or exposure base for the class of business. In most classes of business the exposure base is chosen based on what has been used in the market for the class of business for many years.

In Section 1 we already mentioned some of the most commonly used exposure units by class of business. The idea is that a base premium for a base coverage will be calculated based on the number of exposure units for a given risk.

2.1.2 Base rates or base premium

The second step is to decide how the base premium will be calculated. There are several ways this can be done and it widely varies by class of business and company.

The following three questions will help you decide how the base premium should be calculated for your class of business.

1) Do losses increase with the size of insured?
2) If so, do they increase in the same proportion? For example, will an insured with twice the number of exposure units will have double the losses?
3) Or, are losses independent of size?

These questions allow us to decide what type of premium rate to apply to the exposure base:

- A flat percentage rate per unit of exposure
- A decreasing percentage rate as size increases (more premium but lower rate per exposure)
- Flat premium amount regardless of exposure size
- A decreasing premium per unit of exposure (sliding scale)

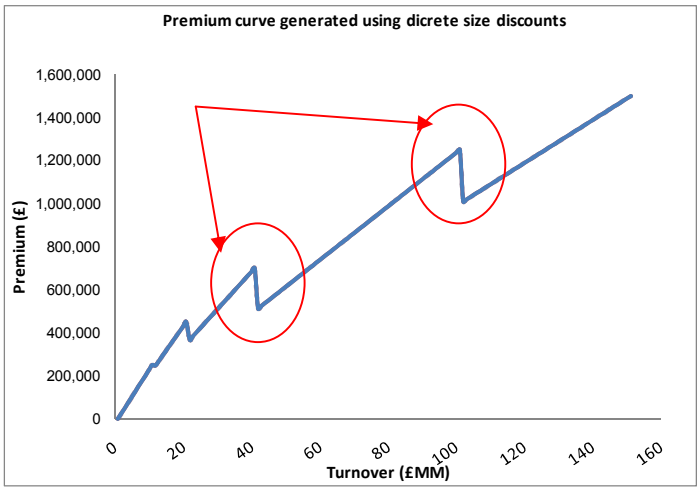
In a way what we are trying to decide here is whether size discounts should be considered for this class of business or not. One thing that is worth pointing is that we are not arguing whether size discounts are appropriate or not, but if they are used anywhere in the rating process, they should be applied consistently.

There is evidence in the market that some classes support a size discount, whether justified by claims experience for the class of business or by an imperfect marketplace. The issue with size discounts is that if not applied consistently and left at users' discretion it could have a significant impact in the technical premium calculation and in rate monitoring.

The example below shows a discount matrix that generates inconsistent premiums. Assume that the base rate is 2.5% of turnover, followed by the premium discounts given by the following discounts table.

Min Turnover	Max Turnover	Premium Discount
0	10,000,000	0%
10,000,001	20,000,000	10%
20,000,001	40,000,000	30%
40,000,001	100,000,000	50%
100,000,001	Unlimited	60%

It can be easily calculated that for turnover of £40MM the premium is 2.5%*40MM*0.7 = £700,000 while for £41MM the premium is £521,500. This chart below shows that when the turnover moves between bands, the premium is inconsistent.



A more consistent approach to including size discounts may be to have a lower rate per ***additional*** unit of exposure, which is also known as a sliding scale. With a sliding scale there is a decreasing rate per unit of exposure, which has an implicit assumption that while each additional unit of exposure increases the potential for losses, the potential for losses does not increase in the same proportion as the exposure base.

The following table is an example of a sliding scale. The sliding scale divides the exposure in bands. All risks with exposure size in the lowest band will pay the same premium, which in this case is £46,750. The price is then built up by looking at in which bands the exposure of the specific risk falls into. The premium is then calculated as the premium for the maximum exposure in the previous range plus the number of exposures in the range times the load per million in range.

For example, for a risk with £73MM of exposure, the base premium would be the premium up to £50MM = £138,275, plus 23 (number of exposures in the next range) times £900 (load per million in range) = £138,275+23*£900 = 158,975.

Sliding scale premiums

Exposure bands

Min in Range	Max in Range	Premium at max in range	Load per million in range
0	1,000,000	46,750	46,750.00
1,000,001	5,000,000	60,775	3,506.25
5,000,001	25,000,000	100,775	2,000.00
25,000,001	50,000,000	138,275	1,500.00
50,000,001	100,000,000	183,275	900.00
100,000,001	200,000,000	233,275	500.00
200,000,001	500,000,000	308,275	250.00
500,000,001	1,000,000,000	358,275	100.00
1,000,000,001	2,000,000,000	408,275	50.00
2,000,000,001	5,000,000,000	498,275	30.00
5,000,000,001	10,000,000,000	548,275	10.00
10,000,000,001	15,000,000,000	585,775	7.50
15,000,000,000	Unlimited		5.00

When size discounts are consistently applied the exposure growth factor between years is automatically calculated without the need for a subjective adjustment. For example, assume turnover was £150MM is 2009 and upon renewal in 2010 is £250MM. This is an increase in exposure base of 67%. If our rating model does not include size discounts, the market premium will need to increase by 67% in order to achieve a 0% rate change on renewal.

However, with the sliding scale the benchmark premium for 2009 was £183,275+50*£500 = £208,275, whereas the benchmark premium for 2010 would be £233,275+50*£250 = £245,775. The rating model implies an increase due to size of only 18% (245,775/208,275 -1 = 18%). Thus, the assumption of this rating model is that the increase in turnover of 67% only increases represents an increase in loss cost of 18%. Thus, with this assumption, the market premium will only need to increase by 18% (all other things equal) to achieve a 0% rate change on renewal.

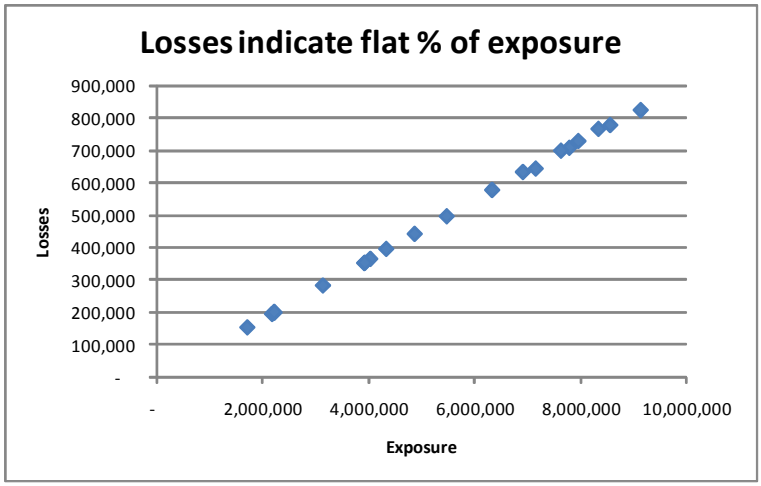
To summarise, when you decide how the base premium should be calculated you are making an ***assumption*** about the relationship between the exposure base and the potential for losses or loss cost differences by size.

If we had claims experience together with historical number of exposures, a simple analysis will indicate what type of base premium would be appropriate.
We start by expressing claims as a percentage of the exposure. We can then draw a graph of claims vs. exposure. If the chart looks like a straight line, this is an indication that claims increase in the same proportion of exposure and therefore a flat percentage rate per unit of exposure may be appropriate.

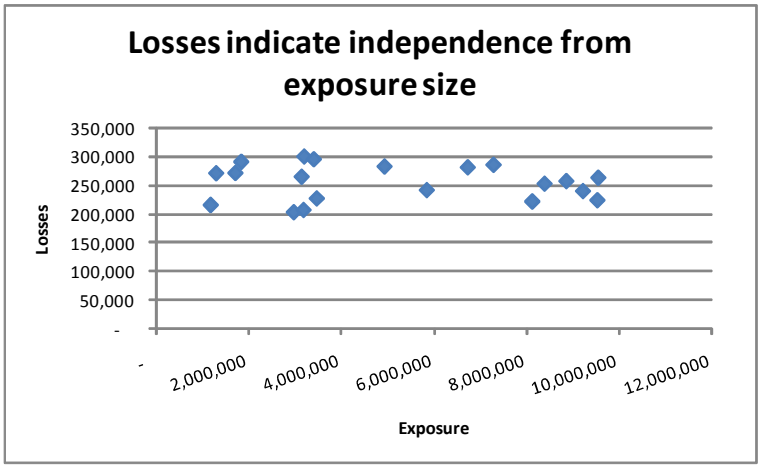
The three charts on the next page show the three cases:

1) Flat percentage rate per unit of exposure
2) Flat premium amount regardless of size
3) Decreasing rate with size (size discounts are appropriate)

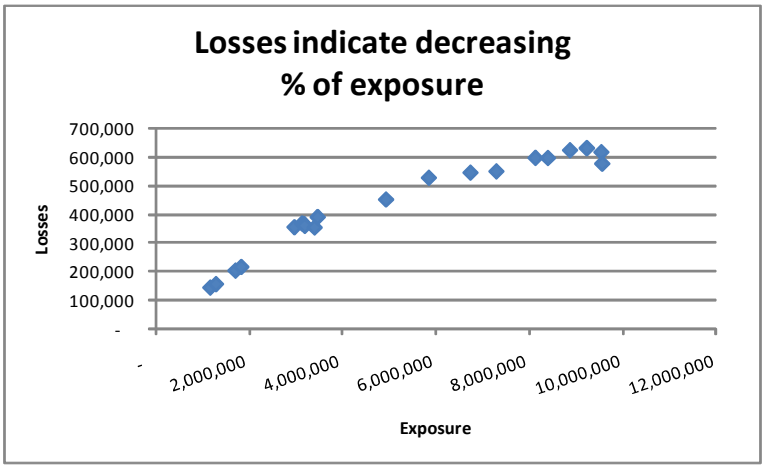
Exposure	Losses	LC Rate
6,899,550	632,554	9.17%
4,023,510	365,397	9.08%
7,776,697	706,905	9.09%
4,859,093	442,429	9.11%
2,169,952	195,688	9.02%
7,948,323	728,112	9.16%
5,464,041	496,367	9.08%
6,319,703	577,385	9.14%
9,122,277	822,919	9.02%
8,547,505	777,255	9.09%
3,909,052	352,537	9.02%
2,217,068	199,860	9.01%
7,142,137	643,256	9.01%
2,209,126	202,371	9.16%
3,919,577	353,285	9.01%
7,618,397	698,287	9.17%
1,702,435	154,718	9.09%
4,325,145	396,033	9.16%
3,130,437	283,350	9.05%
8,326,167	765,350	9.19%



Exposure	Losses	LC Rate
1,174,769	215,688	18.36%
1,294,389	270,398	20.89%
1,710,332	270,917	15.84%
1,837,304	290,110	15.79%
2,971,031	203,219	6.84%
3,138,798	264,287	8.42%
3,179,820	207,006	6.51%
3,194,282	299,304	9.37%
3,402,087	294,621	8.66%
3,468,225	226,822	6.54%
4,930,315	282,014	5.72%
5,844,285	241,369	4.13%
6,731,043	280,684	4.17%
7,286,229	284,892	3.91%
8,122,209	221,736	2.73%
8,387,485	252,463	3.01%
8,858,164	256,887	2.90%
9,219,118	239,697	2.60%
9,527,821	223,904	2.35%
9,547,986	262,570	2.75%



Exposure	Losses	LC Rate
1,174,769	146,846	12.50%
1,294,389	158,563	12.25%
1,710,332	205,753	12.03%
1,837,304	218,455	11.89%
2,971,031	356,524	12.00%
3,138,798	369,750	11.78%
3,179,820	367,587	11.56%
3,194,282	361,593	11.32%
3,402,087	355,518	10.45%
3,468,225	391,909	11.30%
4,930,315	453,201	9.19%
5,844,285	528,569	9.04%
6,731,043	546,561	8.12%
7,286,229	550,839	7.56%
8,122,209	597,795	7.36%
8,387,485	597,189	7.12%
8,858,164	624,501	7.05%
9,219,118	631,510	6.85%
9,527,821	617,403	6.48%
9,547,986	577,653	6.05%



Once you have decided what type of base rate or premium to use, you must then decide what this base rate or premium actually represents. In other words, what is the risk profile ***assumed*** in the base premium.

Some key questions you may consider in order to decide what this risk profile is:

1) What limit of coverage assumed in the base rate? This will depend on the class of business. For example, for motor insurance third party liability this will be unlimited. For other liability classes this may be 1MM limit and for property classes this may be the sum insured.
2) Have these base rates assumed a certain level of deductible or retention or are they 1st loss rates?
3) What is the base territory or country for these rates?
4) For each risk factor, what is the value of the factor assumed in the rates?
5) What is the base currency for these rates?
6) What is the expected level of risk management?
7) What is the expected level of financial strength?
8) What is the expected level of health and safety procedures?
9) What is the standard policy wording (coverage and exclusions) assumed in the rates?

Ultimately there should be at least one risk in the world represented by the base premium. The premium for any deviation in risk profile is calculated by applying the relevant factors for each rating category.

2.1.3 Risk variables and relativity factors

Once the risk profile for the base rate has been determined, each risk is priced relatively to the base risk. For example, if country is a risk variable and base rates are for the UK, according to the country factors below, the base premium for a risk in Spain will be 0.8 times the base premium for the UK.

Country	Country Rating Factor
France	1.150
Italy	1.250
Germany	1.450
Sweden	1.000
Norway	0.900
Greece	0.800
Spain	0.800
Netherlands	1.300
UK	1.000
Ireland	1.250

For each risk variable considered in the benchmark model, the rating factors for each possible value of the risk variable should represent loss cost differentials. For example, for the rating

variable country, the table above assumes that a risk in France has on average a 15% higher loss cost than a risk in the UK.

Exercise: what are the relevant rating variables you should consider in your class of business?

2.1.4 Pricing for higher/lower coverage

As discussed above the base rate has built in an assumption about the level of coverage which may be unlimited, limited by the sum insured or limited by the limit the policy holder chooses to purchase.

Broadly speaking there are two main ways of calculating the charge for higher/lower limits: exposure curves or increased limits factors.

In property insurance, the sum insured is the exposure base. Thus, rates are usually applied to the sum insured which also is the amount of coverage purchased. However, the policyholder may decide to buy a lower coverage because he/she is willing to retain some of the risk. Exposure curves allow you to calculate the premium for the coverage purchased relative to the sum of insured or the discount required for the amount retained.

Below is an example of an exposure curve:

% of exposure	% losses
10%	58.00%
20%	67.00%
30%	75.00%
40%	82.00%
50%	88.00%
60%	92.00%
70%	95.00%
80%	97.00%
90%	98.50%
100%	100.00%

The way to read this table is: at 10% of the exposure or sum insured we expect 58% of total losses. In property insurance it is assumed that loss distributions depend on the % of sum insured rather than the sum insured itself. For example, a loss of £10,000 on a £100,000 property is assumed to have the same likelihood that a loss of £100,000 on a £1MM property, provided the risk profiles are similar.

Therefore, if a policyholder is willing to retain the first 10% of the sum insured, according to the exposure table he will be retaining 58% of the expected losses and thus will receive a premium discount of 58%.

In liability insurance, the exposure base (turnover or payroll) is not a direct measure of the maximum loss potential. Therefore, in liability classes the policyholder decides how much insurance coverage to buy, the policy limit.

In this case the base rate or premium will assume a basic limit of coverage, for example £1MM. If the policyholder wants to increase this coverage an increased limit factor is applied to calculate the premium for the additional limit purchased.

Below is an example of a table of increased limits factors.

Limit	ILFs
1,000,000	1.00
2,000,000	1.75
3,000,000	2.35
4,000,000	2.90
5,000,000	3.25
6,000,000	3.50
7,000,000	3.70
8,000,000	3.90
9,000,000	4.05
10,000,000	4.20

For example, a policyholder buying a £5MM limit will page 3.25 times more than a policyholder buying a £1MM limits. As with all other factors, there is an assumption in the ILFs table that the additional £4MM have the potential for 225% more losses than the losses expected up to £1MM of coverage.

Consistent pricing for higher/lower limits is very important for monitoring of rates on renewal risks. For example, a policyholder that bought a £1MM policy and wishes to increase the limit to £2MM on renewal should see an increase in premium of 75% in order for the renewal to be considered at 0% rate change (all other things being equal).

2.1.5 Developing a multi-currency benchmark model

Inconsistent handling of currencies is perhaps one of the most common pitfalls found in benchmark models for international liability business. Currencies play an important role in the determination of size discounts and increased limits factors. A consistent rating model should assume that base rates are for a specific or base currency. Therefore, when risks are being priced in a different currency than that assumed in the base rate, all inputs should be converted to the base currency, the technical price calculated and then converted to the quoting currency.

The following exhibit shows a case where three risks in HKD are being priced, all of them have the same size HKD 775MM, the base rate is 1% of turnover and the increased limit factors are also given. Each risk is buying in a different currency, GBP 5MM, USD 10MM and EUR 7MM. Assume that at the time of rating 1GBP = 2 USD = 1.4 EUR. Note that all three risks are of the same size and are buying the same amount of coverage. Thus, we expect the model to give the same benchmark price in HKD.

If the rating model is “currency independent”, the applicable ILF for each risk would be different, thus generating a lower premium for the risk purchasing in GBP. If, on the other hand, we assume that the rating model is in GBP, all risks will be priced using the ILF for £5MM, 2.236, generating a consistent benchmark premium.

Base Rate	1%			Limit	ILF
Exposure Base	HKD 775,000,000			1,000,000	1.000
Base Currency	GBP			5,000,000	2.236
				7,000,000	2.646
				10,000,000	3.162

FX to GBP	1.00	2.00	1.40	
Quoting Currency	GBP	USD	EUR	
Exposure	£50,000,000	$100,000,000	€ 70,000,000	
Limit	£5,000,000	$10,000,000	€ 7,000,000	
Increased limit factor	2.236	3.162	2.646	← ILF vary by nominal limit
Premium Quoting Currency	£1,118,034	$3,162,278	€ 1,852,026	
Premium Original Currency	**HKD 17,329,527**	**HKD 24,507,652**	**HKD 20,504,573**	

Note: if currencies are not accounted for, there is a price advantage if a stronger currency is selected.

FX to GBP	1.00	2.00	1.40	
Quoting Currency	GBP	USD	EUR	
Exposure	£50,000,000	$100,000,000	€ 70,000,000	
Limit	£5,000,000	$10,000,000	€ 7,000,000	
Increased limit factor	2.236	2.236	2.236	← Same ILF for £5MM limit
Premium Quoting Currency	£1,118,034	$2,236,068	€ 1,565,248	
Premium Original Currency	**HKD 17,329,527**	**HKD 17,329,527**	**HKD 17,329,527**	

Note: when a base currency is selected, premium consistency is achieved.

A similar problem will occur when the base premium is calculated using size discounts. If the rating model does not have a currency associated to it, using a sliding scale similar to the one we used in Section 2.1.2, a risk in Norwegian Kroner may receive a deeper discount than a risk of equivalent size in GBP.

The issue of currencies is most relevant in liability insurance than in property insurance because in property insurance size discounts are not commonly used and exposure curves are independent of currencies.

2.1.6 Deductibles

The key question when considering deductibles is: are the base rates 1st loss rates or do they assume a certain level of deductible or retention? If they have built-in the assumption that there is a standard deductible, then the next decision is to determine what this deductible is and how it applies.

Ideally deductibles should vary by size of insured and perhaps by type of business and even territory. For some insureds a deductible of £5,000 may be adequate whereas for others it may be worthless.

Then, you must determine the load or discount if a different deductible is chosen. You must also decide how many steps below the standard deductible you are willing to offer the insured. The table below shows an example of a deductible matrix. It shows the suggested deductible with a factor of 1.0 because it is the one assumed in the base rate. In this matrix it is assumed that it is unacceptable to reduce the deductible more than two steps below the suggested deductible.

		Suggested					
		5,000	**7,500**	**10,000**	**15,000**	**25,000**	**50,000**
Selected	5,000	1.00	1.05	1.10	N/A	N/A	N/A
	7,500	0.95	1.00	1.05	1.10	N/A	N/A
	10,000	0.90	0.95	1.00	1.05	1.15	N/A
	15,000	0.85	0.90	0.95	1.00	1.10	1.30
	25,000	0.75	0.80	0.90	0.90	1.00	1.20
	50,000	0.65	0.75	0.75	0.80	0.85	1.00

As with all other rating variable, the load or discount given by the deductible factor includes an assumption about losses eliminated by the increased deductible or additional losses expected due to the lower deductible. For example, if the suggested deductible is 50,000 a selected deductible of 15,000 implies an increase in loss cost of 30%.

In some classes of business there may be many ways in which deductibles apply. This may make it difficult to build standard deductibles and factors in the rating model. However, the model may show a suggested deductible, the selected deductible and the deductible factor used by the user. Doing so would allow you to monitor the differences between suggested and selected together with the applied discount or load. Over time you may find consistent patterns in the data that would enable you to establish benchmark deductible factors.

2.1.7 Underwriting loads or discounts

Up until know we have discussed objective factors that may be considered in the benchmark model. We may say that until now we have discussed factors included in the benchmark pricing for which all users may see the same answer coming from the rating model.

You now need to determine what categories of “soft” factors need to be considered for your class of business. This are generally factors that need to be assessed risk by risk by someone with reasonable experience for the class or based on underwriting guidelines.

There are countless categories of soft factors that may be considered for each class. Some examples may include:

- Risk management
- Fire extinguishers and premises inspection
- Health and safety procedures
- US Exposure

- Jurisdiction (may be different than the country of domicile)
- Financial strength

While the applicable soft factors may be left at the discretion of each underwriter, there may be some underwriting guidelines in place to provide an indication of what may be considered better than average risk management. Remember that the base rate has an implicit assumption about the assumed level for each risk variable.

2.1.8 Minimum premiums and minimum rate per million

Minimum premiums and minimum rate per million of coverage are common in benchmark rating plans. Intuitively minimum premiums indicate that regardless of the size of the insured there are expenses and loss costs that need to be covered by the charged premium.

Minimum premiums usually apply for small risks and minimum rates per million apply for high limit and for excess policies.

Minimum premiums and rates per million are usually applied at the end of the rating process. The model will do all the rating and at the end compare the calculated premium against the minimum premium required and revert to the minimum premium if required.

For consistency, it is necessary to clearly understand what the assumptions behind minimum premiums are. For example, the rating model may be such that for all risks up to £250,000 of exposure the premium may be constant, say £1,500. Does this mean that a risk that grows from £100,000 to £150,000 does not necessarily increase the potential for losses? And if it does, why are we charging the same premium? It may be that the minimum premium has been assumed to be the premium for the largest risk in the minimum premium range and therefore we are already covering the growth within the range.

When it comes to minimum premiums and minimum rate per million the most important thing is to understand the assumptions underlying these minimum premiums as they play an important role for rate monitoring.

2.1.9 Commission or brokerage

Another important factor to consider is whether base rates are gross or net of commission. If they are net of commission, we need to adjust the final premium for commission. If they are gross of brokerage, you must decide what the standard level of commission assumed in the rates is. If the actual commission is different to that assumed in the rates, the final premium should be adjusted to reflect this.

There are two ways of adjusting premiums for commissions. If the company reports on net premium (as it is the case for Lloyd's companies), then internal expenses and profit load are often expressed as a % of premium net of commission. In this case, it is appropriate to gross up the premium as:

$$Final\ Premium = \frac{Model\ Premium * (1 - Assumed\ Brokerage)}{(1 - Actual\ Brokerage)}$$

If the company reports on premium gross of brokerage, expenses and profit load are expressed as % of gross premium. In this case the adjusted premium is:

$$Final\ Premium = \frac{Model\ Premium * (1 - U - Q - F - Assumed\ Brokerage)}{(1 - U - Q - F - Actual\ Brokerage)}$$

where U, Q and F are the underwriting profit load, contingency load and fixed expenses defined in Section 1.

The main point to keep in mind with commission is that if commission increases we need to adjust out technical price to reflect this, otherwise the additional commission will be taken from the profit load.

2.1.10 Terms and conditions

A rating model may assume a certain standard policy wording with certain terms and conditions. Ideally, each available endorsement should have pre-allocated a load and each non-standard exclusion should have a pre-allocated discount. By doing so, you would be removing all subjectivity in the allowance for terms and conditions in the rate monitoring. However, this may be cumbersome to implement in practice.

When the standard policy wording is reviewed and an additional coverage is provided or exclusion is removed as standard, there should be a standard and consistent allowance for this one off change in the rating model or in the rate monitoring process. There may be changes to the policy wording that do not generate extra premium but that could significantly impact the potential for claims.

Allowing for changes in terms and conditions continues to be the single most challenging and subjective item in the rating process.

2.1.11 Determining what factors are part of the technical price

As discussed in Section 1 the benchmark premium is the one calculated automatically with objective data input and the appropriate selection of rating factors. Between the benchmark price and the technical price are underwriting considerations that vary risk by risk but should not depend on market conditions.

For example if a discount is going to be given for risk management, assuming the level of risk management stays the same, will the discount be also given in a hard market? If the answer is yes, then risk management will be part of the technical price.

If after considering the soft factors the rating model produces a technical price of £100,000 but given the state of the market you can only charge £90,000 or will otherwise lose the risk to a

competitor, then the 10% discount should not be part of the technical price as it depends on the market and not the risk profile itself. However, the risk profile may be a consideration for you to decide whether you are willing to accept this risk at 10% below technical price.

2.2 Technical price and rate adequacy

We discussed above that the technical price included an assumption about the loss ratio supported by the rating model. Therefore, if all risks were priced at technical price we would expect the portfolio to run at the target loss ratio. However, the market price achieved is the one that determines the actual loss ratio.

True rate adequacy is defined in terms of loss ratio:

T = target loss ratio given a desired underwriting profit (used or assumed in rating model)

LR = achieved loss ratio (with market premium charged)

For a given set of policies, losses are random and independent of the premium charged. Therefore, if T = LR we say "market rates are adequate", if T > LR market rates are more than adequate and there is redundancy in the rates (if needed, market rates could be reduced and still make the desired profit) and if T < LR we say that market rates are inadequate, and we may need to increase market rates. For many classes of business we may not be able to assessed rate adequacy until many years later.

Nonetheless, comparing the market price with the technical price at the time of selling the policy would provide us an indication of where we expect the actual loss ratio to be relative to the target loss ratio. If all risks are sold at technical price we expect to achieve the target loss ratio. Otherwise the following relationship is expected:

If market premium is below/above technical price, we expect the loss ratio to be above/below the target loss ratio.

However, even if all risks are priced at technical price the actual loss ratio could be different than target due to the randomness of claims.

2.3 Exposure base vs. loss exposure

It is common practice that after a risk is rated and bound; underwriters assess the change in market rate for renewal risks. This change in rate usually requires an assessment of the change in exposure between the prior and current year relative to the change in market price.

We will conclude this note with a warning about what change in exposure is and how it can be measured using the benchmark rating model. There is a tendency to think that change in exposure means just the change in exposure base, for example sum insured. The change in exposure is part of the overall change in exposure.

The overall change in exposure relates to the change in risk profile that produces a change to the loss exposure. For example if the limit increases and the deductible decreases and there is an increase in exposure base, the increase in exposure is a combination of these three changes.

A benchmark rating model is useful to consistently measure the change in exposure. The change in exposure due to each risk variable should be calculated using the corresponding rating factors. For example, in the sliding scale example in Section 2.1.2 the change in turnover from £150MM to £250MM represented an 18% increase in exposure due to size. This is given by the rating model.

Consistently measuring the change in exposure for each risk factor with the rating model produces a consistent and objective measure of rate change for renewal risks as well as it allows us to include new business in the rate monitoring process.