

Discussion on C.M.I. Report, number 9

Mr D. O. Forfar, F.F.A. (introducing the discussion): The *C.M.I.R.* 9 covers the graduation of the mortality experience of the different classes of life for which the statistics have been collected during the 1979-82 quadrennium. The 1979-82 quadrennium falls some 12 years after the 1967 quadrennium on which our standard tables A1967-70, a(90) and PA(90) are based. As will be seen from the report, the mortality experience has in these 12 years moved out of line with that of our standard tables. Indeed, in respect of assured lives the experience of 1979-82 was, on average, some 18% lighter than the experience of 1967-70.

In respect of pensioners, the mortality of the quadrennium was lighter than PA(90) when calculated on an amounts basis, even although PA(90) is deemed to be appropriate to the year 1990.

The Committee felt it appropriate to consider the 1979-82 data from the point of view of the possible preparation of new standard tables should the profession consider this desirable. We are well aware, however, that in the next 12 years we may well see changes in mortality considerably more significant than we have seen in the last 12, particularly at the younger ages.

Interspersed throughout the report are a series of questions for the profession. Many of them are common to each investigation, and these are set out in §1.2. For certain of these questions, the Committee's views are indicated, but such helpful hints are not always given. These are important questions for the profession and the C.M.I. Committee will be very interested in comments expressed about them and related questions.

Indeed, the further work to be undertaken by the Committee depends on the views expressed at this meeting and on the views which were expressed at the Faculty meeting in February.

Mr H. A. R. Barnett (opening the discussion): One question which was not included in the Report is: should the next set of tables be based on 1979-82 or on 1983-86 data? When the graduation working party started this work, there was no question of 1983-86, but it was inevitably a long task and the data are now just becoming available. Whatever the Committee prepares, it will be well into 1989 before it goes to press because there still has to be the extension to younger ages, and the projection for the annuity data. Would it perhaps be better to delay a further 6 months and have tables which are then nearly 3 years out of date rather than $6\frac{1}{2}$ years? I know that mortality tables are always out of date when they are published, but not always by quite so much.

It has been suggested to me that instead of producing bound volumes, we should produce loose-leaf sheets. Because of computerization, we do not really need to print many monetary functions, probably not even life tables. All we need is q_x and/or μ_x with a note of the formula and the range of ages for which it applies. Anybody who wanted to use the table could then feed one or other of those three criteria into a computer. We could then have a simple loose-leaf system of q_x , μ_x and formulae. Why not also bring into the loose-leaf system past tables, even, with the Government Actuary's permission, the English Life Tables? If we did that, we could extend it by bringing in any future four-year period which we or the Committee or the profession think is worth graduating. This would mean that we could both go to press on 1979-82 and follow it up almost immediately with 1983-86.

1983-86 is likely to be the last quadrennium in which the effect of AIDS is insignificant. If we were to look at graduated tables every 4 years, we might also get some additional idea of what the effect of AIDS is going to be. The human race might develop some immunity to the effect on the auto-immune system, so the effect might tend to diminish. On the other hand, it might continue increasing. I know that the special committee is looking at this and it is something that the C.M.I. Executive Committee ought also to look at. This suggested presentation offers a possible way of seeing how it affects assured lives and eventually annuitant mortality.

Mr J. R. C. Elmslie: The committee in constructing their report have accepted the methods of the graduated paper (*J.I.A.* 115, 1) too uncritically and effectively they are asking the wrong questions. Nowhere in the report is there a clear statement of its purpose. This is a deficiency and is symptomatic of an even more serious deficiency, that they failed to ask themselves the question. Most people would say that the purpose is to produce mortality tables that represent the actual mortality of the

experience concerned in the period under review, and much trouble has been taken to test the mortality tables produced to see that that is true, but only subject to certain self-imposed constraints.

It has been assumed throughout that the table must be wholly produced by means of a single formula. Professor McCutcheon said in the discussion of the paper that they were enthusiastic advocates of graduation by means of formula. They are unfortunately such enthusiastic advocates that they have taken the answer for granted, and they have not set out their arguments in favour. While I can see some of those arguments, they do not seem to override the importance of producing a mortality table that actually reproduces the experience as accurately as possible. For example, in § 16.2 of the paper it appears that the GM(1,5) formula gives a better fit than the GM(1,3) formula. It has been rejected because the mortality rate would fall above age 98. Presumably the use of the GM(1,5) formula up to age 90 and another formula thereafter would have given a better fit than the one actually used.

I have found it difficult to follow the argument that the formula should produce a tight sheaf. I can see that a loose sheaf is mathematically inconvenient. However, the fact that a mathematical formula is inconvenient to use does not prevent the mortality rates produced by a particular set of parameters from reproducing the actual mortality more accurately than an alternative formula.

Then there is a requirement that the final parameter is significant, which seems at first sight to be an entirely reasonable requirement. If a final parameter is not significant, why put it in? However the authors and the Committee seem to use 'significant' in a different sense from that in which I would use it. For example, in table 17.7 the GM(5,4) formula is rejected because of a non-significant final parameter. However, since it gives considerably better results than either the GM(5,3) or GM(4,4) formula, I do not see how a parameter which converts a bad fit into a good one can be called non-significant in any real sense.

Table 17.9 seems to give a rather poor fit, particularly between ages 73 and 85, where mortality is consistently under-stated. The table 17.10 fit is much better. However, in § 3.3 of the report the Committee merely say that there is a choice between two formulae and choose the GM(2,2) formula, which is the worse one, without any explanation.

If the Committee claim, as they legitimately may, that they have never said that it was their intention to produce the best possible fit, I can equally legitimately say that if it was not, they should have told us what their intention was. If that were not their intention, I think that they are perfectly right. I believe that the real object should have been to reproduce the real underlying mortality after eliminating random fluctuations; or, more accurately, to produce the real underlying mortality as it will be in the future.

One particular difficulty in producing mortality tables is the heterogeneous nature of the ultimate experience. True ultimate mortality is not reached after three or even six years. It is approached asymptotically, and for practical purposes may only be reached after 15 or 20 years. Therefore if you have an experience such as the linked experience, where almost all the ultimate mortality is in the early years, it will produce low ultimate mortality, but if an experience is largely in the later years, it will produce high mortality. Section 5.2 of the report says that "for duration 5+, linked assurances show a significantly lower level of mortality than permanent assurances; there are two reasons, however, why this may not be important", their phrase "may not be important", would be better phrased as "why this may be a false conclusion". I would emphatically agree with them when they say that it is too early to produce tables for linked assurances, although not entirely for the reason quoted.

The use of a formula generally tends to give a good fit over the period where the experience is substantial, but a number of these graduations produce very poor results over the area where there is little experience. Some tables therefore produce quite implausible results over the ranges from, say, over age 70, and in some cases under about age 40. I do not follow the purpose of the Committee in producing these results. They appear to recommend them for use, but this cannot really be their intention.

Question 3 in § 1.2 asks, amongst other things, whether a five year select period should be used for standard tables. For practical purposes it is impossible to do so with these results because, as a result of over-fitting to follow random fluctuations, we have results which I find incredible: for example mortality at duration 3 is lower than at duration 2 at age 40 and higher than at duration 4 at age 70.

The Committee can hardly be suggesting that these rates are suitable. They ask a question which I think cannot be satisfactorily answered on the information given.

In question 4 they draw attention to a point that I have mentioned: that the experience covers a narrower range than may be necessary for practical work. In many cases the upper and lower ranges, if they are included at all, need to be adjusted from the formulae that are used.

Mr P. A. Leandro: It would be a shame if the Committee were only to publish tables of q_x , μ_x or m_x , or whatever without some sample values of monetary functions that could be used to check against. The main use of q_x or any other function would be in computer programmes to aid the calculations. As one who does this quite frequently, I would like to have something to check the answers against. Perhaps the rates of interest that would be chosen for this purpose would be ones that would mean that the maximum number of significant figures could be tested. The range might be -10% , 0% ; and 10% . To have rates across all the age ranges, perhaps at every 5th year of age, would be useful.

Since we now have measures of the standard errors in the graduated q_x , it would be helpful to publish details of the resulting implied variations in the monetary functions. Are these variations significant?

Mr Elmslie gave the purpose of graduating as to get to the underlying rates of mortality which should not cross at different select periods. I would ask the question: why do the real rates have to be smooth? I am sure that they are not. It is only a convenience that we graduate them, and the fact that there are some unusual things happening occasionally, given that we know what the variations are, surely is not something that we would be incapable of coping with?

Mr C. D. Daykin: As a user of the tables I believe that there is some need for monetary tables, not just for checking, as Mr Leandro indicated, but also because it is convenient sometimes to be able to turn up a few values rather than to have to compute the whole table. I think that we should publish some monetary functions, but am not sure that it is necessary to publish a great many of them. Maybe we can publish them at wider intervals of rates of interest than hitherto, and probably only for the major tables: that is, the assured lives, the annuitants, and the pensioners.

There is also a case for making use of some of the many graduations in the paper where the authors have moved into areas which have not previously been graduated. In some cases the experience probably does not justify having a standard table, but in others there is, for instance, temporary assurances, retirement annuities and perhaps widows. In those cases I do not think that there is the same necessity for having monetary functions available. They would only be used by people in more specialist circumstances where they could produce the functions that they required.

Considering the point made by Mr Barnett I think that there is a strong case for using the 1983–86 experience rather than the 1979–82 experience, although I am reluctant to suggest that in view of the amount of work that has already gone into dealing with 1979–82. Nevertheless, it does seem absurd to produce standard tables on an experience which is quite a few years out of date when the new experience is ready.

1983–86 is important from the point of view of AIDS, being the last period of years in the C.M.I. routine which will be free, or largely free, of AIDS additional mortality. The experience for the period 1987–90 or 1991–94 will become increasingly confounded by additional mortality from AIDS cases.

This suggests to some people that there is no need for a standard table, because it will be out of date as soon as it is produced. I do not believe that to be true. AIDS mortality is not capable of being represented by a straightforward age-related table, such as the tables which we are discussing; it is a two-dimensional affair and it is strongly dependent on calendar year. Therefore it will remain necessary for users who want to take into account the impact of AIDS to do that as a separate *ad hoc* exercise using the two-dimensional set of rates for AIDS such as those we produced in AIDS Bulletin No. 2, and building those on to a standard table which is effectively a 'without AIDS' table. For that purpose I think we need a standard table which is as up-to-date as possible pre-AIDS, that is, 1983–86.

Some would say we could perhaps continue to use A1967–70 because it contains a margin as compared with 1983–86, and that will cover the AIDS requirements. Certainly similar arguments

have been advanced by actuaries on the other side of the Atlantic. That is not very satisfactory, because the margins in A1967-70 are clearly insufficient at some ages and clearly too great at others. It is not a very professional approach just to say that they will all even out, because they may very well not even out in a particular portfolio. They certainly will not give rise to very sensible rating of particular products. So in my view AIDS does need to be allowed for explicitly. We do need a standard table which takes into account the latest experience in the absence of AIDS, and we do need to have some monetary tables.

Adding to the additional suggestions made by Mr Barnett and Mr Leandro, perhaps there is a case for having the rates available in the form of microfiche and/or in the form of diskettes, so that they can easily be input into other people's micro-computers. I suspect that many people are using micro-computers now rather than main-frames for this sort of work. If there could be a diskette with the set of standard tables on that would save much inputting of data as compared with only having a loose-leaf binder for the tables.

Mr R. H. Plumb: In recent months we have seen various stockbrokers' circulars proclaiming the advent of take-over bids within the U.K. life insurance industry, partly as a result of the Rowntree successful bid by Nestlé's on the basis that the commanding heights of the U.K. economy are now open to take-over bids. Whether this is the case or not, we are obviously in the realms of speculation, but what I suggest is that it is becoming increasingly important that the financial strength of life offices is actually much more accurately measured than it has been before.

We have the various self-regulatory organizations, in particular FIMBRA, where best advice is required by independent intermediaries, and financial strength is a measure upon which their advice should be given. This has a direct impact because the reserves set by life office actuaries, and the appointed actuary in particular, are obviously going to be related to the financial strength of the life office. Therefore I think that it is extremely important that up-to-date and accurate mortality tables are always used.

It becomes extremely important that the reserves set for AIDS are of the right order, otherwise we are going to be in a situation where some offices are going to be grossly over-reserving. If such offices are mutuals this is all right, but some offices may be seriously under-reserved. This is a subject for the regulatory authorities. However we may have substantial financial activity in the City on take-overs, and it is extremely important that companies are viewed from a proper perspective which implies publishing the 1979-82 mortality table in its final form as quickly as possible, and then following it with the 1983-86.

We are discussing graduation of mortality tables which to many financial pundits would seem to be very far from reality. No longer is that the case. Savings and investment are an important part of the life office operation and for many years we have been able to put mortality tables to one side, but we cannot any longer, we must have accurate measures from now on. Financial strength is going to become increasingly important in our industry. The public will be demanding it and all will be requiring it.

I agree with Mr Leandro that we need published tables so that any computer programmes can be checked, but I suggest that this should be in diskette form.

Mr C. J. Hairs: In §9.7 of the report, it is suggested that we might allow for future improvements in pensioners' mortality by adopting a similar method to that used for a(90) and PA(90), where the rates of mortality were reduced by one year of age for every twenty years of future time. The report states that this figure might need to be altered, but there is no indication of an alternative figure, let alone just how different a figure might be appropriate. Bearing in mind the uses to which pensioners and annuitants mortality tables are put, the basis used to allow for future improvements in mortality requires as much care and attention as the graduation process used to derive the tables of current mortality. Instead of thinking in terms of reducing mortality rates by one year of age for every twenty years of future time I wish to talk in terms of the annual rate of reduction in the mortality rates themselves. A one-year reduction in age for every twenty years of future time is approximately equivalent to a rate of reduction of about $\frac{1}{2}\%$ p.a. in mortality rates for each year of future time.

To look at the secular trend of the C.M.I. results, we need to refer to the previous C.M.I.R. 8. Using

table 3.1.1b, we can see that male pensioners retiring at or after normal pension age experience mortality by amount of 107% PA(90) in the 1975–78 experience; but only 96% PA(90) in the 1979–82 experience. This represents an annual rate of reduction of mortality of over $2\frac{1}{2}\%$, about five times the suggested indicated adjustment of $\frac{1}{2}\%$. An improvement rate nearly as high, about 2% p.a., is shown for female pensioners, and also for post-1956 female and male annuitants at durations 5 and over. This phenomenon at the industry level of C.M.I. reports was quite sudden; and looking at earlier investigations, we see that a much lower rate of reduction in mortality, less than $\frac{1}{2}\%$ p.a. occurred over the period 1967–70 to 1975–78. The Committee's commentary in *C.M.I.R.* 8 indicated that steps were taken to cross-check that the significant change was genuine and not caused by any artifice of the data. The apparent suddenness of the change introduced a problem for the profession and the Committee.

Now considering my own office's experience, because of the large amount of long-term liabilities in respect of pensioners it investigates pensioners' mortality fairly closely from time to time, including the secular trend. Our methods have been somewhat pragmatic and relatively un-refined compared with those used here. Using the method of least squares, nonetheless, we plot a straight trend line through the actual to expected ratios exhibited year by year. We fitted trend lines to the overall results for the period 1971–87; and also to quinquennial age groupings for nearly the whole period, 1974–87. Overall, we find a rate of reduction in mortality of just over 2% p.a. in aggregate. Trend lines fitted to the early part of this period suggest that the trend of improvement was less in early years, but still steeper than that revealed in the corresponding tables in *C.M.I.R.* 8, and vice-versa for the later years. This, on an overall basis, is some 4 times as great as the suggested rate of improvement in §9.3. When we look at the trend by ages, however, analysis in quinquennial groupings indicated a reduction in mortality at ages 66 to 75 of approximately 3% p.a.; but about half this rate at older ages. This suggests that not only is the rate of mortality improvement higher than suggested, but also that the rate of improvement varies quite considerably according to various parts of the age range.

I commend to the Committee that attention be given to deriving a more satisfactory basis than the suggested 1-in-20 approach for estimating future improvements in mortality for pensioners and annuitants. In my office we feel comfortable only with a graduation of the latest annuitants' and pensioners' mortality, as in the paper. We can then make adjustments as necessary to allow for our own views as to improvements in mortality occurring since the investigation period, as well as future improvements in mortality.

Professor A. D. Wilkie: The a(55) annuitant table produced a useful practical result, but in rather an odd theoretical way. It derived a two-dimensional table based on age and future calendar year by calculating annuity values at some particular rate of interest for those entering in 1955, calculating the implied rates of mortality that would have reproduced those same annuity values if it had been a single life table, and then re-graduating those rates.

The Committee, after graduating the 1967–70 experiences, took a different view about what to produce for a forecast table, and produced the PA(90) one, which was simply the forecast experience table for 1990. The reduction of 1 year in 20 is very closely equivalent to a constant percentage reduction at each age. Indeed, if the formula used were a Gompertz, $GM(0,2)$, formula it would be exactly equivalent to a constant percentage reduction in μ_x . The reduction of 1 year in 20 was equivalent to a constant reduction at each age rather than a varying reduction at each age. It has proved wrong and should have been more like 1 in 10, but as has been pointed out, it was not a smooth change, but rather an abrupt one. Figures in table 3.1.2 of *C.M.I.R.* 8 show the aggregate actual over expected mortality for males of all ages for successive years 1975, 1976, 1977 and 1978, and for 1979, 1980, 1981, and 1982. The percentages A E for the first 4 years were 100, 105, 101, and 101. So far they have been pretty level. The figures for the second 4 years are 92, 93, 91 and 91. Again they have been pretty level, but there was a 10% reduction in mortality among these pensioners between 1978 and 1979—an extraordinary drop in one year of the experience.

What is the right form for practical use for a table which takes account of improvements in mortality? The theoretically correct form is possibly a two-way table by calendar year of birth and attained age, or calendar year of experience and attained age. It could be expressed either way. Although that is one way of approaching it there may be other more practical ways of doing it. A two-

way table probably does not fit into most offices' calculation systems. Is the approach of PA(90), although with a different base and a different projection factor, to produce for example, a projected experience table for 2005 or 2010 practical?

Mr A. R. Armitage: Trying to answer Professor Wilkie's question the main thing we want to do is to quantify the extent of the trend. We do not know it exactly. In a way we have the same problems as we have for AIDS: but whereas with AIDS we need to say that this is the standard mortality now, and there will be some heavier mortality to be added on top, it is the reverse for pensioners' mortality. Therefore I suggest that we have a standard table and use the rates of improvement at ages 60, 70, and 80 to build up our tables as we go along.

Mr M. H. Westley: The figures for pensioners' mortality A/E, year by year, that Professor Wilkie just gave tempt me to ask whether there was any large life office that came into or went out of the investigation in 1979? That leads to a more general point: all these investigations are based on subsets of the population at large, and the report seems to show that statistically these have different experiences. Even within the assured lives group there are significant differences between the various investigations. What the report does not say is whether this is a difference in the class of lives insured by the same offices, or whether it is different offices contributing the bulk of data to the different investigations. I wonder whether we could carry out some form of Latin Square analysis by lumping all the investigations together to produce one grand mortality table, deriving a mortality ratio for each office, and then calculating the mean mortality ratio for each investigation, weighted according to the volumes of data from the contributing offices, and then see whether that standardized mortality ratio actually explains the difference between the investigations?

Mr B. Hayes: The committee poses the question of publishing a whole series of standard tables. It does not press the point, but it seems to envisage completing the full matrix of possible tables. While male/female mortality may have a physiological base, other factors must be considered to rationalize the different mortality experience of different groups. For temporary assurances, for instance, the primary reason for lower mortality experience is possibly the different proportions of married persons effecting such assurances, although I concede that underwriting may have some effect.

Marketing and underwriting changes, for example in response to AIDS, which upset the mix of people effecting such assurances or the availability of such products, could quickly make any standard tables for temporary assurances redundant, even as a core reference. That could be a trap which might waylay the unwary.

Rationalizing different mortality experiences for linked assurances, as against so-called permanent assurances, is a little more difficult. While more recent unit-linked variants might on occasion be more akin to temporary assurances, so high is the cover per unit of premium, most linked assurances are as permanent as any of the more traditional plans. Such divergence as does arise might merely reflect differences in marketing philosophy between offices and be no more significant, or perhaps as significant, as the differences in the experiences of the contributors to the main investigation. There are light and heavy offices in the main experience, but we continuously talk about 'the experience' for whatever period. We are in reality talking about an aggregation of experiences. Unit-linked possibly just presents a different balance of light and heavy, reflecting the different marketing emphasis of different offices. What is important for the actuary is that he understands where he stands and where his office stands as against the core reference, whatever that might happen to be. I see tremendous danger in producing many standards which are then given a credibility beyond what is proper. I see no point in, or rational basis for, a separate linked investigation and call for its abandonment or its merger into the main investigation.

For a long number of years the Irish investigation included, innocently, linked business, because nobody in Ireland thought that there was a difference between a permanent assurance and a linked assurance. This leads me to comment on the question raised by the Committee in § 8.6 of a possible separate Irish table. We recently considered the question at the appropriate sub-committee of the Society of Actuaries in Ireland and we concluded that there was no demand for a separate table. The

consensus was that the standard U.K. experience for the tables was more than adequate, with actuaries making such adjustments as reflected their own marketing plans and business mix.

The comparison of Irish assured lives mortality with the corresponding U.K. experience in table 8.2 shows a much different pattern to the corresponding comparison of I.L.T. 10 with E.L.T. 14, both of which cover the 1980-82 period. The difference in population mortality is much less pronounced particularly at ages over 40. The greater divergence in assured lives mortality reflects a number of factors. Underwriting in Ireland may be much less efficient than it is in the U.K., reflecting perhaps the non-comprehensive nature of private medical records. The availability of ordinary branch life assurance in the Republic may be wider, reflecting the popularity of group deduction schemes. A higher proportion of the lower socio-economic groups may be represented in the Irish experience as compared with that of the U.K., and it would be of interest to see whether this affects the C.M.I. experience; whether the heavy offices are those who are heavy in this deduction scheme business and whether the light offices are those who are not. There is a need to know what is behind the experience rather than take any standard table as an underlying law of mortality.

Mr R. Chadwick: As Professor Wilkie described, the a(55) table took a certain approach to the two-dimensional problem of annuitants' mortality, but a different approach was taken in a(90) and PA(90). These tables are derived from the life office experience of pensioners' mortality, but they are also used for self-administered pension schemes, for which the experience, were it able to be pooled, would probably be 4 or 5 times greater than that of the life offices. It is rather ironic that we work that way round and it is not a good reflection on the actuarial profession generally that that is the case. There is a rather more worrying habit which many actuaries adopt for ease of practice and that is a tendency to use available tables, as published in one-dimensional form. For current annuitants this could be criticized in that they may be used for a year or two either side of 1990, which is the year for which they are meant to apply. However the one-dimensional tables are also used for valuing deferred liabilities. Some actuaries may use PA(90) and think they are being extremely up-to-date by using this rather than a(55), but they seem to ignore the fact that the liabilities are not going to mature for 10, 20 or 30 years. If the C.M.I. Committee were to publish two-dimensional tables in some form, I think that the bad habit is more likely to be overcome.

I am surprised that more work on cohort mortality generally has not been done, not only as it applies to annuitants, but also to assured lives. It is obviously true that today's 40-year-old, let alone today's 20-year-old, with the AIDS threat around is not going to experience the same mortality in 10 years' time as today's 50-year-old or even more so today's 30-year-old.

Mr G. R. Stephen: We see some particularly unusual features in that the crude mortality rates of assured lives at advanced ages tend to decrease with age. There have been a number of suggestions involving class selection and some inherent features of the population. All of which suggests that there is considerable heterogeneity being exhibited. Offices may well have been writing business at advanced ages in greater volumes in recent years. The selection procedures, whether by the proposer or by the underwriting process, may mean that the form of temporary initial selection that we see last for and to a greater extent more than the five years that is normally investigated, and also that there may be, class selection taking place.

I would be unhappy about using a table as graduated at present either for valuation or for the assumed future experience when profit testing. I suspect that we are producing tables at advanced ages for temporary and permanent assurances which are not much use to us.

Professor A. D. Wilkie (replying to the discussion): Concerning the point about permanent assured lives, if we look at figure 17.5 of the paper, that is the graduated rates for durations 5 and over, we see that at the very high ages the experience rates do seem to drop. Possibly the reason for that is that offices have actually lost touch with people at these very advanced ages. Although we ask that offices should exclude such data from their returns some may still get in. So in fitting the graduated formula to the data we have stopped at aged 90 and then projected upwards in what virtually looks like a straight line. If that straight line is not in roughly the right place, where should it be? I did not gather

from Mr Stephen whether he thought that that straight line should be higher or lower. It is much higher than the crude experience. Have we taken it too high? Is it important at those ages? Obviously it does make a considerable difference to the reserves for people aged 97, but how significant is that in the totality of an office's business? I cannot believe that offices have been writing new business specially for 90-year-olds and not for 80-year-olds, for example, or rather were so doing 5 years ago, because this is duration 5 and over experience that we are looking at.

I would imagine that people would like a new assured lives standard table based either on 1979–82 or on 1983–86. The 1979–82 experience cannot be derived from the A1967–70 tables, simply by an age adjustment, because of the fall in mortality in the twenties of age. A percentage adjustment is not too bad, but a new table looks right.

Would a two-year or a five-year select period be right? The data can justify five-year selection and suggests something beyond 5 years. For practical purposes, is 2 years sufficient? From your reactions it is worthwhile at least publishing both.

In reply to Mr Elmslie, the Committee's objective at this stage was simply to graduate the experiences, to present this to the profession, and then to say: how should we adjust these experiences to provide suitable standard tables? We know that at young ages and high ages we need to make adjustments in some cases. One of the reasons for choosing a particular formula rather than another was that it was less likely that we would have to make adjustments if we chose a formula that had a suitable shape rather than one where mortality reached a peak at age 95 and started dropping again, which would not be liked. Obviously the projections for pensioners are nonsense for young ages; they are not based on any data, but are just where the formula happens to project. If we are going to produce a pensioners' table which might be used for early retirement or for widows or widowers, we must construct reasonable rates down to about age 20.

There does not seem to be any special demand for separate tables for medical and non-medical.

Considering §4.5 of the report, Mr Hayes has suggested that it is a good idea not to have too many different standard tables for different experiences, but to have one set of standard tables perhaps for assured lives, and then be able to adjust that for temporary assurances, Irish experience and so on. From your reactions too many standard tables are not popular, so we do not need to do much more about temporary assurances. We are also not proposing to do much more about linked assurances.

Concerning females, the main question is: should we, for assured lives, produce parallel tables for males and females, as the committee has always done for annuitants and for pensioners? Offices, on the other hand, have generally dealt with female premium rates with just an age adjustment. There seems to be general agreement to have sets of what might be called A1979–82M and A1979–82F tables, that is parallel tables for males and females.

The position in the Republic of Ireland has been briefly discussed by Mr Hayes, and we can take up the point that maybe there at least the linked experience and what we have called permanent assurances should be amalgamated. We receive the experience of linked data from Ireland, but because only two offices contribute we have felt inhibited in publishing it.

The immediate annuitant experience has not improved rapidly in quite the same way as the pensioners' one has. Is it desirable to have an up-dated table or will a(90) be sufficient for the time being? Would an up-dated table be rather a nuisance? Would it be better to put everything on to a new 1979–82 base?

Retirement annuitants seem to be a particularly interesting group, but because of changes in legislation from 1st July 1988 they will cease to exist as a new class of business, being replaced by personal pensions in general. They are particularly interesting in that the mortality experience of the deferred section is extremely light from ages 55 to 70 or so, where the deferred and the vested sections overlap. It has been suggested recently that the mortality experience of the deferred section is particularly light because it includes non-returnable annuities, and the offices never hear if the person dies. We shall need to investigate whether that might be the case. The interesting thing is that the combined experience is quite sensible and fairly smooth. It does suggest that the self-employed, or those who take section 226 annuities, choose to start drawing their annuities at a time when their health gets rather worse and they do not draw their annuity so long as they are quite fit. That is a curious form of selection in favour of the life office, but is perfectly understandable on other grounds. What the Committee would like to know is whether there is any desire for a retirement annuity table

at all or is it better just to use the assured lives table in some form in the deferred period and another annuity table in the vested period? There seems to be no support in favour of a standard table for retirement annuitants.

We need something new for pensioners. We have already discussed the possible forms of projection. The Committee has never suggested producing a separate standard table as such for early retirements, although the experience has been graduated and presented here. Presumably new standard tables should preferably be based on 'amounts' rather than 'lives'. A lives table was published along with the PA(90) tables, but nobody uses PL(90).

Should an up-dated replacement for PA(90) go down to young ages, even though we have very little experience? It has been suggested that it ought to go to age 16 rather than 20, because there may be people in the workforce at 16. It might be convenient if the mortality rates roughly represented in-service mortality at the younger ages so that a single table could be used throughout for pension fund purposes.

Widows of life office pensioners, a new and interesting experience, have substantially higher mortality than female pensioners; the same sort of level of mortality as early retirement female pensioners. There could be several reasons for this greater mortality. Female pensioners are those who were at work, whereas the widows of pensioners may include those who are sufficiently disabled not to have been able to work. It is very much an aggregate population-type experience. I have heard from colleagues elsewhere that the experience of widows of certain quite large pension schemes is not significantly worse than that of female pensioners, so maybe the C.M.I. experience is unusual. Your views seem to be mixed on whether there is any demand for a separate table for widows which would be a little heavier than the pensioners' table.

The Committee published the female assured lives table, FA1975-78, as a 16-page document with the mortality table and an introduction, but no monetary functions. I have had the impression that because it was so small it gets lost and is hidden between other books. People may believe that it is not a real, standard table unless it is in a big volume with monetary functions. Thus a book of 200 pages at a substantial cost per volume is desirable whereas something too slender does not carry enough weight. Would offices rather have that? We are not only thinking about large organizations that can calculate the tables quickly, but consulting actuaries working single-handed or offices with only a single actuary in them, and wanting something that they can lay their hands on and open up fairly easily rather than having to turn to a computer to get values. I suspect from what has been said that the right sort of approach would be a set of single-life mortality functions at a limited number of ages so that there would be something to use for spot checking or for individual interesting answers—something like 0%, 4%, 8% and 12%, or 0%, $2\frac{1}{2}\%$, 5%, $7\frac{1}{2}\%$ and 10%. There seems to be general approval for some monetary functions for each mortality table that is presented as a standard table, and for their production in a single volume.

Mr Elmslie asked why we did all this? It was in order to present experience mortality rates which we can compare with one another and which will form the basis of subsequent standard tables. Why did we use the methods that we did? It was partly because there were so many rates to graduate. In the final section of the report there are 109 separate graduation tables, and we needed some method for mass-producing them. It is possible that we could have got better answers by more critical examination of each separate table, but we could not have managed it in quite the bulk that we did.

The reason why the size of the sheaf is important is that empirically, if we start fitting too many parameters, the sheaf starts getting very wide. It is as if there was only so much information to go round and to spread it over too many parameters makes it difficult to know where the rates are.

When talking about the significance of the last parameter fitted, we mean significance in a purely statistical sense. Is the value of the parameter greater than roughly twice the standard deviation away from zero? It is difficult to define one criterion for choosing between a large number of different attempted graduations, and in §§ 15, 16 and 17 of the paper we have tried to describe the criteria that we have used in a subjective but fairly consistent way. Other people might have finished with different answers. There is no unique answer to choosing which order of formula to use, although, having chosen the order of formula and having chosen to do it by maximum likelihood estimations of the parameters, there than is a unique set of parameter values.

There have been suggestions from a number of speakers about looking at the variation by office.

The Committee will consider the extent to which it can do that without breaching the confidentiality which it is important that the offices' returns maintain. I should emphasize that the members of the Committee never see the results for individual offices, even anonymized. Clearly people within the Bureau see them, and they retain them confidentially and have the confidence of the Committee in doing that. The Committee itself does not know the results of individual offices, and does not know even the scatter of results of individual offices, although that was the sort of thing that was investigated when the A1924 29 'light' and 'heavy' experiences were produced. We can see that some indication of the variation by office could be of importance and that there is some suggestions of demand for it.

The Committee feels that the discussion has been very helpful, we have had the views of the profession on the work that we have done so far and we will go ahead, over the next time period, and will prepare and publish, probably without needing to come back to the profession again explicitly, standard tables for use by actuaries and life offices in all the circumstances that seem appropriate.

The President (Mr R. D. Corley): I should like to thank you for being such an attentive audience, and particularly to those who have made a contribution during the morning. We did need it; we have made a note of it; we will use it. On your behalf I would like to thank our three authors, Professor McCutcheon, Mr Forfar and Professor Wilkie, and say that those of us who have been sitting and listening feel that the morning has been worthwhile.