A METHOD FOR SETTING RETRO RESERVES

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OVERVIEW

In a paper presented to the Casualty Actuarial Society in 1965[1], W. J. Fitzgibbon, Jr. explained a method of setting reserves for retrospective premium adjustments. His method is based on the fact that, in general, a group of policies with a low loss ratio will produce a greater retrospective return premium than a group of policies with a high loss ratio. In practice, unfortunately, this relationship is not perfect.

For older groups of policies the actual retrospective adjustments which have already been made provide additional evidence about what the ultimate adjustment will be. This paper describes a systematic method of using this additional information to refine the Fitzgibbon indication and set a more accurate reserve.

THE RETROSPECTIVELY RATED POLICY

A retro policy is an insurance contract which provides for the deposit with the insurer of a *standard premium* at the inception of the policy. Six months after policy expiration and at one-year intervals thereafter, the reported losses arising from the policy are used to determine a *retrospective premium.*

If losses are lower than anticipated, the retro premium will be less than the standard premium, and the difference will be *returned* to the insured. This *retro adjustment* will affect the insurer's books as a *negative* premium. Conversely, losses higher than anticipated will produce an *additional* payment to the insurer, and will have a *positive* impact on the insurer's net premium. This sign convention will be used throughout this paper for actual paid and expected future *deviations* from standard premiums.

A revised retrospective premium is calculated annually until at some point the insured and the insurer agree that no further adjustments are needed. The sum of all retro adjustments which took place during this period is called the *ultimate deviation.*

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[1] W. J. Fitzgibbon, Jr., "Reserving for Retrospective Returns," *PCAS* LII, 1965, p. 203.

At any time there may be several policies for which the ultimate deviation has not yet been determined. It is appropriate that the insurer adjust the earned premiums used in stating its underwriting results to reflect any anticipated *remaining* deviations; that is, those deviations which would result if the final retro premium were determined based on the standard premium earned and the losses incurred to date for these policies, including the insurer's provision for losses not yet reported. This adjustment to earned premiums is made through the *retro reserve*. If net remaining deviations are expected to be negative, a *positive* reserve is established and subtracted from earned premiums. However, if positive net remaining deviations are expected, the converse is true.

DATA USED IN CALCULATING THE RETRO RESERVE

The retro reserve could be calculated for all retrospectively rated business combined. However, since greater detail is required for both the Annual Statement and internal underwriting results, it is preferable to calculate a separate reserve for each line of business for which there is a significant volume of retrospectively rated premium.

Some insurers further divide their business into different types of insureds, and it may be appropriate to use different formulas to set retro reserves for these different types. For example, a large account will generally produce a relatively larger retro return than a smaller account with the same loss ratio. This is because the premium discount is returned as part of the retro adjustment, and the large account will have a lower expense ratio.

The method to be described calculates a separate reserve for each *policy year*; that is, for all policies becoming effective during a calendar year. The term of all such policies is one year; three-year agreements must be broken into three pieces. Retro adjustment premiums, audit premiums, late-reported losses, after-closing loss payments, etc., are assigned back to the year of the policy which generated them.

For each cell (i.e., for each line of business by insured type by policy year combination) as of each reserve date, this method requires the paid retro deviations to date, the earned standard premium, and the expected incurred losses which will eventually arise from this earned premium. This loss number should include provision for incurred but not reported (IBNR) losses and for future development of the present estimated values of open claims to their ultimate values.

Since many retro policies provide for limitations on the amount by which any single loss can increase the retro premium, it is also appropriate to remove large individual losses from the incurred loss amount used in calculating the retro reserve. Such large losses should also be removed from the historical data used in calibrating the retro reserve formulas.

BASIC FORMULAS

At any reserve date, for each of the cells described above, the actual deviation paid through that date is a known quantity. If the ultimate deviation can be determined, the retro reserve is easily calculated using the following formula:

$$\text{(Retro Reserve)} = \text{(Paid Deviation)} - \text{(Ultimate Deviation)} \qquad (1)$$

In practice, it is easier to work with quantities which are ratios to earned standard premium (*ESP*). In this way, comparisons of one policy year to another, or of a policy year to itself at different points in time, may be made on a common basis. Therefore, the ultimate deviation is calculated from the ultimate deviation *ratio* (*DRU*) as follows:

$$\text{Ultimate Deviation} = ESP \times DRU \qquad (2)$$

The ultimate deviation ratio used to set the reserve is a weighted average of two indicated deviation ratios (*DR*1 and *DR*2):

$$DRU = [DR1 \times (1 - W2)] + [DR2 \times W2] \qquad (3)$$

*DR*2 is the indication which comes into play as we begin to consider deviations paid to date in estimating the ultimate deviation ratio. It will be discussed later. For "young" policy years (those years which began fewer than 21 months before the date at which the reserve is being set), the weight (*W*2) applied to *DR*2 is 0. During this period, formula (3) above reduces to simply $DRU = DR1$.

THE *DR*1 FORMULA

*DR*1 is a linear function of the incurred loss ratio (*ILR*):

$$DR1 = [(SF \times ILR) + CF] \leq DRM \qquad (4)$$

Note that this is simply Fitzgibbon's formula, with the added restriction that the indicated deviation ratio is capped at a maximum deviation ratio (*DRM*). Ideally, the slope factor (*SF*) and the constant factor (*CF*) of the *DR*1 equation can be determined by a least squares fit of data points representing old policy years[2] for which the ultimate loss ratios and ultimate deviation ratios are fairly accurately known, as in Exhibit I.

Policy year 1971, for example, has a loss ratio of 64.1%. Net retro returns equal to 13.1% of earned standard premium have so far been made. If it happens that a recent policy year, say 1976, presently has a loss ratio of about 64%, we may expect an ultimate deviation ratio of about −13% and establish a retro reserve accordingly. Similarly, policy year 1969 gives an indication that when the aggregate loss ratio for a policy year is as high as 72%, we may expect a net ultimate return of only about 6%.

The least squares fit line provides a method of smoothing out these data points and of interpolating between them. We may also extrapolate to lower and higher loss ratios. Although ultimate loss ratios for large lines of business will tend to vary over only a fairly narrow range, loss ratios for the first few months of new policy years, or even ultimate loss ratios for small volume lines, may be extreme.

Thus, it is appropriate to cap the additional premiums which we expect to collect at, say, 5% of *ESP*, no matter how high the policy year loss ratio is. This is because such policy years probably contain a few policies with extremely high loss ratios which will hit their maximums and produce additional premiums which are too small to offset all the losses. Meanwhile, many other insureds will have low loss ratios and will earn return premiums which may offset most of the additional premium received from the high-loss policies.

Now observe the policy year 1968 point on Exhibit I. This point lies well off the least squares line. If we strictly followed the *DR*1 indication, we would still be looking for an ultimate return of 10% of standard premium despite the fact that returns of only 7.8% have been made so far. Because very few deviations, either positive or negative, are still coming in due to eighth or later adjustments for this old policy year, we clearly should have dropped the indicated retro reserve of 2.2% of standard premium at some previous date.

The difference between the policy year 1972 point and the *DR*1 indication is in the opposite direction. Because this is not as old a year as 1968, a small number of late retro adjustments may still come in. Nevertheless, it is quite

[2] In practice, it is useful to determine the *DR*2 formula values first and then use them to project paid deviations for two or three more recent policy years, thus obtaining additional data points to use in selecting the *DR*1 curve.

unlikely that the total amount of the indicated negative retro reserve is appropriate.

Policy years 1968 and 1972 demonstrate the weakness of a pure *DR*1-type formula. As policy years age, it usually becomes clear that the true ultimate adjustment will be greater than or less than the *DR*1 formula indication. At that point, the reserve must either be changed to zero or must be revised by some amount on a judgment basis. The *DR*2 formula provides a method for making such a revision in a smooth, systematic way.

THE *DR*2 FORMULA

Judgments about the correctness of the *DR*1 indication can be made only after there are significant amounts of actual paid retro adjustments. Consider policy year 1972, for example. The first policies written in this year were effective 1/1/72 and expired 12/31/72. The first retro adjustment was calculated based on losses evaluated six months after policy expiration, or 6/30/73. It probably took two or three months to prepare loss reports, calculate the retrospective premium, and input the adjustments to the accounting system. The first significant paid deviations for policy year 1972 therefore began to appear in August or September of 1973, about 20 or 21 months after the beginning of the policy year. Although a few deviations, probably due to early policy cancellations, were seen before 20 months, it was not until after then that some weight could be given to the *DR*2 indication in formula (3).

At about 33 months, first adjustments for policies effective in December 1972 were completed and second adjustments for January 1972 policies, valued 30 months after policy inception, began to appear. Twelve months later, third adjustments began, and so on.

The consistency of the pattern of paid deviations from one policy year to another can be seen in Exhibit II, which shows cumulative paid deviations as of each month, taken as a ratio to total paid deviations through 60 months. This consistency provides the basis for the second estimate of the ultimate deviation ratio:

$$DR2 = (DPF \times PDR) + (LPF \times ILR) \tag{5}$$

The first portion of this formula (Deviation Projection Factor times Paid Deviation Ratio) estimates remaining first adjustments. The second portion (Loss Projection Factor times Incurred Loss Ratio) estimates remaining second and later adjustments. In order to understand this formula, refer to Exhibit III to see a typical set of *DR*2 formula values.

Deviation Projection Factor

When setting a retro reserve in any September, the first prior policy year is 21 months old. Observe in Exhibit II that at this age we first begin to see a significant volume of paid deviations coming in. The first part of the *DR*2 formula assumes that first adjustments already paid at any point in time are similar to those first adjustments as yet unpaid. For example, if the early paid deviations are returns equal to 10% of the earned standard premium on the policies producing these deviations, the formula assumes that remaining first adjustment deviations will also be returns equal to 10% of the corresponding premium.

The reciprocal of the 21-month *DPF* of 6.64 represents the portion of all first adjustments which are assumed to have been paid by this age. Multiplying the 21-month paid deviation ratio by this *DPF* thus estimates the ultimate ratio to earned standard premium of deviations due to first retro adjustments. By 36 months it is assumed that all first adjustments have already been processed, and *DPF* decreases to unity, where it remains from that point on.

Loss Projection Factor

In the second part of the *DR*2 formula, the Loss Projection Factor has been so named because it is applied to the expected ultimate incurred loss ratio. Nevertheless, its purpose is to estimate the amount of second and later deviations remaining as of any reserve date.

Note in Exhibit III that from 21 to 31 months, the *LPF* is constant at 0.0500. This is because, no matter how large or small first adjustments are, and no matter whether they are returns or additionals, formula (5) assumes that second and later adjustments will produce an additional premium equal to 5% of incurred losses.

The reason an additional premium is anticipated is that only reported claims, carrying whatever value the Claim Department put on them the last time they were examined, enter the retrospective premium calculation for any policy. Consequently, "case basis" losses valued 18 months after policy inception, when the first adjustment is calculated, are, on the average, understated. At later adjustments, previously reported claims may be revalued upward and new claims which were IBNR at previous adjustments may emerge. Thus, it will likely be determined that additional premiums previously paid to the insurer were too small, or that part or all of the returns previously paid to the insured must now flow back to the insurer. In either case, positive deviations resulting from second and later retro adjustments are likely to dominate negative deviations.

Thus, according to the *DR*2 indication, for any policy year which is about 31 months old, there are few first adjustments but many second and later adjustments remaining to be made, and it is appropriate to hold a negative retro reserve. Thereafter, as the anticipated additional premiums flow in, the *LPF* decreases, reducing the size of the indicated negative retro reserve.

The values for *DPF* and *LPF* are readily determined if a monthly history is available which separates deviations into first adjustments, second adjustments, etc. Absent such a history, acceptable answers can be obtained by assuming that all deviations through 33 months are from first adjustments, those from 34 through 45 months are from second adjustments, etc.

COMBINING *DR*1 WITH *DR*2

The last column of Exhibit III sets forth the weight (*W*2) which is applied to the *DR*2 indication in formula (3). As stated previously, no weight is given to *DR*2 during the first 20 months. Then, as paid deviations begin to accumulate, *DR*2 becomes a better and better estimate of the true ultimate deviation ratio, and *W*2 begins increasing linearly.

Inspection of the pattern of actual paid deviations over time reveals that beyond about five years, retro adjustments are likely to be very small, and additional and return premiums are almost equally common. Beyond this point, therefore, it is not worthwhile to attempt to set a retro reserve.[3] The formula is designed so that when a policy year becomes 60 months old, two things happen which cause the retro reserve to disappear:

1. The loss projection factor becomes 0.0000. Because the deviation projection factor is unity at this point, formula (5) simplifies to $DR2 = PDR$
2. At the same time, $W2$ becomes 1.000, and formula (3) simplifies to $DRU = DR2 = PDR$.

That is, for any policy year which is 60 months or more old, the expected ultimate deviation is equal to the current paid deviation, and no retro reserve is

[3] This statement is true only for the particular company studied at this point in time. The decision about how long to hold a retro reserve should be reevaluated periodically.

held. This point has been reached smoothly in the course of 40 months. At each reserve date during this period, the formula has given due consideration to the incurred loss ratio of the policy year as well as to its actual paid retro deviations.

SAMPLE CALCULATION

Exhibit IV shows a history of the retro reserve for a typical policy year, based on the formulas given in Exhibits I and III. Note in particular the following points in time:

A. 1/31/72, age 1 month. The policies written in January 1972 have, by the end of the month, generated an earned premium of $2,074,000. Most of the $1,795,000 of incurred losses is due to an IBNR reserve, as one month is not sufficient time to allow many accidents to occur, be reported, and have estimates of their values put into the system. The indicated loss ratio of 86.55% generates a *DR*1 indication of +6.13% which has been capped at +5.00%. A negative retro reserve has been established in anticipation of a net ultimate additional premium equal to 5% of the standard premium earned so far. No *DR*2 indication has been calculated.

B. 2/29/72, age 2 months. Earned premiums have increased not only because of more policies being written in February, but also because of additional earned premiums generated by January writings. Incurred losses have increased less than premiums, producing a loss ratio of only 84.90% and a *DR*1 indication of +4.71%, which does not need to be capped.

C. 9/30/73, age 21 months. The loss ratio has decreased to 68.52% and *DR*1 now anticipates a return premium of 9.37%. This is the first month for which the *DR*2 indication is considered, and paid deviations have been projected to an ultimate return of 21.47%. This *DR*2 indication predicts that the ultimate policy year 1972 point would be far below the *DR*1 formula line were it graphed on Exhibit I. This *DR*2 indication is too far off the line to be realistic, but it receives a weight of only 2.5%, and we will eventually see that it *does* tend to move the *DR*1 indication in the correct direction.

D. 8/31/74, age 32 months. Almost all first adjustments, but few second adjustments, have been processed. At this point, the maximum return has been reached and remaining retro adjustments will be dominated by additionals. *DR*2, still predicting that ultimate returns will be greater than *DR*1 does, receives a weight of 30%.

E. 11/30/76, age 59 months. $DR2$ has almost 100% weight and the net retro reserve has decreased smoothly despite the large incurred loss decrease since last month. Note that if only $DR1$ were used, this loss decrease would have caused a retro reserve increase of about $400,000.

F. 12/31/76, age 60 months. The reserve for policy year 1972 goes to $0. Without the $DR2$ formula, we would still have been holding a reserve of:

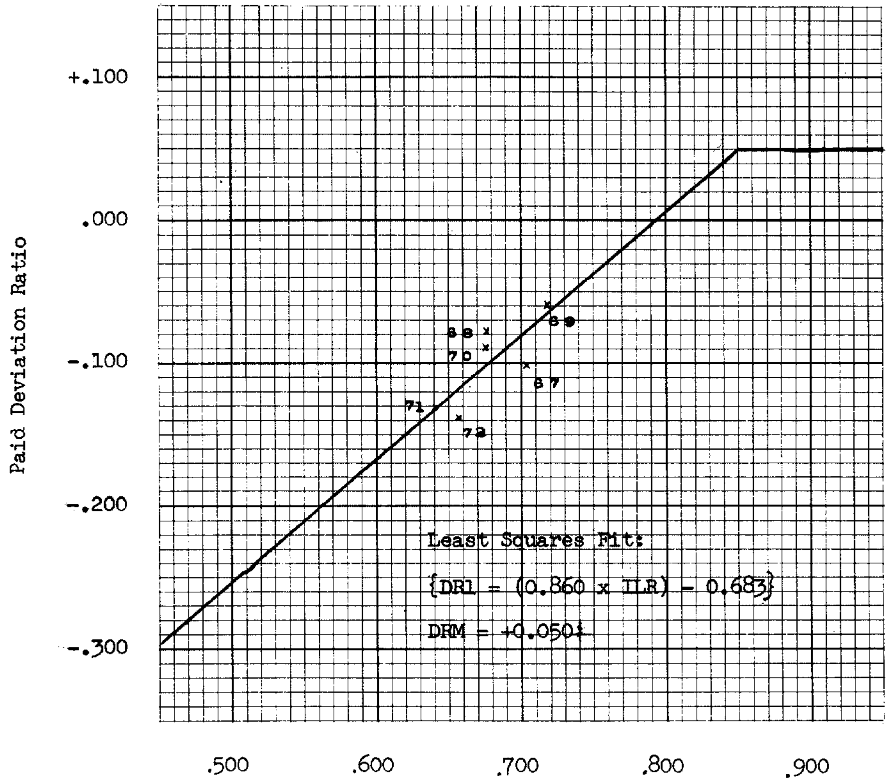
$$-\$10{,}813{,}000 - [\$78{,}128{,}000 \times (-0.1182)] = -\$1{,}578{,}000$$

unless we had dropped part or all of this amount on a judgment basis at some earlier date.

EXHIBIT I

DETERMINATION OF *DR*1 FORMULA
—WORKERS' COMPENSATION

DATA POINTS AS OF 12-31-76



Policy Year	Ratios to Earned Standard Premium: Incurred Losses	Paid Deviations
1967	.703	.101−
1968	.677	.078−
1969	.718	.059−
1970	.676	.089−
1971	.641	.131−
1972	.657	.138−

EXHIBIT II

PAID DEVIATIONS—WORKERS' COMPENSATION

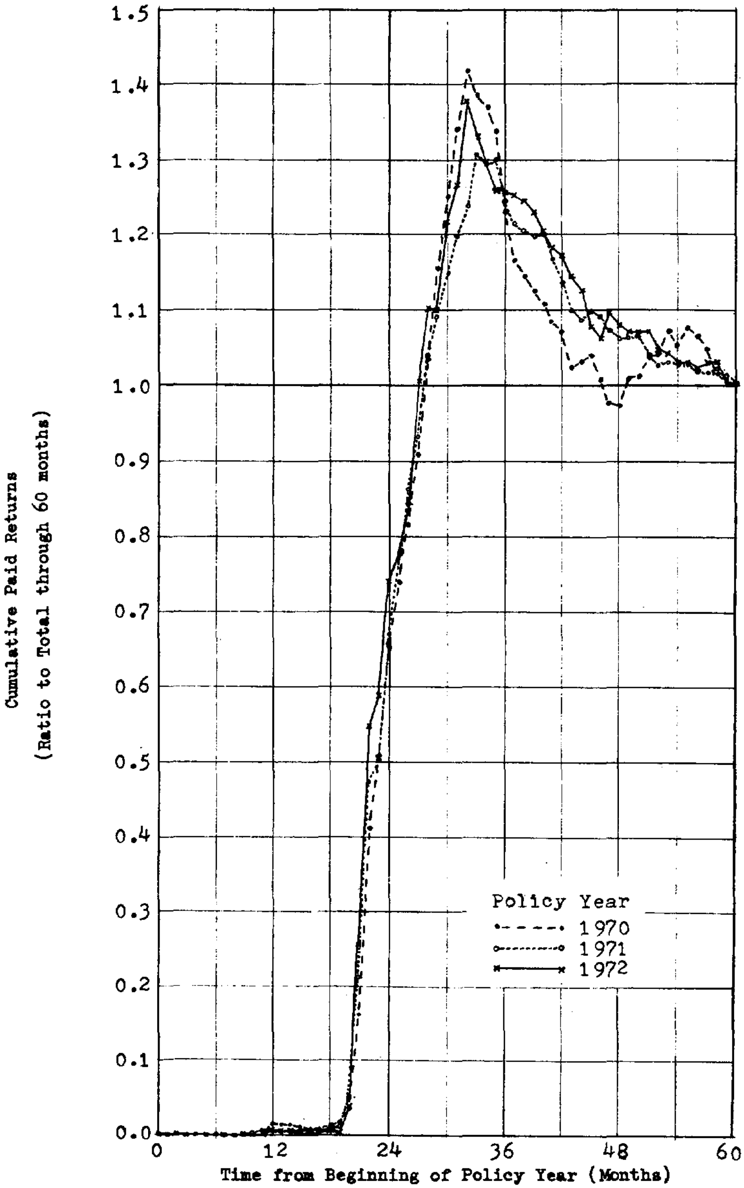


EXHIBIT III

*DR*2 FORMULA VALUES—WORKERS' COMPENSATION

Age of Policy Year (months)	Deviation Projection Factor (*DPF*)	Loss Projection Factor (*LPF*)	Weight for *DR*2 Indication (*W*2)
1 to 20	—	—	.000
21	6.64	0.0500	.025
22	3.96	0.0500	.050
23	3.11	0.0500	.075
24	2.44	0.0500	.100
25	2.14	0.0500	.125
26	1.90	0.0500	.150
27	1.60	0.0500	.175
28	1.43	0.0500	.200
29	1.30	0.0500	.225
30	1.19	0.0500	.250
31	1.11	0.0500	.275
32	1.06	0.0496	.300
33	1.04	0.0444	.325
34	1.02	0.0404	.350
35	1.01	0.0376	.375
36	1.00	0.0340	.400
37	1.00	0.0316	.425
38	1.00	0.0292	.450
39	1.00	0.0252	.475
40	1.00	0.0220	.500
41	1.00	0.0192	.525
42	1.00	0.0164	.550
43	1.00	0.0140	.575
44	1.00	0.0123	.600
45	1.00	0.0102	.625
46	1.00	0.0084	.650
47	1.00	0.0073	.675
48	1.00	0.0060	.700
49	1.00	0.0054	.725
50	1.00	0.0048	.750
51	1.00	0.0038	.775
52	1.00	0.0030	.800
53	1.00	0.0023	.825
54	1.00	0.0016	.850
55	1.00	0.0010	.875
56	1.00	0.0006	.900
57	1.00	0.0004	.925
58	1.00	0.0002	.950
59	1.00	0.0001	.975
60 & up	1.00	0.0000	1.000

$DR2 = (DPF \times PDR) + (LPF \times ILR)$

$DRU = [DR1 \times (1 - W2)] + [DR2 \times W2]$

EXHIBIT IV

SAMPLE RESERVE CALCULATION HISTORY
WORKERS' COMPENSATION—POLICY YEAR 1972

Date	Age	Earned Standard Premium ($000)	Incurred Losses Dollars ($000)	Incurred Losses Ratio (4) ÷ (3)	Cumulative Paid Deviations Dollars ($000)	Cumulative Paid Deviations Ratio (6) ÷ (3)	Indicated Ultimate Deviation Ratios** *DR*1	Indicated Ultimate Deviation Ratios** *DR*2	Indicated Ultimate Deviation Ratios** *DRU*	Estimated Ultimate Deviation (3) × (10) ($000)	Retro Reserve (6) − (11) ($000)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Ⓐ 1-72	1	$ 2,074	$ 1,795	.8655	$ 0	.0000	.0613*	—	.0500	$ 104	$ 104−
Ⓑ 2-72	2	5,152	4,374	.8490	0	.0000	.0471	—	.0471	243	243−
3-72	3	8,090	7,272	.8989	0	.0000	.0901*	—	.0500	405	405−
4-72	4	11,260	10,195	.9054	0	.0000	.0956*	—	.0500	563	563−
5-72	5	14,699	13,385	.9106	0	.0000	.1001*	—	.0500	735	735−
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
7-73	19	69,807	48,613	.6964	33−	.0005−	.0841−	—	.0841−	5,871−	5,838
8-73	20	72,450	49,563	.6841	395−	.0055−	.0947−	—	.0947−	6,861−	6,466
Ⓒ 9-73	21	73,531	50,381	.6852	2,755−	.0375−	.0937−	.2147−	.0967−	7,110−	4,355
10-73	22	73,927	51,040	.6904	5,926−	.0802−	.0893−	.2831−	.0990−	7,319−	1,393
11-73	23	74,223	51,620	.6955	6,365−	.0858−	.0849−	.2321−	.0959−	7,118−	753
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
6-74	30	78,284	52,066	.6651	13,155−	.1680−	.1110−	.1667−	.1249−	9,778−	3,377−
7-74	31	78,287	51,992	.6641	13,686−	.1748−	.1119−	.1608−	.1253−	9,809−	3,877−
Ⓓ 8-74	32	78,603	51,868	.6599	14,880−	.1893−	.1155−	.1679−	.1312−	10,313−	4,567−
9-74	33	78,558	51,803	.6594	14,364−	.1828−	.1159−	.1608−	.1305−	10,252−	4,112−
10-74	34	78,509	51,941	.6616	13,997−	.1783−	.1140−	.1551−	.1284−	10,081−	3,916−
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
8-76	56	78,131	51,519	.6594	11,057−	.1415−	.1159−	.1411−	.1386−	10,829−	228−
9-76	57	78,131	51,512	.6593	11,087−	.1419−	.1160−	.1416−	.1397−	10,915−	172−
10-76	58	78,130	51,589	.6603	11,141−	.1426−	.1151−	.1425−	.1411−	11,024−	117−
Ⓔ 11-76	59	78,130	51,128	.6544	10,832−	.1386−	.1202−	.1385−	.1380−	10,782−	50−
Ⓕ 12-76	60	78,128	51,317	.6568	10,813−	.1384−	.1182−	.1384−	.1384−	10,813−	0

* *DR*1 formula indication before capping at +5%.

** $DR1 = [0.86 \times (5)] - 0.683$

$DR2 = [(7) \times DPF] + [(5) \times LPF]$

$DRU = [(8) \times (1.0 - W2)] + [(9) \times W2]$