IS "PROBABLE MAXIMUM LOSS" (PML) A USEFUL CONCEPT?

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AUTHORS REVIEW OF DISCUSSIONS IN
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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 commentary 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.

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 1 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

Point 1: Clarity of the PML Concept. — Reviewer Black 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," but does not "know" about PML. This reviewer refers to an end result for PML to accomplish, not to the meaning of PML itself, and, thereby, reflects the imprecision of thought which the paper aims to overcome.

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 Benjamin Rush's example,[1] the author secured the sample of the definitions mentioned in the paper. The collected definitions were omitted from the paper as probably not being of interest to actuaries. They were included in popularized or lay versions of the paper published subsequently elsewhere.[2]

One of the most striking sets of definitions 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.
> 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.

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

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[1] See the fascinating description of Benjamin Rush's painstaking research into chronically unprofitable marine underwriting, and equally painstaking efforts to convince his board of directors of the proper corrective action required, 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's example 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!

[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.

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.

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

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 level, appears to be far less than 50 per cent for most types of property, it is 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.

Evidence of inconsistent PML estimating procedures, the facts reported in connection with individual large losses,[4] and studies of tornado and hurricane damage lead the author to the conclusion that at present, because of

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[4] *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.

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. In a smaller proportion of cases, dangerously, the reverse (on larger risks, which are less numerous) is true. 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 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.

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 viz., 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 on by refining it to take into consideration such possibly important causes of heterogeneity with variations in 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, or 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 1 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.[5] 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.

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

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[5] 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.

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 assureds. These forms would include those assureds needing insurance only to the maximum value (per occurrence) represented by a single property of a multiple location account with similar values. The basic definition also includes the person whose other financial resources may equal or exceed the insurable value of his physical properties. 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 al-low rate reductions for inclusion of 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 man-ager 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.

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.[6] This contains more actual data supporting

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[6] G. L. Head, "Insurance to Value," doctoral dissertation submitted to the University of Pennsylvania, Philadelphia, 1968, pp. 115-148.

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 dissertation[7] 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 Benktander[8] and one by P. J. H. Green.[9] 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.

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 per cent of value point on that axis must be cumulated at that point, producing the second leg of the "U."

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.

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[7] *Ibid.,* pp. 143-145.

[8] G. Benktander, "A Note on the Most 'Dangerous' and Skewest Class of Distributions," *Astin Bulletin* Vol. II Part III, April 1963, p. 387.

[9] P. J. H. Green, "Some Skew Distributions," Jubilee Number, *Quarterly Letter,* Algemeene Reinsurance Companies, Amsterdam, July 1964, Vol. II, page 46.