LETTERS TO THE EDITORS

Dear Sirs

S. KUON, A. REICH and L. REIMERS (1987) compared the algorithms of Panjer, Kornya and De Pril as applied to real and made-up Life portfolios. De Pril's method, which was the only one to compute the exact aggregate claims distribution, compared unfavourably with the others in view of its computation amount.

Recently, DE PRIL (1987) presented a paper with a variant of his algorithm, giving an approximation with a slightly better error bound than Kornya's. The main change concerns the recursion formula, which in the terminology of KUON *et al.* now reads

$$\tilde{f}(x) = \frac{1}{x} \sum_{i=1}^{\min(I,x)} \sum_{k=1}^{\min(K,\lfloor x/i \rfloor)} A_{ik} \tilde{f}(x-ki)$$

with a given order of approximation K.

Applying this variant to the examples in KUON *et al.* leads to a substantial decrease in the number of floating point operations, but only to a slight decrease in computation time. The situation changes if one reverses the order of summation using

$$\tilde{f}(x) = \frac{1}{x} \sum_{k=1}^{K} \sum_{i=1}^{\min(I,\lfloor x/k \rfloor)} A_{ik} \tilde{f}(x-ki).$$

As opposed to the first formula, there are only a few, but long, inner products to be computed, which can be taken advantage of by vector-oriented programming languages like APL.

I have listed below the number of bar and dot operations, the CPU time and the error bound for the five examples from KUON *et al.* In each case I have used De Pril's new approximation with $K = 5$. The figures can easily be compared with those arrived at for the three other algorithms mentioned above.

Portfolio	BO	DO	CPU seconds	Error bound
$I = 100, J = 60, L = 3000$	1,451,310	1,563,261	26.197	1.1×10^{-8}
$I = J = 10, L = 250$	11,935	23,537	1.554	1.8×10^{-15}
$I = J = 15, L = 400$	28,940	57,651	2.448	4.4×10^{-15}
$I = J = 20, L = 700$	68,170	116,567	4.383	8.2×10^{-15}
$I = 25, J = 50, L = 100$	13,650	15,358	0.774	1.1×10^{-10}

The CPU time for De Pril's approximative algorithm is about 3–5 times as high as that of Kornya's, whereas its error bound is only one third.

At proof-stage, Mr. De Pril informed me of his recent result that his approximation equals on its support that of Kornya except for a constant factor. In view of this I would recommend using Kornya's recursion formula with a modified

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starting value (the exact value of $f(0)$) in order to arrive at De Pril's approximation and take advantage of its smaller error bound.

Sincerely yours,

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KUON, S., REICH, A. and REIMERS, L. (1987) PANJER vs KORNYA vs DE PRIL: A comparison from a practical point of view. *ASTIN Bulletin* 17, 184–191.

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