

Is “Probable Maximum Loss” (PML) a Useful Concept?

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Résumé de l'article

L'article de notre collaborateur, M. John S. McGuinness, paru dans le numéro 2 (1969) de la Revue, a soulevé une discussion intéressante avec deux spécialistes; l'un, M. Edward B. Black est le directeur d'un service très important de l'Insurance Company of North America, l'autre, M. Robert L. Hurley, est un actuaire, membre de la Casualty Actuarial Society. M. McGuinness nous communique les textes qu'ils lui ont fait parvenir avec l'autorisation de les utiliser dans notre Revue. C'est avec plaisir que nous les présentons ici avec la réponse faite par M. McGuinness aux divers points soulevés. La question du P.M.L., ou perte maximale probable, et sa prévision a une telle importance qu'on ne saurait mettre de côté des études qui la présentent dans ses aspects les plus divers, même si leurs auteurs diffèrent d'opinion; ce qui est normal. Nous les remercions de nous avoir permis d'utiliser leur texte ici. Cela permettra à nos lecteurs d'apercevoir les divers angles sous lesquels la question peut être envisagée. A.

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Is "Probable Maximum Loss" (PML) a Useful Concept?

Discussion of the article by

Mr. Edward B. BLACK and by Mr. Robert L. HURLEY

L'article de notre collaborateur, M. John S. McGuinness, paru dans le numéro 2 (1969) de la Revue, a soulevé une discussion intéressante avec deux spécialistes; l'un, M. Edward B. Black est le directeur d'un service très important de l'Insurance Company of North America, l'autre, M. Robert L. Hurley, est un actuaire, membre de la Casualty Actuarial Society. M. McGuinness nous communique les textes qu'ils lui ont fait parvenir avec l'autorisation de les utiliser dans notre Revue. C'est avec plaisir que nous les présentons ici avec la réponse faite par M. McGuinness aux divers points soulevés. La question du P.M.L., ou perte maximale probable, et sa prévision a une telle importance qu'on ne saurait mettre de côté des études qui la présentent dans ses aspects les plus divers, même si leurs auteurs diffèrent d'opinion; ce qui est normal. Nous les remercions de nous avoir permis d'utiliser leur texte ici. Cela permettra à nos lecteurs d'apercevoir les divers angles sous lesquels la question peut être envisagée. A.—

1 — Mr. Edward B. Black¹

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The author's treatment of the Probable Maximum Loss concept is both interesting and thought-provoking from an underwriter's viewpoint. It is a subject of great importance because a clear understanding of PML and its application can spell the difference between profit or loss, success or disaster, in the property insurance line. Mr. McGuinness aptly establishes this fact in his reference to the large losses at the oil refinery in Louisiana and the exhibition building in Chicago, Illinois. No one can debate the serious outcome of the reported deficiencies in the PML factors in such instances and I suggest these two examples could be multiplied many times in any year although, fortunately, to a considerably less extent. Nevertheless, while I agree with the author's approach to achieve the purpose of the paper, i.e., showing how PML can be made a useful and valuable tool, I find myself dissenting with or questioning the validity of a number of statements. For example, Mr. McGuinness states that the concept of PML is "one of the least clear concepts in all insurance". It is true that the definitions may vary between underwriters when put down in words, but I feel strongly that there is a universal meaning as to the end result which all underwriters expect PML to accomplish. It seems to me that the situation is analogous to the familiar quotation, "A rose by any other name would smell as sweet", i.e., PML, no matter how you define it, is simply *Probable Maximum Loss*. It is neither foreseeable nor possible loss — rather, it is the maximum loss which *probably* will happen when and if the peril insured against actually occurs. My observation is based upon numerous discussions of the subject with underwriters in this country, from both stock and mutual companies, and with underwriters from abroad. The words they use may be somewhat different, but they all translate to the same final meaning.

In view of the above, I do not feel that a new or standard definition will change results and emphatically disagree with the suggestion that there should be two precise definitions, one suited to the insured and

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his risk manager and another suited to the insurer. It seems highly improper to me that the insured should consider anything more than the total value of his property exposed to *any* peril, i.e., the amount subject to possible total loss. The only safe and proper course for the buyer is to purchase enough insurance to protect this maximum exposure. To encourage him to do otherwise through consideration of *any Probable Maximum Loss* concept is to tread on thin ice and could lead to improperly exposing his financial interests.

The same reasoning does not (or should not) apply to the insurer. As Mr. McGuinness so aptly states under the heading "PML and THE STABILITY OF A PORTFOLIO", "the purpose of setting underwriting retentions is to stabilize an insurer's experience so that one or more individual losses will not adversely affect its over-all underwriting result by more than a specified amount during any one year". The PML concept is invaluable here for it is the device that enables the underwriter to accept maximum lines (amounts) on individual risks, thus obtaining maximum share of the total premium while theoretically holding his expected or probable loss exposure within acceptable limits. It is for this reason that the underwriter cannot afford to enjoy the caution and conservatism of selecting the maximum *possible* PML in every instance. Almost invariably, the Windstorm or Tornado PML will be greater than that of Fire and to select the largest peril-PML would result in a tremendous reduction in desirable premium via more limited capacity geared to retentions.

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There are several statements under "METHODS OF MEASURING PML" which appear controversial. First, the author states that facts relating to probabilities are not presently being collected. This is not entirely correct because this long-existing industry deficiency is currently being rectified through the new National Insurance Actuarial and Statistical Association's statistical recording plans. In concert with Mr. McGuinness' purpose, underwriters eagerly anticipate the time when sufficient facts have been accumulated from the Industry to support precise PMLs. Nevertheless, some individual companies have in the past collected, and continue to collect, experience data from their own loss records and other public sources. (Example: Inspection or Rating Bureau reports and analysis of individual loss occurrences.) It is the continual review and study of such instances that develop the skill and aid the judgment of the experienced property underwriter.

Second, and most important, I take issue with the author's statement that "simplest approach to measuring PML is to obtain the amount of claim and the amount of insurance on each risk that has sustained a loss during a given year, and to classify these paired figures by major statistical class." My point of issue is not with the approach, which is meaningful as respects homogeneous units of the same or approximately same value. What I question is the value of this approach from a practical viewpoint when considering the concept of PML. It seems to me that companies fall into two categories when underwriting risks of small value such as lend themselves to the table technique described on pages 94 and 95. Companies with high retention levels are not concerned with PML on such risks — rather, it is a simple matter of rate adequacy or inadequacy. They will either want all of the risk or none of it. Alternatively, companies with small retentions will shy away from the practice of using a PML on such risks even though the PML results developed through the suggested study will be valid. Admittedly, such a study could result in the small company raising its retentions on a class of risks (again, presupposing adequate rates), but I suggest they will *in practice* continue to consider these small risks as 100% PML and rely upon reinsurance treaties to protect them above their retention(s).

From a truly practical standpoint, I suggest the concept of PML would gain much greater reliability if individual losses of \$25,000 or more on properties valued at \$100,000 or more would be studied and results recorded without giving weight to the coinsurance or average clause (if any) in the policy. The author's table (page 96) rightfully points out that there is no relation between the Average Clause and the Amount of Insurance purchased, but the figures shown under Amount of Claim would infer that losses are commonly and correctly adjusted within the framework of the Average Clause requirement. It is unrealistic to make this assumption due to the many variables in an actual adjustment, e.g., what is the *true* Actual Cash Value or Replacement Cost of the Property — proper consideration of inflationary factors — carelessness on the part of the adjuster, etc. I believe a study on the basis described above (dollar loss incurred vs. value), related to the factors mentioned — occupancy, construction, protection, peril, coverage plus exposure — over a reasonable period of time, would be the best method of producing guidelines for reasonable,

efficient determination of individual risk PML. This suggestion's practicality is indirectly recognized by the author in his statements relative to "Judging Underwriters' Performance in Estimating PML." An ongoing, continuously up-dated, study of this type would improve the results desired from use of the PML concept, but would never, in my opinion, entirely replace the subjective evaluation of each risk by the seasoned underwriter.

II — Mr. Robert L. Hurley¹

There is much that the reader may find remarkable in the Paper, "Is Probable Maximum Loss (PML) a Useful Concept?" The term, itself, is believed one of those esoteric symbols of the underwriting fraternity whose members must, in turn, sometimes find certain actuarial arcana a bit mystifying. It is not possible that PML can convey to the actuary the associations (not necessarily all pleasant) that these letters can suggest to the experienced fire underwriter. Presented with the McGuinness warnings on large fire losses, an underwriter may well reflect that there have been fire catastrophies before McCormick Place, which he, incidently, might not regard as likely destined to be the last of such disasters. Nevertheless, a life long schooling not to hazard, needlessly, an undue portion of his company's assets in a single occurrence would typically dissuade the underwriter from placing any significant reliance upon a purely fatalist approach to risk evaluation. Moreover, he could not help being at least a bit curious about any such approach as Dr. McGuinness's which might be construed as showing the underwriter how much he could safely write on the risks offered to him. The actuary, too, would have more than a passing interest in any such demonstration, although, understandably, the underwriter would be the most immediate beneficiary of any such mathematical solution of the age old problem of determining PML.

But before attempting to evaluate the McGuinness proposal, it may be helpful to identify his mathematical sources since they stem more from the economics and sociological than from the actuarial literature.

¹ Mr. Hurley, a Fellow of the Casualty Actuarial Society, is Actuary of Fire Insurance Research and Actuarial Association, New York.

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About the turn of the present century Vilfredo Pareto, who had recently assumed the chair of economics at Lausanne previously graced by the distinguished economist Leon Walras, published a two-volume tome on economic theory buttressed, if not somewhat laden, with mathematics. Probably the feature which, at the time, caught the fancy, not only of the professional economist, but also of the reading public, was the Pareto law which claimed that with an ascent in the income scale while the number of recipients thereof declined sharply, the relative percentage of the total income absorbed by the dwindling number did not, at the same rate. Pareto expressed his law as $N = kx^{-a}$ where N is the number receiving incomes of x greater than k , a threshold value. Not satisfied with his slightly meteoric thrust into notoriety, Pareto pushed along into the wider fields of sociology and philosophy.

Time has relegated Pareto's economic law to a respectable, but maybe nonetheless deserved, neglect. To cite just one teacher who has long been in the vanguard of economic theory, Paul Samuelson noted:

"According to the Pareto law, there is an inevitable tendency for income to be distributed according to a logarithmic curve whereon the upper tail of the income data of many different countries and many different times fell along straight lines of almost the same slopes. He came to believe this as a fundamental law, regardless of social and political institutions, and regardless of taxation. In the past 50 years, more careful studies have refuted the universality of Pareto's law as well as its inevitability."

Pareto's sociological writings won for him only the opprobrium (and this probably not at all deserved) as one of the philosophical fathers of 20th century fascism. Moreover, the earlier disciples of his mathematical theories may have escaped only a somewhat lesser disenchantment faced with the charge that Pareto's work was solely a trivial extension of the somewhat "outdated" system of densities introduced by Karl Pearson in 1894. And even in the current revival of Pareto mathematics, some may believe the contributions to be of more heuristic than corroborative value.

However, this reviewer believes that the Casualty Actuarial Society is not responsible for the partialities with which the accolades may be

distributed in other learned disciplines, and is concerned only with the possible significance of the findings in the allied professions to actuarial problems. And in this regard, we are indebted to Dr. McGuinness for directing our attention to the research currently being conducted by European actuaries on the Pareto curve. To the McGuinness list of references one might add the paper in the 16th International Congress at Brussels in 1960 by Benktander & Segerdahl pointing out "the Pareto distribution is essentially the most 'dangerous' analytical expression that can be used to describe a claim distribution, not withstanding the values of the parameters involved."

While not unappreciative of the almost disingenuous shifts to which even scholars may sometimes resort who are moved by an uncritical reverence for an author, it is believed still incumbent on us not to dismiss summarily the use being made of the Pareto curves in Europe, but to research, such as Dr. McGuinness has suggested, possible applications to U. S. insurance problems. Some Fire (Ex. Dwellings) loss distributions, related to the actual value of the properties, have been taken from the public records of various fire rating bureau large deductible filings in the middle 1960's. It is suggested that these might be viewed as not unrelated to the Pareto equation with some modifications therein.

Now the McGuinness paper proposes three objectives in order to show how PML can be made a useful and valuable tool, by suggesting:

1. a precise definition of PML;
2. how the accuracy of PML estimates is related to the stability of a portfolio of risks;
3. methods of measurable accuracy for determining PML of a risk.

1. The definition of PML

Dr. McGuinness noted that a four year investigation among company underwriting executives revealed a singular lack of unanimity on the meaning of Probable Maximum Loss. One of my former underwriting associates had a favorite jingle pointing up the shades of meaning which underwriters attach to PML. He was, however, once

somewhat taken back when an underwriting trainee who, on being questioned as to the PML on a particular acceptance, responded that since the policy authorized \$100,000, which was the full value of the risk, he judged that the PML should not likely be more than that figure.

Actually, McGuinness offered two definitions of PML and seemed to favor the following modification of the second:

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"The probable maximum loss under a given insurance contract is that portion of $100(m + k)\%$ of the limit of liability which, with probability « p », is greater than, or equal to, any loss covered by the contract."

I am reasonably convinced that my former underwriting associate would not be at all inclined to take exception to this definition, as being much less meaningful than the others with which he was familiar, once the terms had been explained to him. It is likely, however, that he would have a number of searching questions as to the basis of the "m" and "k" and particularly the "p" values. It is not likely that he would be much impressed by a 5% or 1% confidence limit, in the feeling that he could not afford to accept, albeit, such a small probability, in view of the even smaller probability of any large fire loss.

However, this reviewer is inclined to regard the McGuinness definition as being more compact and certainly more mathematically precise, once the parameters of his test have been set. Nevertheless, there is still the lurking suspicion that there may be no substantial gain in understanding, via any such mathematical definition, if the probabilities to be associated with it cannot be handled with the statistical assurances required.

2. How accuracy of PML estimates is related to the stability of a portfolio of risks

It is difficult within a given frame work to disagree with the McGuinness proposition that the immediate purpose of PML is to select the maximum amount of insurance that an underwriter should retain on the risk for his own account — at least, to the extent that this observation may be tautological. Nor can one easily take exception to

the McGuinness formula $C_a - C_e = k$ where C_a is the actual claims total, C_e the expected claims, and k is a constant.

It is noted, however, that an underwriter might arrange his risk selections so that his annual loss ratio variation would be minimal by writing relatively small lines on acceptable risks. Conversely, it is possible for the same underwriter, while allowing for a greater variation in his annual loss ratio expectancy, to increase his company's long-term profit by writing large lines on super-choice risks.

3. Methods for measuring PML

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It is believed that Dr. McGuinness is correct that the statistics needed to determine PML, as defined, are not now collected (except possibly for dwelling risks) on any formal industry program. The McGuinness proposal is believed to involve the collection of losses related to insurable value on initially a simple class basis. He would then determine the maximum percentage of loss involved in, for instance, 90% of all claims in each category.

This procedure is seemingly the reverse of the typical deductible analysis. It is believed that one will readily appreciate the considerably more difficult task of making reliable estimates of the appropriate charge in rates for losses in excess of, say, 90% of insurable value than determining the expected savings under a 1% valued deductible. Incidentally, the percent deductible saving is a function of risk size which, also, would not likely prove a negligible factor in the McGuinness proposal.

It is possible that some companies are now collecting, for their own use, data on the percent loss to insurable value, and such statistics may well be helpful in setting company line sheets and underwriting risk gradings. It is thought that many underwriters are not unaware of the danger involved in projecting top line loss experience in view of the relatively small likelihood of loss in these upper regions, and are guided accordingly in their PML evaluations.

In summary, this reviewer believes that Dr. McGuinness is to be commended for an interesting and thought provoking article of particular value to the CAS membership as a reminder of the work by European Actuaries on the Pareto curves.

III — Author's Reply: John S. McGuinness¹

The two reviewers have between them raised several points and questions that can be valuable in clarifying the paper and some of the thought underlying it. Mr. Hurley's comment on the Pareto curve is a very interesting addendum and merits expansion at a later time. His contribution of actual facts is also a positive and helpful addition.

178 The reviewers' admirably broad range of interests is reflected in their comments. Perhaps it will be an aid to understanding, therefore, first to look at their comments that pertain to the subject of the paper and secondly to look at their other comments. The major points to which the reviewers address themselves seem to be these:

1. the statement in the paper that the concept of PML is "one of the least clear concepts in all insurance"
2. the two-pronged definition of PML
3. how effectively PML now enables underwriters to stabilize their results
4. the fact that the data required for determining PML probabilities are now being collected only for dwellings
5. the significance of Table I in the paper
6. whether values at risk can be determined in practice with sufficient accuracy
7. a potential relationship between the confidence level of a set of PML's and the probability of having a large loss
8. whether the probabilities called for by the definition can be measured with sufficient precision (closely related to point 6)
9. the need to balance eagerness for premium volume against the need for stability in underwriting results
10. the usefulness and danger of the PML concept to an insured
11. applicability of the Pareto curve.

¹Dr. McGuinness, a Fellow of the Casualty Actuarial Society and Canadian Institute of Actuaries, is President of John S. McGuinness Associates, international consultants in actuarial science and management to insurers, governmental regulatory authorities, and large buyers of insurance. This paper was presented to the May 1970 meeting of the Society and is copyright in all countries subscribing to the Bern Convention and in the United States of America. Reproduced with the author's permission.

Point 1: Clarity of the PML Concept. — The reviewer goes directly to the heart of the matter in saying "...but I feel [sic] strongly that there is a universal meaning as to the end result which all underwriters expect PML to accomplish." He correctly states that an underwriter "feels"; he does not *know* about PML. He refers to an end result for PML to accomplish, not to the meaning of PML itself, thereby reflecting the imprecision of thought which the paper is aimed to be helpful in overcoming.

The author started out some years ago sharing the same feeling: that PML was a clear concept to underwriters. Only when he could not get a clear concept from any underwriter, or the same concept from two or more underwriters, did it occur to him that one clear concept might not exist. This "feeling" needed testing to become a belief, however. So, following the example of Benjamin Rush,¹ the sample of definitions mentioned in the paper was secured. The collected definitions were omitted from the paper as probably not being of interest to actuaries. An illustrative sample of them was included in a popularized or lay version of the paper subsequently published elsewhere.²

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One of the most striking sets merits repeating here. These came from three property underwriters in the same branch office of a large insurer (emphasis is supplied by this writer):

PML is the maximum percentage of the risk *that would be subject to a loss* at one time.

¹Benjamin Rush, descendant of a signer of the Declaration of Independence and at age 25 both a skilled marine average (= «loss») adjuster and head of the claim adjusting department of a large marine brokerage firm, joined the Insurance Company of North America in 1895 and immediately faced the problem of how to correct a chronic series of marine underwriting deficits. Fascinating descriptions of his encounter with the even today commonplace lack of data essential for sound managerial decisions, his painstaking research and efforts to secure these data, and his equally painstaking efforts to convince his board of directors of the proper corrective action required, appear in *Biography of a Business* by Marquis James (New York: Bobbs-Merrill, 1942, pp. 188-200) and *Perils Named and Unnamed* by W. H. A. Carr (New York: McGraw-Hill Book Company, 1967, pp. 82-88).

Mr. Rush became a vice president at age 28, was later a long-time chairman of the board of his company, initiated in the 1920's the movement to secure multiple-line underwriting powers for non-life insurers, and was for decades a recognized leader of the whole fire and casualty insurance business. His example of first getting the facts and then attacking the problem remains a shining beacon to those who would make optimal, soundly based technical and managerial decisions. The present paper obviously covers only the first of Mr. Rush's two steps of (1) solving the problem and (2) selling the solution!

² See article of the same title in *Insurance*, New York, 2 August 1969, p. 16; *Assurances*, Montreal, July 1969, p. 83; *Canadian Risk Manager*, Toronto, September/October 1969, p. 15; or *The Review*, London, 31 October 1969, p. 1387.

PML is the maximum amount of loss *that can be sustained* within any specifically defined area.

PML is the total amount of loss, expressed in dollars or as a percentage, *expected to be sustained* in the event a fire occurs within a building.

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It is remarkable that not one but three definitions come from a single office of an insurer whose underwriting has been outstandingly successful, in relation to that of other companies, over a period of years. Yet here are three clearly different concepts of PML ! This and the other clear evidence of the lack of clarity in the concepts of PML has in no way been rebutted.³

Benjamin Rush realized as well as anyone the need both for full and accurate facts on which to base decisions under uncertainty and also for an effective sales effort to have even the clearest facts and the resulting conclusions accepted by people who are used to thinking along different paths. It is realized that one paper on PML or another subject will not, no matter how factually based, win immediate acceptance from a large number of people whose beliefs and actions it in any manner challenges. But if the presentation of such facts can ultimately win the attention of even one person of influence, communication and acceptance will ultimately be established. Only over a long period, also, will it be possible to demonstrate to a large number of people that actuarial help can be useful in defining and solving problems which are of a quantitative nature or which can be framed in quantitative terms.

It may be that a quotation from Gertrude Stein ("A rose is a rose is a rose.") is more pertinent than the quotation from Shakespeare which was offered by the reviewer. It is easy to get caught in the trap of trying to define something by using one of the words being defined. Mr. Black points up sharply that until the word "probable" is defined in numerical terms as a specific percentage, it is impossible for PML to be clear. And unless we can express in quantitative terms what we are trying to do in this portion of the quantitative part of underwriting, we cannot be sure that any two underwriters, let alone the whole fraternity, will be thinking and acting the same with respect to PML.

³ The popularized articles cited above contrast a sample of several of the conflicting definitions of PML that were collected.

Point 2: A Two-Pronged Definition. — Apparently an attempt to make the paper clear has instead resulted in making it unclear. Slightly different forms of the definition were given. Others could also be given for a mortgagee interest or any other insurable or reinsurable interest. The two forms given in the paper are designed to show specifically the elements involved in PML that relate to the property owner and the underwriter. It is felt that a completely generalized definition requires phrasing that may be too abstract to be easily tied by underwriter, actuary, or layman to specific or concrete circumstances:

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The PML for a specified financial interest is that proportion of the total value of the interest which will equal or exceed, in a stated proportion of all cases, the amount of any financial loss to the interest from a specified event or group of events.

The reader will have to be the judge of whether *this* feeling is correct.

Mr. Black is absolutely right that a new or standard definition will not change results unless it is used. It is hoped that the definition offered here will soon be used. It will *have* to be used before any material part of the function of determining PML's can be computerized or otherwise meaningfully automated.

Point 3: Effective Use of PML. — One can agree with Mr. Black that current PML concepts and practices can "... enable the underwriter to accept maximum lines ...", but this is not the same as accepting the maximum *safe* lines or *appropriate* lines. The precise concept and measured estimates the paper suggests will by contrast do the latter.

It is also troubling to see mention of "not ... selecting the maximum *possible* PML in every instance." This reveals a serious logical inconsistency arising from the imprecise concept employed. Not to use the highest PML applicable to any of the covered perils is to defeat the purpose of determining a risk PML in the first place.

The reviewer's expressed opinion (which seems to be the basis for the inconsistency) that the windstorm or tornado PML will almost invariably be greater than the fire PML is open to serious question. Although the hurricane PML, at a 99 per cent confidence level⁴, appears to be far less than 50 per cent for most types of property, it is

⁴ "At a 99 per cent confidence level" means "99 per cent of the time" or "with a probability of 99 per cent" and "implies that the percentage used was obtained by experiment or measurement, not by simple guesswork."

easy to jump to the conclusion that the tornado PML is 100 per cent (at the same confidence level) for practically all types of risks. As one will see after inspecting the area of damage after any tornado, however, the PML is considerably less than 100 per cent, although higher than for hurricane.

182 Evidence of inconsistent PML estimating procedures, the facts reported in connection with individual large losses⁵, and studies of tornado and hurricane damage lead the author to the conclusion that at present, because of the necessarily crude estimates being made, PML's are most often too high and net retentions are most often too low on the more numerous smaller risks, but in a smaller proportion of cases dangerously the reserve (on larger risks, which are less numerous). These two types of errors reinforce each other in unstabilizing a portfolio. If PML estimates are too low, the retention tends to be too high and capacity to be over-used; if net retentions are too low, they are apt to be based on faultily high PML estimates, and capacity is under-used. On this basis, an excessive proportion of reinsurance cessions seems more likely to indicate too low retention limits in a company's line sheet. Any adjustments could most practicably and logically be made in the retention schedule rather than through a logically indefensible tinkering with PML estimates.

Point 4: Present Status of Data Collection. — Mr. Black apparently shares with many other members of the underwriting fraternity with whom the author has communicated the mistaken belief that the necessary facts to use for determining PML's are presently being collected in the manner required through the statistical plans of the National Insurance Actuarial and Statistical Association. Although amounts of insurance are recorded on premium or exposure cards for both family and business risks, they are recorded only on family or dwelling loss cards under the new NIASA statistical plans. A recommendation to show amounts of insurance on business-risk loss cards was overruled, perhaps on grounds of expense. Since both exposure and loss cards are handled only in bulk, it is impossible under the present plans for the corresponding amounts of insurance and of loss to be put together. This is an important deficiency in the commercial-risk plan which should

⁵ National Fire Protection Association *Quarterly*, some rating bureau special hazard reports (prior large losses), and general insurance periodicals such as *The National Underwriter* — Fire and Casualty Edition, report on large fire and allied peril losses in a respectively decreasing degree of detail.

be corrected. Until it is, underwriters' eager anticipation of facts to support precise PML's will be in vain.

By the same token, the rating bureau reports and analyses of individual loss occurrences are not a satisfactory basis for determining PML's. Just like the reports of all large losses (e.g., those over a certain monetary amount such as \$2,500 or \$5,000) that in many companies go to supervising underwriters, these rating bureau reports provide only what the actuary or statistician calls a "biased" sample. Study of such material can lead only to biased and inaccurate inferences. Determining the form and manner in which loss data are collected and analyzed is a special field of statistics — design of experiments or design of investigations — in which actuarial expertise is required if accurate inferences are to be drawn by underwriters or others.

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Mr. Hurley intimates, and the author agrees, that on a simple class basis the data for any one company will be insufficient to determine PML's with the necessary accuracy for types of risks where they play the most important part: the large, not very numerous types. This is the basis of the suggestion in the paper that the data be gathered on an inter-company basis as part of the over-all statistical gathering process.

Because of both an insufficient volume of data and the danger that any available data are being gathered through deficient techniques, any continual review and study that is now going on within companies without actuarial participation is very unlikely to lead to accurate PML estimates.

Point 5: Large Risks v. Small Risks and Table 1. — Mr. Black is fearful that the PML's based on class data would not be sufficiently accurate because the PML percentage is likely to vary significantly among risks of different size. In the absence of facts, one cannot say if this is correct. An opinion that differences in degree of fire resistive compartmentation are more important than differences in size or value might be considered equally valid. In effect, it seems that Mr. Black is saying that while the first of the three stages of accuracy suggested in the paper is meaningful, it can be considerably improved upon by refining it to take into consideration such possibly important causes of heterogeneity as size of risk. This seems equivalent to saying that the second or third stages suggested in the paper will produce more accurate results. The author agrees.

Despite differences in size, all the risks in a class can provide useful data for determination of PML's for the class. Homogeneity is a matter of degree rather than a matter of absolutes, else the classification plan now used has little value. Even though as Mr. Black suggests there are many risks of smaller size for which a company with high retentions does not need to determine a PML (because the total value or amount of insurance on each such risk is less than the company's retention limit) it is still necessary to collect the exposure and loss data on smaller risks to provide an adequate picture of the class PML *and of how it may vary with size of risk*. Thus his suggestion for collecting data only from individual losses of at least \$25,000, and only for properties valued at \$100,000 or more, is inappropriate since it would produce statistically biased results. It would also waste the valuable information and added stability in the statistical results that can be secured from the data on the smaller risks and smaller losses. This is another illustration of the value of, and the need for, a properly designed statistical investigation.

It should also clear up any misunderstanding to point out that Table I in the paper applies to all sizes of risks, not just small ones. The table is designed to show how losses under policies with different average clauses should be adjusted to the same basis. It is not designed to serve as a source of PML estimates.

Point 6: Accurate Determination of Values at Risk. — The author did not imply, as Mr. Black infers, "that there is no relation between the Average Clause and the Amount of Insurance purchased . . .", but he is willing to let any facts produced speak for themselves. And while Mr. Black's point that there are bound to be errors in some loss adjustments is quite valid, an assumption that average clause requirements are not enforced in a material proportion of cases raises the question whether inadequate rates or inadequate loss adjustment procedures are responsible for most of the unsatisfactory underwriting results of recent years. The author opts for rate inadequacy.

There will be some inaccuracies in any loss data. The fact that we cannot remove all inaccuracies does not seem good reason for failing to remove those that we can remove. Data from which biases due to different insurance-to-value relationships have been removed or reduced are clearly more accurate than data still containing these biases.

Until we are well into the third stage proposed in the paper, subjective evaluation of risks by seasoned underwriters should be useful in adapting class PML's to individual risks. It is important to realize in this connection, however, that this underwriting activity will resemble much more closely the application of one year's experience twenty times, rather than the application of twenty years' experience, to the extent that it is not continuously improved by the collection of new facts and by the statistically well designed testing of underwriters' theories as they are developed. The cooperative activity of underwriters, who are in the best position to identify actual and potential factors for differentiating risks, and actuaries, who are best equipped to test and measure the pertinence of such factors, is indispensable for progress.

Point 7: Confidence Levels and Probability of Losses. — One must agree with Mr. Hurley that it is easy for an underwriter to confuse the desirable confidence level with the probability of a large loss of some single given size. For example, even if there is only a 95 per cent probability that any loss in a given class of risks will not exceed 50 per cent of value, all losses will not occur to the largest risks. Further, not all of the 5 per cent of losses that exceed 50 per cent of value will occur to the largest risks, and not all of the few total losses in this small group will occur to the largest risks. The probability of total losses to the largest risks in a class is therefore much, much less than 5 per cent (or even than 1 per cent) under such circumstances. It should not be forgotten, however, that no matter what the confidence level used for the PML may be, the underwriter must always be prepared to accept a total loss on any policy he writes.

The PML confidence level for an individual class will be less than the confidence level applying to the stability of a company's complete portfolio, because fluctuations tend to offset from one class to another. Although it would be best to withhold final judgment until a test with actual data can be run, the author believes it not improbable that a 95 per cent confidence level for PML might be satisfactory for all or most classes of risks.

Point 8: Measuring the Required Probabilities. — It is also easy to agree with Mr. Hurley that the suggested definition will have little practical value unless the probabilities to be associated with it can be handled with the statistical assurances required. This is exactly why not only one but three gradually improved methods of obtaining the

needed statistical assurances are explained in the paper. A complete and precise methodology for setting retentions — the goal for which PML is simply a tool — has already been provided elsewhere.⁶ The missing elements are the needed data to fit the models provided and the conviction of underwriters and executives that existing subjective methods can be improved upon.

186 *Point 9: Balancing Premium Volume and Stability.* — Mr. Hurley goes directly to the heart of a dilemma requiring a managerial decision. Mr. Black touches it less directly. Mr. Hurley notes that an underwriter or underwriting manager must at some time make the choice between how much stability he requires in his portfolio and how much potential profit he is willing to forego to achieve it. An underwriter with factually based PML's and also factually based underwriting retentions is of course in a much better position to make this choice than today's underwriter, who has neither.

Point 10: The Insured and PML. — In saying that "It seems highly improper to me that the insured should consider anything more than the total value of his property exposed to *any* peril . . ." Mr. Black is apparently thinking of an insured who has only a single property that is 100 per cent subject to total loss from a single event. Both the generalized form of the definition given above and the two specific forms in the paper are designed to cover all types of insureds, including those with multiple locations of similar value who have need only for insurance to the maximum value (per occurrence) represented by a single property, and including those whose other financial resources may equal or exceed in value their insurable physical property. An insured and his risk manager need to consider PML in buying insurance as much for pricing as for determining limits of insurance. The not uncommon practice in marine insurance of securing coverage on hulls only for total losses (because of the Pareto curve involved, only small-percentage losses or total losses are practical possibilities) is one example. The very practical limitation, because of bulk, on the amount of some types of goods that can be burgled at one time makes PML important both for pricing and for determining needed amounts of insurance against open stock burglary. The PML of a protected dwelling in jurisdictions that do not allow rate reductions for inclusion of

⁶ J. S. McGuinness, «Controlling the Effects of Catastrophes in Insurance Against Floods and other Elemental Perils.» IV *Transactions* of the XVth International Congress of Actuaries, New York, 1957, pp. 190-203.

average clauses in dwelling policies is a very important consideration to the owner or landlord who wants to avoid the extremely excessive premium charges that fire insurance to full value entails. There would be no need for 70, 80, or 90 per cent average clauses (and only 100 per cent average clauses would be needed or in use) if PML was not a practical and necessary consideration for the insured, no matter whether a single property or properties at several locations are involved. Finally, PML estimates of rating bureau engineers in sprinklered-risk and special-hazard reports must be applied from the insured's point of view. In short, the applicability of the PML concept to the insured and his risk manager is much more complex than the reviewer indicates and is clearly a practical necessity. Modern developments in the theory and practice of risk management would form a valuable subject of study for any underwriter.

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Point 11: Applicability of the Pareto Curve. — We are indebted to Mr. Hurley for his erudite discussion of the Pareto curve and some of its history. Since the paper was written, an unpublished doctoral dissertation has been made available to the author.⁷ This contains more actual data supporting use of the Pareto curve, some from California from the early 1900's and more recent data from Oregon from the 1960's. The empirical results reported in the dissertation⁸ match very nicely the theoretical results of Mandelbrot and others reported in the paper.

Mr. Hurley's mention of the Benktander-Segerdahl paper of 1960 should be supplemented by reference to a later paper by Benktander⁹ and one by P. J. H. Green.¹⁰ In the latter, Mr. Green shows that there are other curves that are more dangerous than the Pareto. It should also be noted that "dangerous" as used by these authors refers to the degree of risk that a given excess-of-loss premium would be insufficient if losses are actually distributed according to the curve. It does *not* refer to a risk of being inaccurate, i.e. to any possibility that there may be a more appropriate curve to describe a given loss distribution.

⁷ G. L. Head, *Insurance to Value*, doctoral dissertation submitted to the University of Pennsylvania, Philadelphia, 1968, pp. 115-148.

⁸ *Ibid.*, pp. 143-145.

⁹ G. Benktander, « A Note on the Most 'Dangerous' and Skewest Class of Distributions, » II *ASTIN Bulletin* III, April 1963, p. 387.

¹⁰ P. J. H. Green, « Some Skew Distributions, » Jubilee Number, *Quarterly Letter*, Algemeene Reinsurance Companies, Amsterdam, July 1964, Vol. II, p. 46.

Mr. Hurley should also be thanked for noting the need to point out that the Pareto curve is in usual form asymptotic to the X-axis, and that because property values are finite the tail beyond the 100-percent-of-value point on that axis must be cumulated at that point, producing the second leg of the "U".

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Summary. — The reviewers are to be congratulated on bringing out, through the wide range of their remarks, many facets of the paper that needed amplification and clarification. In providing the opportunity for such clarification, not the least of their contributions has been to point up the direct and practical applicability of the paper in demonstrating one path toward improvement of underwriting results. While the paper was not intended to be provocative, it was intended to stimulate action to improve a limited portion of present underwriting techniques. The reviewers' comments, and the opportunity they have provided for amplification, should prove to be of great value toward this end.