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THE "MODIFIED BORNHUETTER-FERGUSON" APPROACH TO IBNR ALLOCATION

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Abstract

This paper presents a "Modified Bornhuetter-Ferguson" approach to allocating IBNR. Essentially, this approach involves a credibility-weighted average of the earned premium and case-incurred loss (or loss adjustment expense) allocation bases. This combined allocation provides a more reasonable and stable result than methods based solely on either earned premium or case-incurred loss. Moreover, the method is easy to automate, explainable in intuitive terms, and does not require the use of an "off-balance" adjustment factor.

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1. INTRODUCTION

In property/casualty loss reserving, the definition of the relevant groupings (or "reserve segments") results from a trade-off between the conflicting goals of obtaining homogenous groupings and achieving a sufficient volume of data. For instance, the Casualty Actuarial Society's *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves* [2] states the following:

> Credibility is a measure of the predictive value that the actuary attaches to a body of data. The degree to which consideration is given to homogeneity is related to the consideration of credibility. Credibility is increased by making groupings more homogenous or by increasing the number of claims analyzed within each group. A group of claims should be large enough to be statistically reliable. Obtaining homogenous groupings requires refinement and partitioning of the total database. There is a point at which partitioning divides data into cells too small to provide credible development patterns. Each situation requires a balancing of the homogeneity and amount of data in each grouping.

In consideration of this principle, reserving actuaries often combine many accounts, programs, and/or Annual Statement lines of business into a single reserve segment. By doing so, the reserving actuary is able to achieve a proper combination of volume and homogeneity. These reserve segment definitions are then utilized to produce a reasonable estimate of the incurred but not reported (IBNR) loss and allocated loss adjustment expense.

These resulting IBNR estimates, however, may need to be allocated down to a more detailed level. For instance, the Annual Statement may require IBNR estimates at a finer level of detail than the reserve segment definitions. In addition, company management may require accident year results (including IBNR) at the individual program or account level in order to properly

manage the business. These accident year results by program or account can then be compared with the corresponding estimates produced by the company pricing actuaries. This comparison between reserving and pricing can serve as a useful process of "checks and balances" within the actuarial department.

Actuaries should be aware, however, of the possible pitfalls of allocating IBNR down to an extremely fine level of detail. For instance, such allocations may incorrectly imply a degree of precision that does not exist. The actuary must be aware of this risk and communicate any related concerns to the end user.

Given that such a breakdown is appropriate, there are two common—and simple—methods for allocating IBNR: the earned premium method and the case-incurred loss method. Both of these methods are subject to serious weaknesses. For instance, the earned premium method essentially allocates IBNR for each reserve segment and accident year in proportion to the calendar year earned premium for each program or account. This method ignores the fact that certain programs may have experienced a much greater claim frequency, paid loss ratio, and case-incurred loss ratio, and thereby merit a larger proportion of the indicated IBNR. On the other hand, the case-incurred loss ratio method allocates IBNR in proportion to the underlying case-incurred loss (or ALAE) amount. Essentially, this method is equivalent to applying an identical cumulative loss development factor to the case-incurred losses for each component program or account. Unfortunately, this method often results in very unstable and unreliable allocations, especially for recent accident years and long-tailed reserve segments.

The following section describes the "Modified Bornhuetter-Ferguson"[1] allocation method, which provides a simple alternative to the earned premium and case-incurred methods.

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[1]The original Bornhuetter-Ferguson methodology [1] pertained to the establishment of reserves for an entire reserve segment. From this point forward, we will abbreviate "Bornhuetter-Ferguson" as "BF."

2. THE MODIFIED BF ALLOCATION

The Modified BF method essentially offers a compromise between allocating by earned premium and allocating by case-incurred loss or ALAE. The relative weights assigned to each of the two methods vary by accident year. For the most recent accident year, most (but not all) of the weight will be given to the earned premium allocation. As an accident year matures, more weight is assigned to the case-incurred allocation.

This section describes the method by means of a specific reserving example. Let's assume that the reserve review has been completed for a given reserve segment. The results of this hypothetical review are shown in Table 1.

In this table, let's assume that the projected ultimate loss amounts (and the corresponding selected loss IBNR) have been determined by some reasonable loss reserving methodology. The specific methodology utilized is not relevant to the IBNR allocation procedure. The table only displays projections for the latest three accident years; the Modified BF procedure, however, will work for any desired number of years.

In addition, let's assume that this reserve segment is comprised of three specific programs. Table 2 provides the breakdown of earned premium and case-incurred loss by program, for each of the three calendar/accident years.

The first step in the Modified BF procedure is to allocate the IBNR in proportion to the calendar year earned premium for each program. Table 3 displays the results of this calculation.

The second step involves allocating the IBNR in proportion to the case-incurred loss amount for each program,[2] as shown in

[2]For lines of business that are subject to very large claims, or "shock losses," the actuary may choose to utilize limited (for example, "basic limits") losses for the case-incurred allocation.

TABLE 1

Calendar/ Accident Year	Earned Premium	Cumulative Case-Incurred Losses	Projected Ultimate Losses	Loss IBNR	Projected Ultimate Loss Ratio
2000	1,200	700	900	200	75.0%
2001	1,200	650	900	250	75.0%
2002	1,200	200	900	700	75.0%

TABLE 2

Calendar/ Accident Year	Program	Earned Premium	Cumulative Case-Incurred Losses
2000	A	500	400
2000	B	400	200
2000	C	300	100
2001	A	500	350
2001	B	400	200
2001	C	300	100
2002	A	500	185
2002	B	400	10
2002	C	300	5

TABLE 3

Calendar/ Accident Year	Program	Earned Premium	Pro Rata Earned Premium	Allocated IBNR
2000	A	500	0.417	83.33
2000	B	400	0.333	66.67
2000	C	300	0.250	50.00
2001	A	500	0.417	104.17
2001	B	400	0.333	83.33
2001	C	300	0.250	62.50
2002	A	500	0.417	291.67
2002	B	400	0.333	233.33
2002	C	300	0.250	175.00

TABLE 4

Calendar/ Accident Year	Program	Cumulative Case-Incurred Losses	Pro Rata Case-Incurred Losses	Allocated IBNR
2000	A	400	0.571	114.29
2000	B	200	0.286	57.14
2000	C	100	0.143	28.57
2001	A	350	0.538	134.62
2001	B	200	0.308	76.92
2001	C	100	0.154	38.46
2002	A	185	0.925	647.50
2002	B	10	0.050	35.00
2002	C	5	0.025	17.50

Table 4. For very immature accident years, claims may emerge sporadically, and allocating IBNR according to case-incurred losses will generally produce very unreliable and unstable results. Yet, we don't want to completely ignore the information contained in early case-incurred loss tallies. On the other hand, for older accident years, case-incurred loss ratios tend to provide a more accurate indication of the relative profitability of the underlying programs. Even so, we still may want to "smooth out" the projected ultimate loss ratios to some degree by considering an earned premium allocation.

In order to determine the proper weighting between the earned premium and case-incurred allocations, the Modified BF approach calculates an "implied loss development factor (LDF)" for each accident year. This implied LDF serves as a proxy for the maturity of the accident year, and is simply defined as the ratio of projected ultimate losses to case-incurred losses. As an alternative, we could select the LDF for each accident year by examining the underlying case-incurred loss triangle, making link ratio selections, then taking the product of the relevant link ratios—just like in traditional chain-ladder reserving methods.

TABLE 5

Calendar/ Accident Year	Cumulative Case-Incurred Losses	Projected Ultimate Losses	Implied LDF	Weight to Case-Incurred Method	Weight to Premium Method
2000	700	900	1.286	0.778	0.222
2001	650	900	1.385	0.722	0.278
2002	200	900	4.500	0.222	0.778

TABLE 6

Calendar/ Accident Year	Program	Case-Incurred Based Allocation	Premium Based Allocation	Weighted Average Allocation
2000	A	114.29	83.33	107.41
2000	B	57.14	66.67	59.26
2000	C	28.57	50.00	33.33
2001	A	134.62	104.17	126.16
2001	B	76.92	83.33	78.70
2001	C	38.46	62.50	45.14
2002	A	647.50	291.67	370.74
2002	B	35.00	233.33	189.26
2002	C	17.50	175.00	140.00

The advantages of the implied LDF calculation are that it is easy to automate and that it reflects the method actually utilized to select the ultimate losses (which may be much different from the case-incurred chain-ladder method).

For each accident year, the weight given to the case-incurred allocation is equal to the reciprocal of the implied LDF; the weight given to the earned premium allocation is then equal to the complement (relative to unity) of the case-incurred weight. In this manner, the weights are assigned according to the traditional Bornhuetter-Ferguson formula (subject to the implied LDF), which provides the rationale for describing the method as a Modified BF approach. Using the data in our example,

TABLE 7

SUMMARY

Program	Calendar/ Accident Year	Earned Premium	Cumulative Case-Incurred Losses	Projected Ultimate Losses	Projected Ultimate Loss Ratio
A	2000	500	400	507	101.5%
	2001	500	350	476	95.2%
	2002	500	185	556	111.1%
	2000–2002	1,500	935	1,539	102.6%
B	2000	400	200	259	64.8%
	2001	400	200	279	69.7%
	2002	400	10	199	49.8%
	2000–2002	1,200	410	737	61.4%
C	2000	300	100	133	44.4%
	2001	300	100	145	48.4%
	2002	300	5	145	48.3%
	2000–2002	900	205	423	47.1%
All Programs	2000	1,200	700	900	75.0%
	2001	1,200	650	900	75.0%
	2002	1,200	200	900	75.0%
Total	2000–2002	3,600	1,550	2,700	75.0%

Table 5 calculates the implied LDF and the respective weights, for each of the accident years.

Once these relative weights are determined, the Modified BF method calculates a weighted-average IBNR allocation for each accident year. Table 6 displays the calculation of this weighted-average allocation.

As a final step, the method can be used to produce management reports that display the projected ultimate loss ratio by accident year for each underlying program. An example of a final, end-user management report is provided in Table 7. This table essentially combines the results of our illustrative example into a useful summary exhibit.

This Modified BF approach offers several theoretical advantages over allocations done solely on the basis of either earned premium or case-incurred loss. For instance, the Modified BF approach combines both elements of information in the underlying allocation; that is, the allocation method considers both the size of each underlying program (via the earned premium allocation) and the relative underwriting results to date (via the case-incurred loss allocation). As a result, the Modified BF method should produce more reasonable and stable allocations than either simpler method in isolation. Furthermore, this combined estimate is produced by a familiar weighting technique—namely, the BF weighting—that has proven over many years of use to be a reasonable method for combining an experience-based estimate with an a priori estimate.

In addition, the Modified BF approach offers three practical advantages. First, the Modified BF approach is easily automated in an Excel/Access environment, which allows for a quick turnaround on the resulting management reports. Second, the resulting allocations always sum to the total IBNR, eliminating the need for any "off-balance" adjustment factors. Third, the method is easily explained and understood in intuitive terms, which results in greater acceptance of the results.

3. AN ALTERNATIVE TO EARNED PREMIUM ALLOCATION

The Modified BF approach, as presented above, does not offer the flexibility of adjusting the a priori loss ratio by program. This lack of flexibility may cause problems in certain circumstances. For instance, let's assume that we are dealing with the most recent accident year for a very long-tailed reserve segment, and that we have selected an ultimate loss ratio of 75%. Since the case-incurred loss amount for this accident year would be very low, the Modified BF method would allocate IBNR largely in proportion to earned premium. Thus, each of the programs in this reserve segment would show a loss ratio of roughly 75%.

TABLE 8

Calendar/ Accident Year	Program	Earned Premium	Cumulative Case-Incurred Losses	Expected Loss Ratio	Expected Ultimate Losses
2002	A	400	50	65.0%	260
2002	B	400	75	75.0%	300
2002	C	400	25	85.0%	340

In contrast, let's assume that there are three equally sized programs in this reserve segment with very different expected levels of profitability. Specifically, Program A has historically been priced at a 65% expected loss ratio, Program B at a 75% expected loss ratio, and Program C at an 85% ratio. In this case, if the management reports project a roughly equal (at 75%) loss ratio for the most recent accident year for each of the programs, the accuracy of these reports will be challenged.

The solution to this problem would be to replace the earned premium portion of the allocation with an "expected loss" allocation. As an example, Table 8 provides some hypothetical data for calendar/accident year 2002; assume that the total projected ultimate loss ratio for this accident year is 75%. In addition, let's assume for this year that the earned premium is evenly spread between three programs, and that the programs have been priced as described above.

In this case, the earned premium allocation in the Modified BF method is replaced with an expected loss allocation, as shown in Table 9. By comparison, the earned premium allocation would have assigned $250 of IBNR to each of the three accident programs. As a final step, the Modified BF procedure would then combine the expected loss allocation with the case-incurred allocation, in a manner similar to that described in the previous section.

TABLE 9

Calendar/ Accident Year	Program	Expected Ultimate Losses	Pro-Rata Expected Losses	Allocated IBNR
2002	A	260	0.289	216.67
2002	B	300	0.333	250.00
2002	C	340	0.378	283.33

4. MATURE ACCIDENT YEARS AND NEGATIVE IBNR

For very mature accident years (for example, accident years that are developed to 84 months or more), the Modified BF procedure for allocating IBNR may not work as well as another, simpler method. In particular, for older accident years, the Modified BF method allocates IBNR largely in accordance with case-incurred losses; moreover, for these accident years paid losses will tend to be very close to case-incurred losses. In fact, for many specific programs or accounts in the detailed allocation, all of the accident year claims will be closed, and paid losses will equal case-incurred losses. Even so, the Modified BF method may allocate a large proportion of the remaining IBNR to these programs. For reserve segments that are subject to very late-reported claims, or reopened claims, this allocation may be appropriate. For other segments, however, the actuary may consider replacing the Modified BF approach with an allocation in proportion to either open claim counts or case reserves.

In addition, the Modified BF method may be inappropriate for accident years with negative IBNR amounts. In this case, the "implied LDF" that is utilized in the Modified BF weighting procedure is less than unity. As a result, the weight given to the case-incurred allocation is greater than unity, and the weight given to the earned premium allocation is less than zero.[3] Thus, in situa-

[3]In the more-common case where IBNR is positive, the weights assigned to both the case-incurred and the earned premium allocation are between zero and unity.

tions with negative IBNR, another allocation method (such as a straight case-incurred allocation) may be more appropriate.

5. SUMMARY

The Modified BF allocation procedure presented in this paper provides a simple and reliable method for allocating IBNR down to a finer level. The resulting IBNR allocation can then be utilized to create validated accident year management information reports.

The Modified BF methodology can also be utilized to perform the IBNR allocations that are required for statutory or GAAP reporting—either on a net, direct/assumed, or ceded basis. For example, the approach can be used to allocate ceded IBNR to individual reinsurer for Schedule F purposes.

In addition, the procedure can easily be modified to handle loss, loss adjustment expense, or even salvage/subrogation. The obvious modification would be to replace the case-incurred loss with the relevant component—for example, paid or case-incurred ALAE (depending on whether case reserves are established for ALAE), or salvage/subrogation received.

REFERENCES

[1] Bornhuetter, Ronald L., and Ronald E. Ferguson, "The Actuary and IBNR," *PCAS* LIX, 1972, pp. 181–195.

[2] Casualty Actuarial Society, *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves*, May 1988.