TRANSACTIONS OF SOCIETY OF ACTUARIES
1964 VOL. 16 PT. 1 NO. 45

VOL. XVI, PART I MEETING NO. 45

TRANSACTIONS

JUNE, 1964

KING'S DATING METHOD IN A HEALTH INSURANCE VALUATION SYSTEM—ACTUARIAL NOTE

E. PAUL BARNHART

HEALTH insurance valuation and experience records involve several considerations which impart renewed practicality to the use of the "King intervaluation method"[1] as a basis for dating policy records. There is considerable discussion in the literature[2] concerning the merits and demerits of this method, usually in reference to life exposure formulas. The chief objection that has been advanced against King's method appears to be that it is simply impractical to attempt to convert existing records to fit it, regardless of any advantages. On two occasions, however, it has been my task to create a valuation and statistical record system for use with individual health insurance where there were either essentially no existing records, or else the existing records required such drastic overhauling to render them adequate for actuarial use that it was easy to include conversion to the King method along with all the other reconstruction needed. I expect that similar circumstances are likely to be encountered by others who have been assigned the responsibility of developing adequate actuarial records for use in health insurance, and this paper is therefore presented for the purpose of describing those considerations which led me to adopt King's method when it became possible, practically, to do so.

For those not immediately familiar with the method, a brief description will be in order. Both an "Office Year of Birth" and an "Office Year of Issue" are determined, which are quite independent of the age rules actually followed in issuing the policies. "Office Year of Birth" may be assigned according to the January 1 nearest to the actual calendar date of birth of the insured. Thus an insured born June 15, 1920, will be given an "OYB" of 1920. If the birthdate is July 15, 1920, the "OYB" becomes

[1] Originally suggested by George King in a note printed in *JIA*, XXVII, Part I, 218.

[2] E.g., Wolfenden, *TASA*, XLIII, 259; XLIV, 67; XLV, 50; Marshall, *TASA*, XLVI, 25; Beers, *TASA*, XLVI, 361; Gershenson, *Measurement of Mortality*, p. 115.

1921, the dividing date being July 2. These rules can be followed regardless of whether the insuring age at issue is determined by next, nearest, or last birthday, or even some other basis. As presented above, the rule itself will lead to valuation and morbidity experience analysis on an "age x nearest birthday" basis. One could just as well adopt rules appropriate to, say, an age last birthday basis, in which case all persons born from January 2, year N to January 1, year $N + 1$ would have an "OYB" of $N + 1$ in the records. The essence of the King method as presented in this note is to date in reference to January 1, independently of whatever rules determine policy issue age.

A similar rule governs the "Office Year of Issue." Policies issued July 2, year $N - 1$ through July 1, year N have an "OYI" of N. Issues of July 2, year N through July 1, year $N + 1$ will have $N + 1$, and so forth. This rule is invariably followed for office year of issue, since the object is to set up dating on a calendar-year basis. Hence there is no alternative, as with office year of birth, of dating by the January 1 next following actual date of issue or some other rule. It will be evident that under this method all policy years are treated as commencing on January 1.

When only year of birth or year of issue is recorded, it is obviously most difficult ever to convert to conventional dating, or vice versa. Column limitations in a punch-card system may therefore commit the system to remain more or less permanently on the initial basis. With a modern tape system, where record content may be more extensive, it is usually possible to record year, month, and day of actual birth and of actual issue, so that even though the King or a conventional method is originally adopted for valuation and statistical processing, these functions may be readily converted at a later date, if this is desired, to another method.

With this as introduction, let me turn now to the reasons for adopting the King dating method.

I. A RECORD SYSTEM INDEPENDENT OF MIXED AGE AT ISSUE RULES

One of the systems I had to construct dealt with a wide variety of in-force business. Some of this had been issued age at last birthday, some age nearest birthday, and some even age next birthday. Obviously, use of a conventional dating method would have forced separate identification of each such block, together with use of valuation reserve factors or formulas adjusted to be consistent with each. In life insurance, this may not be much of an extra problem, since as often as not these different blocks of business will also be subject to valuation on different mortality and interest bases, and different tabular factors are necessary anyway. But in health insurance, it is normally possible to value all business on essentially the same underlying morbidity and interest basis. Thus, while adjustment for benefit variation from one plan to another is of course necessary, it may prove convenient to avoid further differentiation arising from diverse age at issue rules. We had a few plans where the issue age basis was changed without, at the same time, adopting any other revision. With the King method, it is possible to handle such a plan as a single valuation block.

In connection with the fact that the records are independent of the age rules, it has long been recognized that the King method is able to eliminate certain types of bias from the data. In fact, this ability of the system was the major reason why Mr. King originally proposed it, since he found it to be more accurate than the conventional alternatives.

For example, if it is known that an abnormal proportion of the business is issued just prior to an age change, the age data will be distorted. The King method eliminates this type of bias. It must be realized, however, that this may, in practice, be a *disadvantage*. If the business in fact involves such age bias, it may prove to be preferable to analyze experience on this basis, deliberately retaining the bias so that experience costs will be consistent with the true incidence of gross premiums. I did not feel, however, that this was a serious enough consideration, in the data I was working with, to outweigh the advantages favoring the King method.

II. MORBIDITY ANALYSIS IN WHICH "OFFICE POLICY YEARS" AND CALENDAR YEARS BECOME IDENTICAL

Every student of exposure formulas becomes acquainted with the fact that policy-year and calendar-year studies each possess certain advantages over the other. To a certain extent, the King method makes it possible to have the "best of both," although this happy state of affairs must be enjoyed with some definite caution.

With health insurance, the relatively high frequency of claims usually makes it convenient to deal with claims by calendar year of incurral rather than by policy year, to avoid the more detailed dating involved in policy-year studies. Furthermore, the more rapid movement of secular trends in health insurance experience make calendar-year studies more advantageous. Policy-year studies are normally done at relatively infrequent intervals. Thus calendar-year investigations are relatively more advantageous with health than with life insurance studies. With the King method, it becomes practical to carry out calendar-year morbidity studies on a select basis (a serious disadvantage of calendar-year studies under conventional dating). To accomplish this, the same office year of birth and office year of issue rules are followed on claims as on the exposure. The claim-incurred year, however, remains simply the calendar year in which the claim is incurred.

This results in some unique handling. The records will contain some first-year claims showing an incurred year prior to the office year of issue, and a rule must be used assigning such claims to the following year. This does not result in a built-in overstatement of claims assigned to the first year, since other policies will be exposed as being in the first year for less than one full year, offsetting these cases which are treated as exposed in the first year for longer than a full year. To illustrate, a policy issued August 1, 1963, will, in a select study, be handled as though exposed within the first policy year for 17 months, since any claim incurred prior to January 1, 1965, will be considered incurred in 1964 and the office date of issue is regarded as January 1, 1964. Similarly, a policy issued June 1, 1964, will be exposed as first year for only 7 months, so that the two cases compensate and result in a total first-year exposure of 2 policy years. This reasoning ignores the unbalanced effect of first-year lapses, however, on fractional premium policies. This effect will normally result in some *understatement* of the aggregate first-year exposure, the difference being spread into the later durations. This understatement is not a relative understatement in comparison to the claims, but rather a shift of some of both claims and corresponding exposure into the second year. It is my opinion that this is not a significant defect in most health insurance studies, but this remains as one potential difficulty that calls for some caution. A more serious defect than this understatement of first-year exposure volume is the fact that a portion of what is truly second-year exposure is regarded as first-year and vice versa, the same being true of each consecutive pair of years. The experience should be tested to determine whether this inherent error is likely to lead to any significant distortion of select results. The over-all effect of the exchange between years involved is partially self-canceling, and even if the result is, say, slight overstatement of first-year select costs, there will be a compensating understatement in renewal costs, so that the net ultimate error is apt to be, at worst, a slight distortion in the persistency and interest discount applied to a small portion of the costs in subsequent tests or calculations. Again, however, caution must be observed.

The exposure itself must be measured carefully in a select study on the King method. For example, the common and simple technique of averaging the valuation in force at the beginning and at the end of the calendar year is apt to understate the first-year exposure, since new policies are actually observed, on the average, starting several months after their true anniversaries, and lapsation will again cause distortion. A more accurate method, which is the one I adopted, is to use an additional "entry" date field showing the year and month the policy actually entered the exposure. The exit field also shows actual year and month. Thus a policy issued August 1, 1963, is measured as actually exposed from August 15, 1963, until the middle of the month of lapse or the end of the observation period, even though it is still viewed as an "office" issue of January 1, 1964. As mentioned above, it will be measured as exposed for up to $16\frac{1}{2}$ months during the first "office policy year" of 1964. If year, month, and day of issue are recorded, as mentioned earlier, this extra field may be dispensed with, since both exposure and office year of issue may be derived from the information. In my own system, however, I retained the "entry" field as a means of dating in-force changes occurring in the records, and we continued to measure amount of exposure by this field.

III. VALUATION USING TERMINAL RESERVES

While terminal reserve factors are simpler to compute than mid-terminals, this is a very slight advantage of the King method in view of the widespread use of computer techniques at the present time. My comments here are not intended to represent this as any particular advantage commending the system but rather to point out that terminal reserve factors will be required instead of mid-terminals and to discuss what changes, if any, will result in aggregate valuation reserves as a consequence.

Consider the amount of insurance which, under conventional dating, falls into the cell (x, N) representing valuation issue age x, issue year N in valuation year T. Assume the policies to be issued age nearest birthday and that t represents the "valuation" policy duration in year T of policies issued in year N according to whatever method is being employed (e.g., two-year preliminary term), x also being so determined. Thus the conventional mid-terminal factor or reserve per unit amount in-force will be

$$\tfrac{1}{2}({}_tV_x + {}_{t+1}V_x) ;$$

and, assuming that (x, N) has an in-force volume of $2A$, the aggregate reserve for this valuation cell will be

$$A({}_tV_x + {}_{t+1}V_x) .$$

If this same block of business is dated by King's method, it will fall into four different cells, which we identify as follows:

$$(1): {}^k(x, N+1);\ (2): {}^k(x+1, N+1);\ (3): {}^k(x, N);\ (4): {}^k(x-1, N) .$$

Now let us assume uniform distribution of the business in original cell (x, N), both as to issue date during the calendar year and as to birthdates for any given date of issue. Then the volume of insurance $2A$ divides among the four King cells, respectively:

$$.75A\,, \quad .25A\,, \quad .75A\,, \quad .25A\ .$$

The unit reserve for each King cell will be, respectively,

$$_tV_x,\ _tV_{x+1},\ _{t+1}V_x,\ _{t+1}V_{x-1}\ ,$$

and we can construct the following chart exhibiting the various portions of the two aggregate reserves in comparison:

King Method	Conventional Method
(1) $.75A\,_tV_x$	$.75A\,_tV_x$
(2) $.25A\,_tV_{x+1}$	$.25A\,_tV_x$
(3) $.75A\,_{t+1}V_x$	$.75A\,_{t+1}V_x$
(4) $.25A\,_{t+1}V_{x-1}$	$.25A\,_{t+1}V_x$

(1) and (3) are identical, so that the King reserve is less than, equal to, or greater than the conventional according to whether

$$(_tV_{x+1} - {}_tV_x) \lesseqgtr (_{t+1}V_x - {}_{t+1}V_{x-1})\ .$$

The scales can tip one way or the other depending on the range of x and t, the benefit valued, and the reserve basis, so that no ready conclusion may be drawn. Most companies probably have the bulk of their health in-force falling at short durations of less than 5 years or so. To take one example, if we are considering guaranteed renewable to age 65 hospital policies on men being valued on the 1956 Intercompany Tables with 1941 CSO mortality at $2\frac{1}{2}$ per cent, and most of the business is of short duration, not over 6 or 7 years, then for both daily room and miscellaneous benefits the right-hand term above exceeds the left up to roughly male age 40, while the reverse is true above this age. Hence, if the average age of male policyholders is quite young, the conventional reserve will probably be larger, whereas if the average age is rather high, the King reserve is probably greater. If $t + 1$ is the first year beyond the preliminary term period, so that the left-hand term is still zero, the balancing age will be a little lower, around 34 or 35.

A more realistic situation results if, instead of assuming uniform distribution in all respects, we assume a steady increase in volume in-force as issue dates progress through the year. To test this circumstance, let us assume that the annual rate of in-force density for issues of January 1 is $2A$ and that the density progressively increases over the year at an annual rate of 10 per cent, whereas uniform distribution of birthdates still prevails so far as issues of any given date are concerned. Hence for the conventional cell (x, N) the total volume in-force will be

$$2A\int_0^1 1.1^y dy = 2.0984A .$$

The volume distributed over the 4 King cells will now be

$$.8075A, \quad .2669A, \quad .7664A, \quad \text{and} \quad .2576A .$$

We now have this chart comparing the two reserves:

King Method	Conventional Method
(1) $.8075A\,{}_tV_x$	$.8075A\,{}_tV_x$
(2) $.2669A\,{}_tV_{x+1}$	$.2417A\,{}_tV_x$
(3) $.7664A\,{}_{t+1}V_x$	$.7664A\,{}_{t+1}V_x$
(4) $.2576A\,{}_{t+1}V_{x-1}$	$.2828A\,{}_{t+1}V_x$

On the right, the volume factors of (1) + (2) and (3) + (4) both add up to $1.0492A$, one-half the total volume of $2.0984A$. Again, (1) and (3) are identical, so that the King reserve is less than, equal to, or greater than the conventional according to whether

$$.2669\,{}_tV_{x+1} - .2417\,{}_tV_x \lesseqgtr .2828\,{}_{t+1}V_x - .2576\,{}_{t+1}V_{x-1} .$$

If we express ${}_tV_{x+1}$ as ${}_tV_x + k$ and ${}_{t+1}V_{x-1}$ as ${}_{t+1}V_x - m$, the above reduces to

$$.0252\,{}_tV_x + .2669k \lesseqgtr .0252\,{}_{t+1}V_x + .2576m .$$

For all but the oldest issue ages and longer durations, ${}_{t+1}V_x$ exceeds ${}_tV_x$ by an increment far larger than k or m, so that in most situations the King reserve will undoubtedly be less than the conventional. For example, take the $100 miscellaneous hospital benefit, male issue age 35, duration $t = 5$. In this case, ${}_{t+1}V_x - {}_tV_x$ is of the order of $3.80, k about $.02, and m about $.04, so that the left-hand term above is obviously the lesser, and the King reserve is less than the conventional for this valuation cell, as for most. The conventional reserve overstates a "true" theoretical reserve, since the use of mid-terminals assumes uniform distribution which is not the case here. The King reserve probably understates the true reserve by about as much as the conventional overstates it. Unless the in-force is extremely skewed, these differences are unlikely to have any great significance.

IV. CONCLUSION

All things considered, it is my opinion that the King dating method confers at least the tangible advantages discussed under points (1) and (2) above, and I would recommend it for consideration to anyone engaged in setting up a health insurance actuarial record system whenever the circumstances are such that adoption of the King dating can be practically accomplished.