TRUE INHERENT HAZARDS AND THE FUTILITY THEREOF

John W. Carleton
(introduction by Robert A. Bailey)

June 22, 1992

Enclosed is a copy of an actuarial paper on the subject of Fair Discrimination in Insurance Rate Regulation which was written April 11, 1950 as a personal and confidential letter from John W. Carlton, then Actuary of the Liberty Mutual Insurance Company, to Arthur L. Bailey, then Actuary of the New York Insurance Department. It was part of the help my father received in preparing the paper he presented to the CAS on May 22, 1950 entitled, Credibility Procedures - "LaPlace's Generalization of Bayes' Rule and the Combination of Collateral Knowledge with Observed Data." It could be considered a review of that paper.

I have enjoyed reading this paper several times over the years. It remains as relevant now as it was when written. I believe enough time has passed to permit its release.

Robert A Bailey

April 11, 1950

STRICTLY PERSONAL

SUBJECT: TRUE INHERENT HAZARDS AND THE FUTILITY THEREOF

Dear Arthur:

This letter is prompted in part by various discussions we have had in the past regarding fundamental approaches to insurance ratemaking.

It is recognized that my contributions to these discussions occasionally may have seemed facetious to the point of irresponsibility. The observations which seem troublesome and the inferences which seem to flow from them require a nice balance between humor and serious consideration. Anyone who appears to believe that ignorance is an asset which the insurance industry should not dissipate thoughtlessly runs the risk of being thought of as either an irresponsible person or a futile humorist. Neither characterization is sought, but the latter is preferred to the former. Please give me the benefit of the doubt as you go along. Also, please keep this letter to yourself.

Nevertheless, if the fundamental approach to the pricing problem in insurance which you seem to accept is correctly understood by me, then it is of some importance that it be examined with care. It is stressed that concern is with the basic approach and not the improved techniques with which you from time to time suggest the industry implement that approach. Minor differences of opinion in the latter are separate issues.

The careful examination of this philosophy of pricing is of some importance for at least two cogent reasons. First, in the intensified operation of state rate regulation, the pursuit of this theory is bound to have some influence on required expense loadings, even if only to maintain the status quo. Anything which has a significant influence on the amount of money which the public pays the insurance industry to handle its loss dollars should not be taken for granted. Second, the pursuit of this theory may operate to make the product which the industry sells less and less what the customers want to buy. With regard to this reason it seems desirable to remember that the nature of the insurance business is such that the price structure is an integral part of the product that is sold to the public. Both of these reasons would seem especially cogent to those who want public support for the free enterprise system of insurance.

To give continuity to what follows, it may be well to provide a preliminary outline. First, I'd like to set up a concept of true inherent hazards. Second, I'd like to describe the operation of a ratemaking system which purports to provide as a pure premium for each risk (or maybe each class of risks) the best statistical estimate of the true inherent hazard. Next, effort will be made to tear down the true inherent hazard concept — and with it the rationale for a ratemaking system which sets up its measurement as a goal. Fourth, there will be reviewed the well-known circumstances which seem to make it necessary that some such ratemaking system be used if competitive carriers are to be expected to provide a market for substantially all comers — whether the system has a statistical rationale or not.

After four above, I am very much puzzled. It is hoped you are the same. In the rest of this letter, the puzzlement is used to justify a somewhat different standard of fair discrimination than is implicit in the pursuit of the inherent hazard approach.

You have from time to time expressed reluctance to provide a definition of the true inherent hazard on the grounds that as an unknowable it, according to furnished authority, does not lend itself to a certain kind of definition. Nevertheless, from the manner in which you use the expression I have acquired a concept of what I think you mean which, it is believed, can be conveyed in language even if not precisely defined.

Your good friend, Bertrand Russell, admits as valid for conveying ideas what he calls ostensive definitions. It is believed that by pointing at a static model, the idea which I have of your true inherent hazard can be conveyed without undue loss from one party to another.

If there is a dice box with ten dice in it, and if the person rolling the dice loses a dollar for each spot, then the numerical value of the inherent hazard for the roll is $35. The operations which comprise the Risk for the policy period is represented by the rolling of the dice. Seemingly, any risk can be represented this way, although, of course, small fire policies and the like would require polyhedral dice with blank facets predominating. Needless to say, in the insurance business only the total number of spots is known after each roll. The number of dice in the box cannot be directly counted or otherwise determined either before or after rolling.

You once commented on the small inherent hazard associated with large retrospectively-rated risks with high maximums. It is assumed that you had reference to the portion of the total inherent hazard assumed by the carrier. Since rating is concerned only with hazards assumed under specific contracts, it might be thought necessary to delimit the concept so that it will relate only to the hazard transferred contractually. However, it is thought that if this nicety were supplied, it would not interfere with or contribute to the ideas to be discussed. It is more convenient to think of the inherent hazard as an attribute of the insured, all or part of which may be transferred by the insurance contract.

It is, of course, possible to express this "expectation of spots" as a symbol with a mathematical definition sufficiently general to embrace expectation of loss. I don't want to do that for reasons which will become apparent later on. It seems better to start off by visualizing a dice box and abstracting from it the idea of a true inherent hazard. Such an idea involves

1. At any point of time the Risk has an exact quantitative inherent hazard, which quantity is absolutely independent of the method selected for approximating its measurement.

2. If the inherent hazard were known exactly, differences between actual losses and the inherent hazard would be a matter of chance — chance being defined ostensively by pointing at a dice box. More about chance later.

The absence of the time dimension from a roll of a dice box and the presence of the time element in the usual subject matter of insurance may

seem troublesome, but the difference is not thought to have any bearing on the significant issues.

Now, rightly or wrongly, I think the basic approach to ratemaking which you accept is one which says in effect that the correct price for a risk is one which comprises the best estimate obtainable of the true inherent hazard and a suitable expense loading.

The best estimates referred to above are obtained by statistical inference from past experience. That is, dice boxes are grouped into classes and sub-classes according to size, shape, weight, color, or some other attribute which might lead to the surmise that they have similar spot potentials and the scores of past rolls are used to estimate quantitatively the current average spot potential. The heterogeneity of preliminary groupings may be tested by spot experience and re-groupings may be made. A pyramid of groupings may be used so that in effect the estimate for a small group uses its own experience, the experience of the next more general group, and so on, each with appropriate weights.

Fortuitous extremes may be identified by statistical techniques and discounted. The circumstance that the number of dice in a box does not remain constant over long periods may be recognized in the procedure — either quantitatively or arbitrarily. The spot experience of individual boxes may be compared with the average experience of their group and statistical inferences drawn as to the degree to which these individual boxes differ in spot potential from the average. And so on.

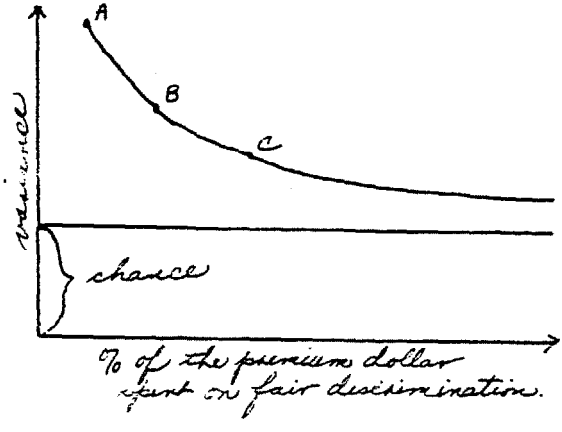
Workmen's Compensation prospective rating procedure looks as though it were such a statistical pursuit of inherent hazards, by state, by in-

dustry group, by class, and by individual risk. Although a comfortable majority of the people in the business do not have the expression "inherent hazard" in their active vocabularies, I think that those who do, if pressed, would say they thought the dice analogy applied to what was being done.

Moreover, I think that if a professional statistician were to examine the Compensation rating procedure and read the literature on the subject, he would be forced to the conclusion that there must be this concept of inherent hazard in the background and that the procedural steps must be someone's idea of how to use the statistics to approximate its measurement. This professional statistician might also conclude that the statistical techniques used are somewhat crude, that many relationships which should be tested and recognized are not being tested and recognized, that the detail in many of the rituals is not commensurate with the precision of the answers, that there are numerous inconsistencies, etc. If he were energetic, he might proceed to work on correcting these deficiencies.

This statistical pursuit of the inherent hazard is about ninety-nine and forty-four one hundredths per cent for the purpose of effecting fair discrimination among risks. With the concept of true inherent hazard in mind, the degree of success with which fair discrimination is effected can be revealed by the loss ratio variance. With this dice-box concept, the loss ratio variance will be the chance variance increased by the contribution to variance made by rating errors.

Moreover, refinement in the pursuit of the inherent hazard costs money, so, qualitatively at least, we could plot the percentage of the customer's premium dollar which is spent on effecting fair discrimination against an indication of the results achieved somewhat as follows:



To spend an absolute minimum on fair discrimination (Point A) a flat premium per policy would be used. Under this approach every New York Workmen's Compensation policyholder would pay a little over $350 and receive a card telling him he was insured. The total proceeds would be adequate to cover the benefits and the smaller expenses of handling the problem on this basis. The maximum percentage of the premium would be used to pay losses. This approach, however, would not even satisfy those socialists who advocate the tax approach to spreading losses, since it would burden the little fellow for the benefit of the corporate giants.

The next step (Point B) would involve a single payroll rate for all industries. Presumably, this refinement would materially reduce the loss ratio variance — at a price. I heard once that the Wyoming Monopolistic Fund operated on this basis but have been unable to confirm the rumor with information available in the office. This level meets the socialists' objections to Point A. Unfortunately, it cannot be used by competing private carriers unless they all have underwriters who are both ignorant and unprejudiced. It is unusual to find both of these attributes in the same underwriter.

The next step (Point C) would involve the establishment of a relatively few, say twenty, payroll rate classifications. Private insurance can operate at this level in the small risk field, particularly if it shys away from statisticians and actuaries. For the large risk field either more refinement or some other mechanism probably is necessary.

From Point C on there are introduced refined classification manuals, manuals of classification interpretations, fifty-page statistical plans, individual risk rating, individual risk rating exceptions, stamping bureaus and stamping bureau correspondence, payroll limitation rules, payroll auditors' manuals, special occupational disease procedures, a hundred odd endorsements to measure out a precise amount of coverage, etc. — all of which require the employment of more people by carriers and producers to handle a given amount of business.

The curve has been drawn as a continuous one, convex downward, approaching as an asymptote the ideal situation in which the rating measures the

inherent hazard accurately and all residual loss ratio variance is due to chance. The main objective is to convey the idea of diminishing returns which is *not* always immediately obvious when individual refinements are being considered, but which is obvious, I believe, when the whole pattern is reviewed.

The level of the chance asymptote will depend upon whether it is assumed that the tail of the curve is a statistical pursuit of inherent hazards under a given degree of classification refinement or it is assumed that the tail involves both statistical refinements and classification refinements. In the latter instance, the asymptote would be the variance which you can determine quite accurately from the distribution of accidents by size of loss. In the former instance it would be considerably higher.

It is noteworthy that even if one accepts the premise that the goal of rating procedure is to pursue inherent hazards (as hereinbefore conceived) by using data, statistical or other, intelligently and scientifically, one still should stop the pursuit somewhere along the diminishing returns curve. I don't think it is sufficient that each suggested refinement be evaluated against its cost independently. Rather, I think some as yet unthought of mechanism for appraising the direction in which rating methods are moving should be injected — although I don't know what or how.

You have said that the mean rating error for New York Workmen's Compensation risks is about 40% (meaning from the lower asymptote, I assume). I don't know how much of our customer's money we are spending in effecting

fair discrimination, but it is more than half of the expense loading. Nor is it known how the comparison of the 40% error with the amount expended should be made, but it does seem prudent to ask if we are moving in the right direction — even granting the inherent hazard concept.

Now it seems to me that the mathematics you are currently developing are essentially improved techniques of implementing the approach to insurance pricing which has been gingerly explored in what has been set down above. It is thought you could not explain fully your developments without at some time bringing in, explicitly or implicitly, the concept of chance — chance as used by the mathematicians who built up the theory of probabilities. To have an inherent hazard to pursue, it would seem that there must be a residue of causal determinants whose exact nature and interplay remain unknown but which will somehow produce results which can be expected to vary around a specific central value.

The concept causes no trouble in crap-shooting problems, but there is a tremendous difference between the behavior of the crap shooter and the behavior of the insurance business. The crap shooter goes to great lengths to keep the known causal determinants and the limited unknown residue separated. He puts a known number of balanced dice with known spot configurations in a box and then willfully operates so that the residual causal determinants will remain unknown to both himself and his opponent. If he is honest, he never moves a causal determinant from the unknown to the known.

The insurance business shows no such self-restraint. It is incessantly subtracting sources of variation from the residue and putting them in the rating manual. There are a number of practical reasons but no apparent theoretical reasons why this activity could not reduce chance to an insignificant consideration. Set forth below are a series of steps whereby one source of variation after another is subtracted from the residue and put in the manual.

1. The final premium for a Workmen's Compensation policy might be established at the time the policy is written. In this instance, the hazard would embrace the unknown volume of activity as an additional source of loss variation. I know of no theoretical reason why this augmented hazard would not be insurable.

2. The premium can be determined substantially as at present on the basis of actual payrolls. Compared with (1), the scope of insurance has been reduced by transferring the source of variation mentioned above from the hazard to the rating procedure.

3. The premium might be based on actual payrolls limited to the maximum compensable wage. Assume further that the ratemaking method somehow takes care of the current medical cost level. Then, the scope of insurance would be reduced by transferring from the hazard to the rating

procedure the contribution of inflationary and deflationary changes.

4. The premium might be based on man hours with appropriate changes in the ratemaking method. Another source of variation, the variability of exposed hours per dollar of limited payroll, would be transferred out of the hazard and into the rating procedure.

5. Man hours within a classification are not constant as respects hazard. Some people in the 8810 classification spend 10% or more of their time in transport planes. The man hour basis might be refined by subdividing classification rates according to what the employees are doing.

   Another source of variation, crude exposure measurements, would be partially transferred out of the residue.

6. The remaining two stages are essentially further efforts to get good relevant exposure measurements. The fractional man-hour basis in (5) suggests that real progress could be made in transferring sources of variation by using man minutes (or seconds) while engaged in activities which expose the hand to injury,

man minutes while engaged in activities for which the back is subject to strain, etc. — with appropriate rates for each and all.

7. Having gotten down to (6) it should be possible to eliminate the time element and use counts of situations. The manual would have to be by kind of injury and by situation. If a man leaves his hand in an unguarded metal cutter while the blade is falling, he is almost certain to have it cut off -- say 95% certain. If a travelling salesman is involved in a plane wreck he probably will be killed. A premium based on "audited" counts of such "exposures" should contain a loss element which would be within 10% or 15% of the actual losses even on very small risks. After having pursued fair discrimination this far, the insurance business will have rated itself out of the insurance business.

Mercifully, the procedural obstacles ceased being merely difficult and became insurmountable very early in the series of steps, so there is no real concern with the lower end of the ladder. The series of steps is set forth first to define a direction in which rating procedures may be moving and second, to raise a question with regard to your inherent hazard concept. To the second matter first.

I don't find any inherent hazards here which are exact "quantities absolutely independent of the method selected for approximating their

measurement." It seems that the method of approximating their measurement can be made so absurdly precise as to eradicate chance entirely. With a large definite permanently segregated residue of unknown causal determinants such as there is in the dice-box analogy, I could rationalize the pursuit of the inherent hazard approach to ratemaking and understand the logical place your mathematical developments have in it, even though I probably would be unable to understand the mathematics themselves. However, with a collapsible residue, the use of the "true inherent hazard" as a criterion or standard with which to compare a pure premium to measure its correctness is very puzzling. Perhaps the answer is that the terms "true inherent hazard" and "precisely accurate rate" have not an absolute significance, but are limited by the unexpressed qualification "with respect to the level of rating refinement currently in vogue." When so qualified, the terms do not seem to have much significant meaning.

The more important aspect of this direction in which rating procedures might be made to move is that it may make what we have to offer less acceptable to insurance buyers. The insurance industry may be finding itself spending more and more of the customers' money in making the product less and less what the customers want to buy. If I were an insurance buyer I would look upon the insurance transaction as a device for replacing uncertain outgo with certain outgo (or outgo subject to certain upper limits). The transaction would be desired so that I could proceed to devote my undivided efforts to butchering, baking, or candlestick making with the happy awareness that my ignorance of future fires,

third-party liabilities, defalcations, etc., was no bar to my turning in a satisfactory operating result. Hence, I would like this certain outgo to be in terms of something convenient for normal budgeting so that I could establish prices and run my fiscal affairs easily: per payroll, per gross sales, per store, per gross of candlesticks, etc. I don't think I would want my insurance carrier to spend a lot of money figuring out quite closely just about what my losses should have been and then billing me for this approximation to my actual losses plus the cost of servicing them, plus the cost of doing the figuring — particularly not if the carrier spent enough money to do such a good job that the whole idea of transferring uncertainty into certainty was impaired.

Needless to say, this discussion is confined pretty much to the question of rates for the policyholders who buy insurance in the popular sense of the word. Some policyholders buy the spreading of their losses in time, various services, etc. The pricing of packages which contain significant amounts of these ingredients involve a number of other considerations.

Of course, the possibility that rating methods will ever be developed to the point that the insurance element is perceptibly diminished is negligible, even though the practical limit on refinements seems to get moved back from one year to the next. The immediate difficulty with the direction of motion outlined above is that the complications annoy the customers and probably would annoy them more if they thought they were expensive.

Granting that it's impossible to move very far in the direction indicated, the first question which suggests itself is why willfully move in that direction at all. If there is an answer to this question — and there is — the second question is why move any further than necessary. Why in particular should supervisory officials push that way.

New information seems to be what used to bring into being rating refinements that limit the scope of insurance. As soon as a carrier finds out that it cannot underwrite freely the automobile business that emanates from a general agent in a town, it will endeavor to have that town set up as a separate rating territory. As soon as underwriters find out that young drivers produce poorer experience than others, a separate classification must be set up in order that a market can be found for that business. As soon as the right people find out that some excavating risks use dynamite and others do not, it will be necessary to subdivide the class in order that the dynamite users can find a market. Prior to the intensified interest in fair discrimination and other rating standards, the insurance industry hacked away at itself with rating complications only as fast as underwriting knowledge grew — nothing much to worry about.

It might seem that a dim view could be taken of rating law interpretations which accelerate this complication process.

Would it be out of order to consider fair discrimination not as an ultimate goal which must be actively pursued by statistical and other means until it is finally reached, but more realistically as a requisite of

a good insurance market. As of any point of time there must be enough fair discrimination so that substantially all legitimate buyers can have a reasonable choice of carriers. Beyond that point (with incidental exceptions) it need not be pushed. Return the onus of increased complexity to the leisurely expansion of underwriting knowledge. Considering the actual dispersion of loss potentials within classifications, particularly in automobile rating territories, such an approach seems to be only realistic.

There are forces in the insurance market which, if left to themselves, tend to curb the drive toward expensive complexity. Agency-producing carriers have to compete for the good will of their agency plants. Direct-writing carriers cannot sharpshoot the market because of the necessity that they retain their business for long periods during which the specific attributes of their risks may change. Perhaps these and other similar factors would, if allowed to operate, keep the level of complexity balanced with the requirements of the market.

When middle pure premiums and arbitrary percentage change limitations have been discussed in the Compensation Board Actuarial Committee, concern has been expressed from some quarters that such devices interfere with the determination of correct rates. It is probably reasonable to assume that those concerned are either consciously or unconsciously subscribing to the pursuit of inherent hazards theory of ratemaking. You have said that the Department has not only condoned but has actually encouraged such technical inconsistencies because they enhance the ac-

ceptability of filed rates with the buying public. I have suggested that if such acceptability is a controlling consideration, then rate makers would do well to start with the marketing problem instead of a hypothetical statistical problem. In an unguarded moment you once suggested that such an approach be reduced to writing.

With fair discrimination being interpreted as a requirement of a satisfactory market rather than as the ultimate but unattainable goal of pursuing inherent hazards, devices which make rating procedures more acceptable to the buying public acquire a new legal stature. The complete development of such an approach would require the time and attention of a great many people. However, it is possible to start by making a few observations and, perhaps uncritically, drawing immediate inferences from them. Let's talk about New York Workmen's Compensation first.

1. From the success of the middle pure premium method, it might be inferred that a good system should endow a going rate with a certain validity and let it alone unless there is a good reason for a change.

2. From the success of arbitrary percentage change limitations, it might be inferred that a good system will not change any rate too much at any one time. It might be inferred further that a direct visible limitation is more convincing than an incomprehensible credibility formula.

3. From various experiences, although not generally in New York, it can be inferred that minor changes up and down are more annoying than satisfying.

4. From general considerations it might be inferred that the refinement of the system should not be incommensurate with the inherent limitations in providing for the unknown future. If the insurance industry goes around with a serious face endeavoring to measure with calipers a cloud in a high wind, it is only to be expected that rate controversies will be created by the pretty much irrelevant calipered measurements.

5. The justification for a rate change most satisfactory to the general public seems to be an understandable answer to the question: are you making money or are you losing money. The answer, to the extent possible, should be in regular accounting terms familiar to most business men.

If these were thought to be the more important considerations in setting up a system of manual ratemaking for Workmen's Compensation insurance, the procedure would probably be quite different from the one currently in effect.

Let us assume that a manual ratemaking procedure were devised in terms of these and similar considerations and that individual risk rating procedures were also retailored in terms of more easy buyer acceptance. It seems highly probable that such a price structure would result in both a better public acceptance of private insurance and a less accurate measurement of hazards. The paradox is very puzzling.

Believe it or not, this long inconclusive letter is not an effort to sell any particular bill of goods. I am honestly puzzled by the extent to which the set of premises which your mathematics requires actually corresponds with the rating problem. Examination of this question seems to be tied up with the issue of pricing objectives. It is felt that the latter issue from the long range viewpoint may be of more than academic interest.

Hence, this letter should be considered solely as a means of raising questions. Please don't ascribe any implied conclusions to me.

Also, please send me a copy of the paper you are preparing as soon as you have a satisfactory draft.

Best regards.

JC:lvw

John Carleton