STUDY NOTE ON DEDUCTIBLES

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Deductible clauses are common in property and casualty insurance policies. This study note illustrates some of the reasons for the rise in popularity of deductible policies and examines some considerations in pricing such policies, and outlines a basic illustration of pricing deductible policies.

With a deductible clause the insured is responsible for the first X dollars of each claim. For a first party coverage the insurer will pay the insured for the amount of loss in excess of the deductible, while for a third party liability policy the insurance company will pay the full loss amount and the insured will pay the insurer for the portion of the loss within the deductible layer. The deductible may apply only to losses or to the sum of losses and allocated loss adjustment expenses (ALAE).

Deductible clauses have historically been used for first party property coverage. For example, a personal automobile policy may exclude the first $250 of loss when the insured is at fault. One reason for the use of these relatively small deductibles is so that the insurer can avoid the expenses associated with processing and investigating claims for a small payment. It may cost more than $100 to investigate and process a $100 claim. Furthermore, most insureds can afford to pay a small deductible (it does not have a significant impact on the insured's financial condition).

The use of deductible provisions can also discourage the filing of small nuisance claims and frivolous claims. Thus, deductible policies can serve to control moral hazard. This is particularly true in the case of small deductible policies for auto physical damage.

Recently, deductible policies have been used more frequently for third party liability insurance and for workers' compensation coverage for large corporations. These corporations may retain the first $100,000 or more per claim while the insurers provide excess coverage.

The use of large deductible policies has increased dramatically during the last 5 to 10 years for the following reasons:

1. Insurance cost savings;
2. Loss control incentives;
3. Reduced residual market burdens; and
4. Cash flow advantages.

With a deductible policy the insured is responsible for paying:

- An excess insurance premium; and
- Claims in the deductible layer.

The insured will typically pay a fraction of the first dollar premium for an excess or high deductible policy and be responsible for claim payments within the deductible layer. Therefore, if the insured believes that it is a better risk than the average risk in insurers' rating classifications, then the insured may be able to reduce its overall insurance costs[1].

An insurer may encourage an insured with poor loss experience (especially poor loss frequency) to purchase a deductible policy. This would shift a portion of the loss frequency exposure from the insurer to the insured. Since the insured retains smaller losses, they have a direct incentive to control losses (particularly to reduce the number of losses).

Residual market cost savings has contributed to the popularity of deductible policies. In the late 1980's and early 1990's, many states had unprofitable workers' compensation assigned risk markets. Each carrier writing within the state shared in the assigned risk losses based on its premium volume. Shifting insureds from a first dollar policy to a large deductible policy reduced the insurer's premium volume and hence its share of the assigned risk losses.

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[1] For example, an insured may have recently instituted a loss control program which is expected to reduce losses. However, while insurers will eventually refine their pricing, they may not initially give the insured full credit for

Cash flow advantages to the insured have also contributed to the increased use of deductible policies. With a deductible policy, the insured is able to hold onto its "deductible" funds for a longer period of time. Instead of paying for first dollar insurance coverage on the first day of the policy period, a relatively small premium is paid for the excess policy and losses within the deductible layer are paid as claims are settled. Therefore, the insured can invest a portion of the money it would have paid for its first dollar policy. If the insured is able to earn a substantial return on the invested funds (relative to the rate used by an insurer to discount premiums), the insured may be better off retaining its deductible claims.

PRICING DEDUCTIBLE POLICIES - CONSIDERATIONS

While the focus of this section will be pricing a large deductible policy, the methodology could also be used to price a small deductible policy (e.g., first party property policy). Additionally, we discuss pricing small deductible policies on pages 15-18.

We will start out with some assumptions for a first dollar policy:

Table 1		
Standard Premium	=	$1,000,000
Expected Loss Ratio	=	68%
ALAE (% Loss)	=	12%
Commission (% Premium)	=	5%
Other Variable Expenses (% Premium)	=	12%
Fixed Expenses	=	$50,000

the loss control plan. With a deductible policy, the insured is anticipating that the program will be effective and it will save money.

With the above assumptions, the underwriting income to the insurer for this policy, excluding investment income, is:

Table 2		
1)	Premium	$1,000,000
2)	Losses	(680,000)
3)	ALAE	(81,600)
4)	Commission	(50,000)
5)	Variable Expenses	(120,000)
6)	Fixed Expenses	(50,000)
7)	Underwriting Income[2]	$18,400

The above example in table 2 does not recognize the effect of investment income. If we were to reflect investment income, the "expected" net present value of the cash inflows to the insurer would exceed the underwriting income. That is because the premium is collected in the year the policy is issued while the losses will be paid out over an extended period of time. Therefore the insurer earns investment returns on the premium (net of up-front expenses), which is assumed to be invested when collected.

When pricing a deductible policy the insurer must analyze each cost element to ascertain the impact of the deductible. Therefore, when evaluating the price to charge for a deductible policy we have the following considerations:

- How will the deductible affect the insurer's net losses;
- How will the deductible affect ALAE costs;
- How are expenses affected;

- Should a larger relative profit/risk margin be charged for the deductible policy;
- Some insureds will not be able to reimburse the insurer for deductible losses (e.g., due to bankruptcy). Remember that the insurer is responsible for paying third party claimants and seeking reimbursement from the insured; and
- If the insurer prices based on a discounted cash flow model, how will a deductible policy affect the cash flows?

PRICING DEDUCTIBLE POLICIES - EXAMPLE

We will focus on pricing a $100,000 policy deductible. The following sections discuss how each first dollar cost element could be adjusted to price a $100,000 deductible[3].

Loss

A loss distribution depicts the probability of a loss of a given size and the probability of a loss being above or below a certain loss size. A loss distribution can be used to compute the expected percentage of total losses excess of a certain dollar threshold or the expected losses excess of the deductible amount.

Let the function f(x) represent the loss frequency for losses of size x, then:

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[2] (1) – (2 + 3 + 4 + 5 + 6)

[3] The illustration depicts one way to reflect deductible provisions in pricing policies. However, there are other ways to price such policies.

$$\int_0^\infty f(x) = 1$$

$$\int_0^\infty x\, f(x) = \text{expected size of loss}$$

The percentage of ground-up losses excess of deductible (D) is called the excess ratio (at D) and can be calculated using either of the following formulas:

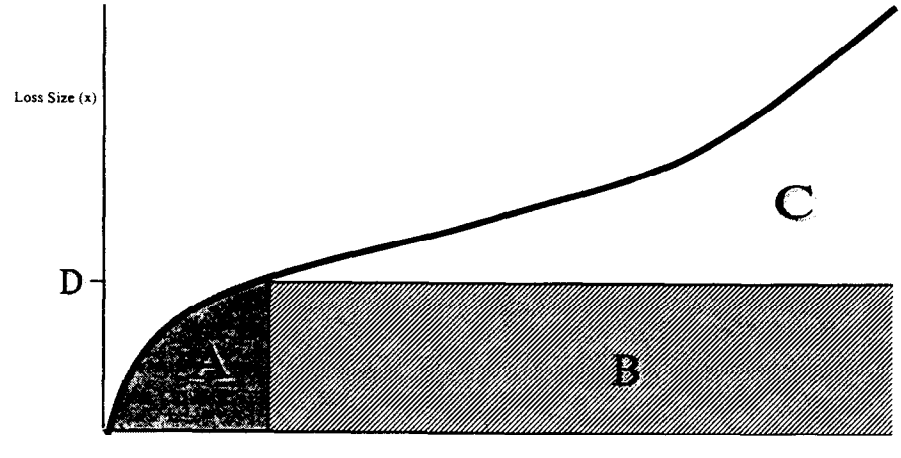
1) $$\frac{\int_D^\infty (x-D)f(x)dx}{\int_0^\infty x\, f(x)dx;}$$

or;

2) $$\frac{\int_0^\infty x\, f(x)dx - [\int_0^D x\, f(x)dx + D\int_D^\infty f(x)dx]}{\int_0^\infty x\, f(x)dx}$$

The following figure is a graphical depiction of formula (2):

Figure 1
Excess Ratio at D
Graphical Depiction



F(x) = Cumulative Claim Frequency

Formula 2 = $\frac{(A+B+C) - [A+B]}{A+B+C} = \frac{C}{A+B+C}$

This concept may be easier to follow with a simple discrete example. Assume our claim universe consists of the following:

Table 4		
(1) **Frequency of Claims**	**(2)** **Dollar Amount**	**(3)** **(1) x (2)**
50.0%	$1,000	$500
25.0	5,000	1,250
12.0	15,000	1,800
5.0	50,000	2,500
5.0	100,000	5,000
2.0	200,000	4,000
0.8	500,000	4,000
0.2	1,000,000	2,000
100%	**Average**	**$21,050**

In Table 4 the average loss (across all outcomes) is $21,050 or the sum of (1) x (2).

One interesting phenomenon with third party casualty losses is that the very large losses have a dramatic impact on the overall average severity. As seen in the example in table 4 above, the 0.8% probability of a loss at $500,000 adds $4,000 to the average severity while the 50% of claims at $1,000 only adds $500.

Assume we want to compute an excess ratio at deductibles of $100,000; $200,000; $300,000 and $500,000. An excess ratio is the proportion of losses excess of a specific dollar amount relative to the total losses. Using the discrete counterpart of the first formula above, we can calculate the excess ratio at 100,000 as:

$$\frac{.02\,(200{,}000 - 100{,}000) + .008\,(500{,}000 - 100{,}000) + 0.002\,(1{,}000{,}000 - 100{,}000)}{21{,}050}$$

or;

$$\frac{2{,}000 + 3{,}200 + 1{,}800}{21{,}050} = 33.3\%$$

Therefore, we would expect that one-third of the ground-up losses represent losses excess of $100,000 per claim. The excess ratios for other loss limits can be calculated similarly and are displayed in the following table:

Table 5

Loss Limit	Excess Ratio
$100,000	33.3%
200,000	19.0
300,000	14.3
500,000	4.8

Assuming we are pricing a $100,000 deductible policy, our estimate of losses excess of the deductible can be calculated as follows in table 6:

Table 6

A) First Dollar Premium	$1,000,000
B) Ground-up expected loss Ratio	.68
C) Excess Ratio	.333
D) Expected Losses Excess of Deductible = A x B x C	$226,440

Alae

Sometimes ALAE is included with losses and the sum of loss and ALAE is subject to the deductible. Other times the deductible applies to losses and ALAE is the responsibility of the insurer.

If loss and ALAE are subject to the deductible then the calculations in the previous section should be completed with the sum of loss and ALAE instead of losses only. Therefore, the size of loss distribution should be constructed based on the sum of loss and ALAE. The excess ratio then applies to the expected ground-up loss and ALAE which in this example would be:

Table 7	
1) Full Coverage Premium	1,000,000
2) Loss Ratio	68%
3) Expected Losses (1) x (2)	680,000
4) ALAE ratio (% Loss)	12%
5) ALAE (3) x (4)	81,600
6) Ground-up Loss & ALAE (3) + (5)	761,600

However, when ALAE is fully covered by insurance and not subject to a deductible, the ALAE provision in the deductible premium is the same as the ALAE provision in the full coverage premium.

In this example we are assuming that the deductible applies to losses only. Therefore, the use of a deductible is not expected to reduce ALAE costs. In pricing a $100,000 deductible policy for our example, the full ALAE load of $81,600 is included.

Commission and Other Variable Expenses

If these expenses vary directly with premium, then these expenses can be incorporated by dividing the sum of the other provisions by one minus the commission and variable expense loading. An example is displayed at the end of this section. Additionally, due to the fact that agents usually provide the same or sometimes more services with a large deductible policy, agents commission may be a flat dollar amount (and treated as a fixed expense) or sometimes the insured pays the agent's commission directly (and therefore a specific provision is not included in the insurance premium).

Fixed Expenses

With a third party deductible policy, the fixed expense component is likely to increase due to the increased administration expense required for deductible policies[4]. With a deductible policy the insurance company has to essentially perform all the work it does with a first dollar policy plus:

- send bills to insureds for deductible payments;
- monitor payment of deductibles; and
- in some cases, pursue collection of deductible funds through a collection agency or lawsuit.

[4] In contrast, for a first party deductible policy, the fixed expenses will typically be reduced as the insured is responsible for paying claims below the deductible.

For our example, we will assume that the incremental expenses are equal to 5% of the funds in the deductible layer. Thus, the incremental fixed costs are calculated in table 8 as follows:

Table 8	
1) Full Coverage Premium	1,000,000
2) Loss Ratio	0.68
3) Excess Ratio	0.333
4) Losses in deductible Layer (1) x (2) x [(1) - (3)]	453,560
5) Cost of processing deductibles	0.05
6) Incremental fixed costs (4) x (5)	22,678

Additionally, this example assumes a $50,000 fixed expense component for the risk being priced (regardless of the deductible level chosen). Therefore a total fixed provision of $72,678 is included in pricing a $100,000 deductible policy.

Risk Margin

With a deductible policy, the insurer is providing coverage for the less predictable losses with a larger random component. Therefore, the insurer may want to include a specific incremental risk margin. Although the calculation of risk margins is outside the scope of this study note, we will assume for discussion purposes that the insurer wishes to include an additional risk margin of 10% of excess losses. For our example, a $100,000 deductible, the additional risk margin equals $22,644 (.10 x $226,440).

Profit Provision

The full coverage policy generates an $18,000 underwriting profit. This represents 1.8% of the full coverage premium. While the proper treatment of profit in a rate is beyond the scope of this study note, we will assume that the insurer's profit goal is an underwriting profit of 1.8% of premium. We can then include an additional variable provision of 1.8% in determining the deductible premiums.

Uncollectible Deductible Funds

An additional risk associated with deductible policies is the uncollectability of deductible payments. This occurs when the insurer makes a payment and seeks reimbursement from the insured. However, the insured is not able or willing to reimburse the insurer. The uncollectability of these funds will negatively affect the profitability of the insurer.

Often, insurers receive collateral for potentially uncollectible deductible funds; however, it would be rare for the insurer to collaterize all potential deductible payments. To include a loading for uncollectible deductible payments, we will assume the insurer uses a loading of 1.0% of the expected deductible payments. Therefore, the loading for uncollectible deductible payments is calculated in table 9 as follows:

Table 9	
1) Losses in Deductible Layer	453,560
2) Uncollectible Loading	.01
3) Uncollectible Provision	4,536

This item can also be treated as a fixed expense component.

Final Premium

The final premium at a $100,000 deductible can be computed as follows based on the provisions discussed in the sections above:

Table 10

Item	Amount
1. Losses above deductible	$226,440
2. ALAE[1)]	81,600
3. Fixed Expenses	
a) original	50,000
b) additional provision	22,678
4. Incremental Risk Margin	22,644
5. Uncollectible Deductible Funds	4,536
6. Subtotal (sum of 1 through 5)	407,898
7. Variable Expenses	
a) commission[2)]	0.0%
b) profit	1.8%
c) other	12.0%
8. Final Premium (6) ÷(1-7a-7b-7c)	$473,200

[1)] Assuming deductible only applies to loss
[2)] Assuming insured pays commission

FIRST PARTY PROPERTY POLICIES (SMALL DEDUCTIBLES)

As we discussed, the same general methodology used to price large deductibles can also be used to price small deductibles. However, small deductibles involve several additional considerations.

Cost Considerations

Many first party coverages include a significant number of small claims (e.g., minor fender benders in automobile insurance). The cost to investigate these losses is often prohibitive since the cost to investigate the claims can be greater than the loss payment. Therefore, most first party policies include deductibles of between $50 and $500[5].

Data Limitations

One difficulty associated with pricing small deductible policies is that the loss information associated with claims below the deductible is frequently unavailable. For these claims, the insured typically pays for the repairs and never reports any information to the insurer. The exclusion of these small claims presents a complication in constructing size of loss distributions. However, this limitation maybe overcome by:

- Performing an extrapolation based on full coverage loss experience; or

[5] The $50 to $500 charge is common for personal lines. Commercial lines coverage will have higher deductibles.

- Fitting a size of loss distribution based on the loss experience excess of the deductibles.[6]

Once the limitations are overcome, the methodology for large deductibles can be used to price small deductible policies.

Risk Characteristics

One complicating factor in pricing deductible policies is that different types of risks purchase different levels of deductibles. As Mr. Gillam and Mr. Frane state in their review of Mr. Bickerstaff's paper "...The people who purchase $50 deductible coverage are a completely different set of people than those who purchase $100 deductible coverage (see list)". This statement does not bias the approach outlined above unless the different set of people generate claims with different size of loss distributions[7]. If different risks generate claims with different size of loss distributions, then different distributions should be constructed when pricing the deductible policies[8]

Different Approach

Sometimes pricing small deductible policies includes slight modifications:

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[6] See Bickerstaff's paper in the list of related readings at the end of this study note.
[7] However, individual claims must be appropriately adjusted in determining the size of loss distribution.
[8] A discussion of how to construct different size of loss distributions from one data source is outside the scope of this study note.

1. Separate experience by deductible is analyzed and rates are established by deductible based on analyzing this experience; and
2. The data is sometimes arranged differently and the above outlined calculations on pages seven through nine modified (even though the mathematics is identical).

Regarding the first point from above, a substantial amount of data must be available in order to establish separate rates by deductible. Therefore, this approach will only be feasible for large insurers.

Regarding the second point, instead of calculating an excess ratio as described on pages seven through nine, some actuaries modify the calculations slightly by grouping the data differently as displayed below in table 11 for a $100 deductible.

Table 11

Actual Experience[9]

Loss Limit	Number of Losses	Total Amount
$100 and Below	N_1	L_1
Over $100	N_2	L_2
Total	$n_1 + n_2$	$L_1 + L_2$

Then a loss elimination ratio (or LER) is defined as the percentage of losses eliminated due to a specific deductible. The excess ratio defined on pages seven through nine is equal to 1-LER.

[9] Reprinted from casualty contingencies (exposure draft) Chapter 13 "Deductibles, Excess Coverage, and Coinsurance Clauses" (as a note, the losses should be fully developed and adjusted to current terms).

The LER at a $100 deductible is equal to:

$$\frac{L_1 + 100\, n_2}{L_1 + L_2}$$

The pure premium excess of a certain deductible is then determined by multiplying the ground-up pure premium by (1 - LER). This calculation is mathematically equivalent to multiplying by the excess ratio (as described in table 6 on page 9)[10].

[10] See Page 7, the excess ratio =

$$\frac{\int_0^\infty (x - D)\, f(x)\, dx}{\int_D^\infty x\, f(x) dx}$$

By adding and subtracting $\left[\int_0^\infty x\, f(x) dx\right]$ to the numerator, the following is derived:

$$= \frac{\int_0^\infty x\, f(x) dx - \left[\int_0^D x\, f(x) dx + D \int_D^\infty f(x) dx\right]}{\int_0^\infty x\, f(x) dx}$$

$$= 1 - \left[\frac{\int_0^D x\, f(x) dx + D \int_D^\infty f(x) dx}{\int_0^\infty x\, f(x) dx}\right]$$

This continuous case is analogous to the followig discrete formula (where D = 100):

$$1.0 - \left[\frac{L1 + 100\, n_2}{L1 + L2}\right]$$

OTHER CONSIDERATIONS

Loss Distributions

For the purposes of this paper, we used a single discrete size of loss distribution. There are many potential distributions that can be used to model insurance losses. The actuarial literature contains many papers describing loss distributions and methods used to fit the distributions to insurance losses[11].

Interaction Between Loss Experience and Deductible

Some believe that insureds with the lowest loss potential will choose large deductible policies. Therefore, the insureds will save money as deductible losses will be less than anticipated. In pricing deductible policies, it is important to reflect any loss potential differences by insured.

If the insurer's better risks move from first dollar to large deductible policies, then:

- for the insureds remaining at a first dollar policy the expected loss ratio will be higher and rates may need to be increased; and

- the large deductible insureds may have a lower than average expected loss ratio and therefore rate credits may be warranted.

[11] For example, see the list of related readings at the end of this study note.

CONCLUSION

The concepts illustrated in this study note provide a basic introduction to deductible pricing. Deductible clauses are common in property and casualty policies and it is important for actuaries to understand the reasons for their popularity and their effect on the rate-making process.

List of Related Readings

1. Loss Distributions; Hogg and Klugman;

2. "Excess of Loss Pricing on the Theory of Increased Limits"; Miccolis, Roberts.

   PCAS LXIV, 27;

3. "Fundamentals of Individual Risk Rating"; Gillam, W.R. and Snader, R.H.

4. "Estimating Pure Premiums by Layer"; Finger, Robert J.

5. "Retrospective Rating: Excess Loss Factors"; Gillam, W.R.

6. "Lognormal Model, Automobile Collision Deductibles and Repair Cost Groups"; Bickerstaff, David R.; PCAS LIX, 68.

   - Discussion by Gillam, William S., PCAS LIX, 103
   - Discussion by Frame, Daniel P., PCAS LIX, 103
   - Discussion by Sawyer, J. Stewart III, PCAS LIX, 106

- Discussion by Nelson, Dale A., PCAS LIX, 109

7. "A Practical Guide to the Single Parameter Pareto Distribution"; Philbrick, Stephen W., PCAS LXXII, 44

8. "Estimating Casualty Insurance Loss Amount Distributions"; Patrick, Gary S., PCAS LXVII, 57.