

## 8.7 An improved method of estimating cumulative readership

### INTRODUCTION

In addition to providing average-issue readership estimates for all publications surveyed, the UK National Readership Survey also publishes in its reports "estimates of the percentage of people who would see at least one of a series of issues of a publication". Unfortunately, as is shown below, such cumulative estimates are not very accurate and are inconsistent with other data obtained from the same survey and indeed given in the same volume of each report. An improved method of estimating cumulative readership is suggested.

### THE CURRENT NRS METHOD

Because issue-readership is not directly established by the current NRS methodology, any cumulative readership estimates must be derived by the use of a model. The current NRS approach is first of all to establish probabilities of reading for each 'frequency-group' of respondents for each publication.

Once these probabilities are established, they are used to produce cumulative readership estimates for each publication. In the Introduction to the NRS report it is stated that "The total adult probability of a single issue is projected by binomial expansion to provide cumulative readership estimates for 2, 3, 4, 5, 6, 7, 8, 10 and 12 issues of a publication". That statement is not quite true. In fact, the calculation is carried out by the binomial expansion of the probabilities for each frequency-claim group and then summed across all the frequency groups weighting by the number of claimers in each case.

The cumulative percentage readership estimates are given in the report for 2-8 issues, 10 and 12 issues for all publications covered in the survey. An example is shown below for the *Readers Digest* based on All Adults. (Table 1)

### DISADVANTAGE OF BINOMIAL EXPANSION

In assessing whether the cumulative percentage readership estimates yielded by the binomial expansion method are likely to be sufficiently accurate, a reasonable approach is to see whether there is any other information which can confirm or disprove the results. In this case of course there is a very useful measure

TABLE 1

Estimated percentages reached by N issues.

NRS July 1981 — June 1982

1 issue %	2 issues %	3 issues %	4 issues %	5 issues %	6 issues %	7 issues %	8 issues %	10 issues %	12 issues %
16.8	21.3	23.3	24.5	25.2	25.7	26.0	26.2	26.4	26.5

obtainable from the tabulated survey data for monthly magazines — the cumulative 6-issue readership. That is obtainable by summing the "non-zero" responses to the frequency claim question; for example in the case of the *Readers Digest* above, 73.39% claimed zero, thus 26.61% claimed to read at least one of the last 6 issues.

The inconsistency in the binomial expansion method now becomes apparent. We can tabulate from the survey data that the 6-issue cumulative readership of the *Readers Digest* is 26.61%, yet the binomial expansion method estimates the same 6-issue readership as 25.7%. (It is perhaps surprising that two such inconsistent figures should be published only a few pages apart in a industry readership survey report). Moreover, the model's estimate of the 12-issue cumulative reach is still below the observed 6-issue readership.

The problem is that the binomial expansion model attributes a zero probability to any informant not reading the publication within the last 6 months, which means that its coverage estimates lie on a curve which gets closer and closer to the tabulated 6-issue level, ultimately reaching it after an infinite number of issues but never exceeding it. A moment's thought will show that it is of course completely unrealistic to limit the ultimate coverage estimate of a publication to that of six issues and the mind boggles at the thought of a newsagent restricting the sale of the seventh issue of a magazine to those could prove they had already seen at least one of the previous six! Yet the binomial expansion method has an ultimate limit of the tabulated 6-issue coverage, and moreover demonstrably underestimates the observed reach with its own prediction. Table 2 includes for 50 NRS monthly publications the observed 6-issue reach, the binomial expansion 6-issue estimate as given in the

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report and the percentage error in each case. The binomial expansion is of course always an underestimate, averaging  $-3.9\%$  for the 20 general monthlies and  $-5.5\%$  for the 30 women's monthlies.

The deficiencies of the binomial expansion model have been emphasised in 'Cumulative Readership', Appendix B of *Readership Measurement Reviewed* by Pym Cornish and Michael Brown. This excellent document is well worth careful reading, and in their thoughtful approach to the subject of cumulative readership, the authors are in no doubt as to the weaknesses of binomial expansion, describing it as ".....clearly a poor model of actual cumulative readership for all except small values of  $n$ ....."(issues).

#### THE BETA-BINOMIAL APPROACH

An alternative to binomial expansion model is the Beta-binomial expansion. The Beta function has been widely used all over the world and indeed in the USA for example is accepted as a standard method of projecting cumulative readership beyond the observed one-issue and two-issue levels. The Beta-binomial does not suffer from the disadvantage of being limited to the 6-issue cumulative reach, but is able to project beyond that point and increase the cumulative coverage estimate as more issues are taken into account. It is probably not a coincidence that the Beta function forms the basis for both of the two most widely used formula reach and frequency models in the UK and USA; the function's qualities make it excellent for such a purpose.

However, when applied to the UK NRS data, using a binomial expansion of the probabilities to calculate the necessary two-issue cumulative coverage, the Beta-binomial's accuracy is no better than the binomial expansion; in most cases the Beta-binomial overestimates the the 6-issue reach compared with the observed result. **Table 2** gives a comparison between the Beta binomial and the observed result for 20 general monthly magazines, and **Table 3** for 30 women's monthly magazines: it will be noted that the Beta-binomial overestimates every one of the 20 general monthlies with a mean error of  $7.4\%$ . It overestimates 26 of the women's monthlies and underestimates 4, with a mean error of  $5.1\%$ .

When one considers that the binomial expansion model underestimates the observed 6-issue results, it can be seen that, at that level, the Beta-binomial will produce reach estimates which are in the region of  $11.6\%$  higher

than the binomial expansion, and that this difference will increase as more issues are taken into account. It is hardly surprising that variations of this size have caused confusion among those who attempt to compare schedule evaluation results from the two types of model. It is important to be aware of the inherent differences between the calculation methods and to avoid making direct comparisons which are meaningless.

#### THE TRUE-CUME SOLUTION

Although the Beta-binomial expansion at least avoids the problem of an artificial ceiling from which the binomial expansion suffers, the results are still fairly unsatisfactory. However, it is not the Beta function which is at fault but the input parameters. To solve that problem, a method has been devised to modify the Beta-binomial expansion and to incorporate the observed 6-issue reach in each case. As a result, the cumulative issue readership estimate at the 6 level exactly matches the observed result and all other cumulative reach estimates are adjusted accordingly. The benefits of the Beta function are retained while ensuring that the fullest advantages are obtained from making use of all relevant available data from the survey. The modification algorithm allows any single cumulative readership observation to be used as the modifying parameter to the Beta-binomial expansion. The method is thus also suitable for surveys which use a 12-issue frequency scale or even those which use a time-based filter to give observed cumulative readership in say the last six months.

Because the modified Beta algorithm is demonstrably accurate at the observed issue level, it is likely to be more accurate than the original Beta-binomial expansion at other issue levels. This improvement in accuracy is of course carried over when the modified Beta routine is incorporated in a multi-vehicle reach and frequency model. With the UK NRS data, the modified Beta (known at Telmar as 'True-cume') normally produces results that are greater than the binomial expansion but smaller than the original Beta-binomial. For example, for the *Readers Digest* (the monthly publication with the largest UK readership), comparative results are as shown in **Table 4**.

A similar pattern can be observed with women's magazines, in **Table 5**.

A graphic illustration of these figures is provided in **Figure 1**. It can be clearly seen how the binomial expansion model approaches but never exceeds the

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**TABLE 2**  
**Estimated percentage reach of six issues**

NRS July 1981 — June 1982

All adults	General monthly publications				
	<i>Observed</i>	<i>Binomial</i>	<i>Error %</i>	<i>Beta-binomial</i>	<i>Error %</i>
Reader's Digest	26.61	25.7	-3.4	28.0	+ 5.2
Do It Yourself	8.49	8.0	-5.8	8.9	+ 4.8
Custom Car	6.25	6.1	-2.4	6.9	+10.4
Mayfair	4.48	4.3	-4.0	5.0	+11.6
Practical Householder	5.34	4.9	-8.2	5.4	+ 1.1
Car Mechanics	4.17	4.0	-4.1	4.6	+10.3
Motor Sport	4.00	3.9	-2.5	4.4	+10.0
Practical Motorist	4.48	4.3	-4.0	4.7	+ 4.9
Hot Car	3.74	3.6	-3.7	4.1	+ 9.6
Cars & Conversions	3.20	3.1	-3.1	3.6	+12.5
Men Only	3.46	3.4	-1.7	3.8	+ 9.8
Fiesta	3.26	3.2	-1.8	3.7	+15.3
Penthouse	3.53	3.4	-3.7	3.9	+10.5
Street Machine	2.63	2.6	-1.1	2.9	+10.3
Car	2.74	2.7	-1.5	3.2	+16.8
Film Review	3.30	3.1	-6.1	3.4	+ 3.0
Knave	2.23	2.2	-1.3	2.5	+12.1
Geographical Magazine	2.27	2.1	-7.5	2.3	+ 1.3
Illustrated London News	2.80	2.6	-7.1	2.8	+ 1.0
Club	1.53	1.5	-2.0	1.7	+11.1
			-3.9		+ 7.4

6-issue limit, while the true-cume estimate is correct at the observed 6-issue level in contrast to the unmodified Beta-binomial.

## CONCLUSION

Hopefully, more data (perhaps from panels) will be forthcoming in the future to enable us to obtain a truer picture of cumulative build up of readership over several issues. In the meantime, the true-cume modification to the beta-binomial expansion makes use of the well-established Beta function while simultaneously conforming to observed cumulative readership measurements. It makes the maximum use of all available cumulative data in the NRS without demanding

further cumulative measurements. It permits the extrapolation of cumulative readership estimates beyond the 6-issue observation and avoids the illogical and inconsistent results yielded by the binomial expansion. True-cume represents a demonstrable improvement on both of the cumulative readership models described in this document and its use is recommended until such time as further information becomes available.

## REFERENCES

Cornish, Pym & Brown, Michael (1980) *Readership Measurement Reviewed: A study of development options for the NRS*. JICNARS, December.

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**TABLE 3**  
Estimated percentage reach of six issues

NRS July 1981 — June 1982

All Women	Women's monthly publications				
	Observed	Binomial	Error %	Beta-binomial	Error %
Woman and Home	23.25	22.5	- 3.2	25.1	+ 8.0
Good Housekeeping	19.47	18.5	- 5.0	20.5	+ 5.3
Family Circle	12.31	17.6	- 3.9	19.8	+ 8.1
Vogue	17.43	16.0	- 8.2	17.4	- 0.2*
Cosmopolitan	14.03	13.5	- 3.8	15.0	+ 6.9
Living	12.77	12.2	- 4.5	13.6	+ 6.5
She	14.24	13.3	- 6.6	14.6	+ 2.5
Ideal Home	14.66	13.5	- 7.9	14.8	+ 1.0
True Romances	9.73	9.5	- 2.4	11.0	+ 13.1
Homes & Gardens	11.59	10.8	- 6.8	12.0	+ 3.5
House & Garden	11.42	10.6	- 7.2	11.7	+ 2.5
Woman's World	10.40	9.9	- 4.8	11.4	+ 9.6
Woman's Journal	9.51	9.2	- 3.3	10.3	+ 8.3
Home & Freezer Digest	7.64	7.3	- 4.5	8.0	+ 4.7
Annabel	7.28	6.9	- 5.2	7.5	+ 3.0
True Story	6.86	6.7	- 2.3	7.7	+ 12.2
Company	5.83	5.5	- 5.7	6.1	+ 4.6
'19'	6.44	6.0	- 6.8	6.6	+ 2.5
Over 21	6.43	6.0	- 6.7	6.8	+ 5.8
Honey	6.01	5.5	- 8.5	6.0	- 0.2*
Pins & Needles	6.29	5.8	- 7.8	6.3	+ 0.2
Harpers & Queen	5.94	5.3	- 10.8	5.7	- 4.0*
Look Now	3.97	3.7	- 6.8	4.0	+ 0.8
True Magazine	3.31	3.2	- 3.3	3.7	+ 11.8
Hers/New Love	3.48	3.3	- 5.2	3.8	+ 9.2
Parents	3.19	3.0	- 6.0	3.3	+ 3.4
Woman's Story	2.52	2.5	- 0.8	2.9	+ 15.1
Mother	2.51	2.3	- 8.4	2.6	+ 3.6
Fashioncraft/Homecraft	2.56	2.4	- 6.3	2.5	- 2.3*
The Food Magazine	1.80	1.7	- 5.6	1.9	+ 5.6
			- 5.5		+ 5.1

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**TABLE 4**  
**All Adults Readers Digest.**

Cumulative percentage readership estimates.

<i>Issues</i>	<i>Observed</i> %	<i>Binomial</i> %	<i>Beta</i> %	<i>True-cume</i> %
1	16.8	16.8	16.8	16.8
2	—	21.3	21.3	20.8
3	—	23.3	23.8	23.0
4	—	24.5	25.6	24.5
5	—	25.2	26.9	25.7
6	26.6	25.7	28.0	26.6
7	—	26.0	28.9	27.4
8	—	26.2	29.6	28.0
9	—	26.3	30.3	28.6
10	—	26.4	30.9	29.1
11	—	26.5	31.4	29.6
12	—	26.5	31.9	30.0

Source: NRS July 1981 — June 1982

**TABLE 5**  
**'Woman and Home' All women**

<i>Issue</i>	<i>Observed</i> %	<i>Binomial</i> %	<i>Beta</i> %	<i>True-cume</i> %
1	13.0	13.0	13.0	13.0
2	—	17.6	17.6	17.0
3	—	19.9	20.4	19.4
4	—	21.2	22.4	21.0
5	—	22.0	23.9	22.2
6	23.3	22.5	25.1	23.3
7	—	22.7	26.1	24.1
8	—	22.9	27.0	24.8
9	—	23.0	27.7	25.4
10	—	23.1	28.4	26.0
11	—	23.2	29.0	26.5
12	—	23.2	29.5	27.0

Source: NRS July 1981 — June 1982

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FIGURE 1

