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John S. McGuinness

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Is "probable maximum loss" a useful concept? [1]

par

JOHN S. McGUINNESS [2]

Avant-propos

Le *P.M.L.* comme on dit dans le jargon du métier, c'est le montant maximal de la perte que l'on peut anticiper au cours d'un sinistre survenant dans les lieux assurés. Ce peut être l'assurance totale, mais aussi une fraction qu'il est d'usage d'exprimer en pourcentage de celle-ci. Ainsi, on dira le sinistre maximal prévisible est de 10, 30, 50 ou 75%. L'affirmer est chose facile, mais avoir raison est une autre affaire. C'est ce que l'on a constaté dans des cas restés célèbres, comme à Chicago, à la McCormick Place. On y avait annoncé une possibilité de sinistre limitée et l'on a eu une perte quasi totale. Si l'on savait qu'il s'agissait d'un immeuble en béton, l'on ne

[1] This article is based on a paper presented at the May 1969 meeting of the Casualty Actuarial Society.

[2] John S. McGuinness Associates, consultants in actuarial science and management, 15 Kevin Road, Scotch Plains, New Jersey — 07076.

tenait pas compte de la nature extrêmement combustible du contenu et de la faiblesse relative de la structure. Ailleurs, en Europe, il y a eu également des sinistres dont on n'aurait pu prévoir l'importance sans paraître affreusement et inutilement pessimiste. Et cependant, la perte a été totale ou quasi totale. Est-il possible d'établir une méthode de prévision un peu plus sûre que les approximations actuelles ? C'est ce à quoi tend Monsieur John S. McGuinness, dont nous faisons paraître
84 l'article ici. Qu'il soit assureur ou réassureur, le lecteur le lira sans doute avec intérêt, parce qu'il met le doigt sur un des problèmes les plus graves en assurance directe. Le sinistre maximal prévisible c'est, en effet, la base de toute acceptation, de tout plein d'assurance, de toute politique de production saine, prudente parce qu'elle prévoit les bornes du risque. Si la sélection est bonne, la participation ne le sera que si elle tient compte des ressources de l'assureur, de ses réassurances, de l'exactitude de ses prévisions normales. Car, à côté du cas courant, il y a le cas anormal, toujours possible. C'est à cause de cela qu'une assez stricte méthode de travail s'impose. Et c'est là que l'article de Monsieur McGuinness prend l'intérêt des choses immuables dans un contexte changeant. La plupart des matériaux nouveaux sont théoriquement incombustibles, mais dans des conditions données, ils deviennent endommageables, parce qu'ils peuvent être abîmés par l'eau, le feu, la chaleur extrême, le gel. Qui aurait deviné qu'un moteur d'ascenseur, logé au sous-sol, en se carbonisant, pût dégager une telle chaleur que le revêtement du plancher fait d'un produit plastique pût, à son tour, se carboniser et dégager une fumée âcre, s'incrustant solidement au mur. La chose s'est produite cependant. Elle a entraîné un dommage d'un million de francs. Comment prévoir à l'avance qu'un petit feu, prenant dans un panier à papier puisse se communiquer au reste de l'immeuble par les conduites de ventilation et causer une perte de $300,000 ? Comment croire que le feu se promenant libre-

ment à travers le réseau de ventilation — encore un fois — puisse rencontrer sur son chemin des produits combustibles (livres, papier, fiches) ? Le tout s'est traduit par un sinistre de $600,000. C'est peu si l'on met en ligne de compte la valeur de l'immeuble. Il s'agit de 3% peut-être. Dans un cas comme celui-là, que doit-on indiquer comme maximum prévisible ? 10% ? Probablement, mais c'est fait à vue de nez, au pifomètre. C'est ce problème que Monsieur McGuinness étudie ici avec une méthode et des conclusions dont on lui saura gré, sans doute. — G.P.

The term « PML » or « probable maximum loss » is one of the most widely used terms in property insurance underwriting. But it represents one of the least clear concepts in all insurance. This fact is reflected by the results of a four-year study that involved collecting the personal and company definitions of PML from over one hundred underwriters and underwriting executives. No two of their definitions fully agree.

In the absence of a clear and specific meaning, the term can be a true invitation to disaster, because it thus provides a foundation of sand for the quantitative part of risk selection. The Lake Charles, Louisiana, oil refinery and McCormick Place, Chicago, fires of the 1960's dramatically demonstrated this fact to several insurers. On the other hand, if buttressed by a clear and specific definition and if based on properly collected and analyzed facts, the term can be an extremely useful and valuable tool. The purpose of this article is to show how it can be made such a tool by suggesting (1) a precise definition, (2) how accuracy of PML estimates is related to the stability of a portfolio of risks, and (3) methods of measurable accuracy for determining the PML of a risk.

Definition

The principal similarity among the definitions of underwriters and other non-actuaries is that they are expressed in qualitative rather than *quantitative* terms. Here are some examples:

> PML is the maximum loss one could anticipate if none of the protective devices and measures operates properly.

> PML is the loss one would anticipate under the most adverse circumstances that could reasonably be anticipated.

> PML is that loss which may be anticipated under reasonably adverse conditions, taking into overall consideration the size and location of the property, construction, occupancy, partial cutoffs, protection of hazards, explosion possibilities, susceptibility, exposures, internal protection and public protection as determined by inspection.

None of these definitions gives or calls for facts from which a measurement on a numerical scale can be directly made.

A second similarity is that the underwriters' definitions are oriented to causes and risk characteristics rather than to results. This is a natural reflection of their basic interest in the quality of a risk: how it compares with other risks in its class and whether it is likely to be over-priced (i.e. profitable) or otherwise. But it is a result — the actual percentage of loss that is likely to be sustained — which is of prime importance.

A third similarity is that practically all of the definitions are related solely to the peril of fire. This fact also reflects a natural human preoccupation with the past and with the familiar, since by far the bulk of property insurance loss dollars pay for fire damage. On the other hand, all the insured perils must be considered if a definition is to be suitable. A definition that meets this test is the following:

> PML is the underwriter's estimate, based on experience, of the maximum loss that a company would incur as a result of damage caused by the most destructive peril(s) insured by the policy or policies under consideration.

The Lake Charles loss mentioned above is in point, because it was reportedly triggered by an explosion and ultimately involved at least as much damage as fire damage.

A fourth similarity is that many of the definitions clearly relate only to buildings, and most of them relate only to buildings and contents. This again reflects the familiar and the concrete. A definition is needed, however, that will also take into consideration physical losses to less numerous properties such as bridges and tunnels, radio and water towers, craft and vehicles, and growing things, as well as time-element losses to all types of property. Even though separate policies, with separate amounts of insurance, may be issued on these different types of risks, a single insurer commonly has some of each in its portfolio. Since the whole purpose of defining and estimating PML is to stabilize the loss ratio of an insurer's *whole* portfolio, the definition must embrace all these elements if it is to serve its purpose.

The McCormick Place fire illustrated the need for a suitably broad definition. The Chicago Fire Department responded promptly, there was ample water pressure, and nothing else failed. PML estimates that were less than 100 per cent (as reportedly almost all of them were) had reflected only the building hazard, however. The highly combustible contents of an exhibition provided the fuel for the loss. A definition that does not take into account such pertinent external hazards as extra delays in resuming business operations, due to wartime rationing of construction materials or possible strikes at a sole supplier of essential machinery, is also deficient.

A fifth similarity, repeated in a surprising proportion of cases, is that within the same company or even within the same office there are materially different definitions being used by underwriters. Here is an example of three definitions from one branch office of a large insurer (emphasis 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.

Based on the above discussion, the following definitions are suggested:

> The probable maximum loss for a property is that proportion of the total value of the property which will equal or exceed, in a stated proportion of all cases, the amount of loss from a specified peril or group of perils.
>
> The probable maximum loss under a given insurance contract is that proportion of the limit of liability which will equal or exceed, in a stated proportion of all cases, the amount of any loss covered by the contract.

The first of these two definitions is pertinent to the insured and his risk manager, while the second definition is of course more directly pertinent to the underwriter, since it is tied directly to his underwriting results. The first definition requires four pieces of information and the second calls for three pieces. These merit a closer look.

The first datum required for the property definition is the value of the property. The second required datum is a proportion of that value. These are definite, measurable quantities. The first can be expressed as a monetary amount,

and the second either as a monetary amount or a percentage of value. The fourth required datum is the peril or group of perils that is or are being considered. Since there are apt to be considerably different PML's for the different major perils, it is usually wise to determine these PML's separately and then to select the largest for use. For the insurance definition, the amount of insurance is needed instead of the value of the property, and the second needed datum differs correspondingly. The fourth datum is not needed explicitly for insurance.

The third datum is the major essential which is missing from existing definitions of PML. Unless we state in specific numerical terms the degree of probability which we desire, PML cannot have a clear or precise meaning. This probability must be factually based and should be measured as accurately as possible, not just pulled from the air or based on unaided judgment. The probability should also be selected on the basis of factual criteria that suitably link it to the objective underlying its selection: a definite degree of stability in underwriting results. This problem of measurement from facts merits a closer look.

Evidence gathered by actuaries and others shows that the distribution of losses by proportion of value from any peril for a group of similar risks — or over a very long period of time for the same risk — follows what is known as the Paretoan distribution, as indicated in Figure 1. This distribution or curve is U-shaped. Its shape is almost exactly the opposite (i.e., upside down) of the « normal » curve that fits many distributions or groups of statistics. Therefore the arithmetic mean or average of the Paretoan curve is a much less meaningful statistic.

Figure 1 may be clarified by pointing out that it shows about 18 per cent of all the claims equal exactly one per cent

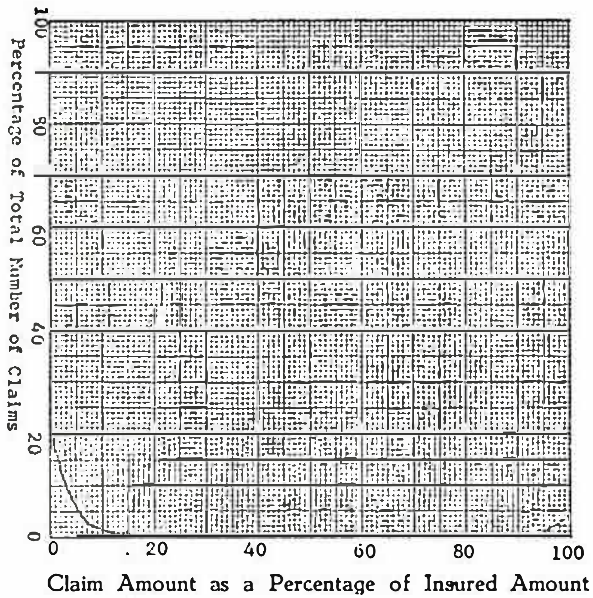

Figure 1. — Shape of a Relative Frequency Distribution of Property Claim Amounts as Percentages of Insured Amounts.

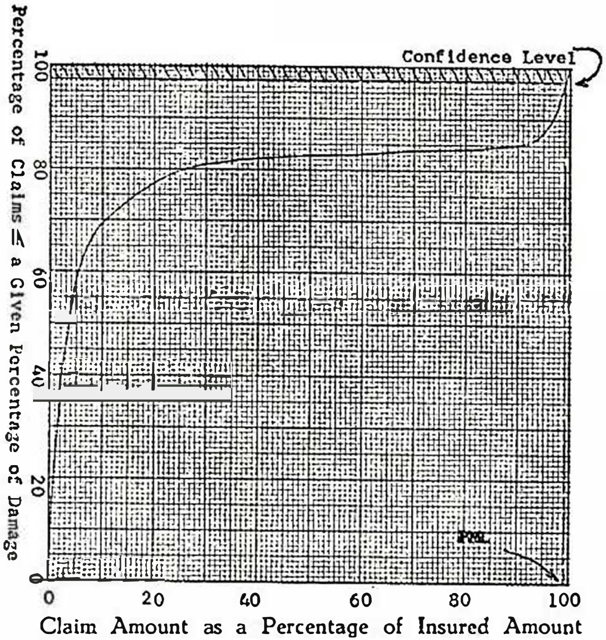

Figure 2. — Shape of a Cumulative Relative Frequency Distribution of Property Claim Amounts as Percentages of Insured Amounts.

of the amount of insurance, about 1.5 per cent of all claims equal ten per cent of the amount of insurance, only a small fraction of one per cent of all claims equal any percentage between 30 and 90 per cent of the amount of insurance, and about four per cent of all claims are total, i.e. they equal one hundred per cent of the amount of insurance.

The shapes of actual curves will of course differ according to the quality of public fire protection, construction, occupancy, peril(s) involved, and other factors.

For our purpose of measuring or determining a probability, our task is easier if we transform Figure 1 into a cumulative or ogive form, which coincides with the « greater than or equal to » form of our definition of PML. This has been done in Figure 2.

Figure 2 shows that about 69 per cent of all the claims are equal to ten per cent *or less* of the amount of insurance and that about 97.3 per cent of all the claims are equal to or less than ninety-nine per cent of the amount of insurance. Under these circumstances, one could well use a PML of 87 per cent if he wished to be 95 per cent sure that he was correct, or a PML of 100 per cent if he wished a higher degree of assuredness that he was correct.

PML and the Stability of a Portfolio

PML's primary use is in the quantitative part of underwriting or risk selection. Here it is used as the basis for attempting to secure an adequate spread of risk, by limiting the amount of an insurer's liability to loss from a single occurrence. It is used primarily in connection with the fire peril, and to a lesser extent in connection with other perils giving rise to localized losses, for example sprinkler leakage, water damage, and explosion. It is still less used in connection

with windstorm, earthquake, and similar loss to individual properties. It is used very little and with extreme imprecision in connection with catastrophic exposures that give rise to losses to several insured properties at the same time. With respect to the financial soundness of insurers, however, a precise use in connection with the catastrophic exposure is its potentially most important type of employment.

92 The immediate purpose of determining the PML for any specific property or risk is to provide a basis for selecting the maximum amount of insurance that an insurer should retain on the risk for its own account, the insurer's « net retention. » PML is a tool to be used in achieving a particular result — the retention — not an end in itself. Parallel to determining the company's own retention or exposure to loss on a particular risk, the maximum amount to which an insurer wishes to expose its treaty reinsurers on the same risk is also based on the underwriter's assessment of the PML.

In turn, the purpose of setting underwriting retentions is to stabilize an insurer's experience so that one or more large losses will not adversely affect its over-all underwriting result by more than a specified amount during any one year.

The ultimate objective for determining the PML of an individual risk is therefore to help stabilize the over-all claim results of a portfolio or group of risks during each year or other accounting period. Most insurers set a goal each year of a specific monetary amount of claims. This may be done explicitly, or it may be done implicitly by stating a target premium volume and a target loss ratio.

The stability objective is, then, to experience an *actual* total amount of claims, C_a, no greater than the target (« expected ») amount, C_e, plus k, a margin or contingency element stated in monetary terms. This contingency element, « k »,

which equals $C_a - C_e$, can be equated either with the accumulated amount of unexpended catastrophe loadings to all premiums received since a certain starting date, or with a certain proportion of surplus designated as a catastrophe reserve.

Realistically, some chance fluctuation (as well as fluctuation from other causes) above or below the targeted amount of claims must be expected. Any favorable fluctuation below the target is welcome and requires no defense. But any adverse fluctuation, above the target, must be limited in accordance with the financial resources available to the insurer to absorb it. The size of an insurer's surplus, and the relative size of its surplus and the targeted amount of claims, determine how much of an adverse fluctuation the insurer can safely absorb and how high a probability it requires that a selected maximum allowable adverse fluctuation will not be exceeded.

Even if the PML's on all of an insurer's risks are determined with great accuracy, however, adequate stability of results will not be achieved unless the insurer's retentions on the different classes of risks are appropriately graded. How to achieve these appropriate gradings lies outside the scope of the article, even though closely related to its subject. It needs emphasis, however, that unstable underwriting results cannot properly be attributed to inaccurate determination of PML's unless the influence of an insurer's retention schedule (line sheet) and other pertinent factors is first examined and found to be favorable.

Methods of measuring PML

Methods now in use for determining PML's are necessarily based on sketchily informed judgment, since the degree of accuracy to which PML can be measured depends largely

on the quality and quantity of pertinent statistical information that is available. It is not possible, for example, to determine the probabilities previously described with out having facts on which to base them, and such facts are not presently being collected, except for dwellings in some jurisdictions, in the manner required.

It is therefore appropriate to examine what facts are needed to measure PML and then to investigate how and if these facts can economically be obtained. There are also different methods by which PML can be measured. These all deserve examination so that, even if at present only the simplest and least accurate is feasible to use, it can be seen whether at a later time more accurate methods can be substituted.

The 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 (occupancy, construction, protection, and peril or coverage). Separation by major individual peril is to be preferred. The pairs of figures can be translated into loss percentages, a frequency distribution of these percentages (as shown in Figures 1 and 2) can be made for each of the sub-classes described, and the maximum percentage of loss involved in 90, 95, 99, or some higher percentage of all the claims in each category can be determined. The use of data for more than one year would increase the spread and probably the stability of these results.

An adjustment to reflect the different proportions of insurance to value would materially improve accuracy. This could take the form of a further subdivision of data by type of average or coinsurance clause. It would be a four-way or five-way split (none, 80%, 90%, and 100%, or all these

plus 70%) that would further fragment the data. It might alternatively be simplified into a two-way split (i.e., with or without an average clause) by multiplying the loss percentage of each risk insured with an average clause by the percentage of that clause. This would approximately put all the results from these latter risks on a 100 per cent average-clause basis, as Table 1 illustrates. It is clear from the table how the average clause achieves equity by holding claim payments to exactly the same percentage of the amount of insurance, whether or not the insured honors his commitment to purchase the specified amount of insurance. At the same time it avoids distortions in ratemaking from underinsurance.

A further step towards increased accuracy would be to analyze the total results of all six sub-classes at one time by a statistical technique familiar to actuaries that is called multiple correlation. The effects of differences between the different years during which the data were collected, between geographical subdivisions, and effects of other variables included in the statistical collecting plan or rating structure should be included in the correlation model. This step could be put into practice in connection with the statistics that are currently being collected in the United States if corresponding claim amounts and insurance amounts were kept together.

A third stage would be to include in a correlation model all of the variables included in the fire insurance schedules and other rating plans. This would involve making available to a central statistical agency the schedule-rating makeups (rating details) for individual risks that in the United States are now kept at the company or state level by the individual rating and inspection bureaus.

At present probably only the first stage is possible. While this would probably produce PML estimates with a wide variance, they would still be a major improvement be-

cause they would be fact-based and because the variance, a useful and specific statistical measure, would be known. Nothing required for measuring PML's on a class basis is not already required for accurate ratemaking. Indeed, establishment of such fact-based PML's could be a step in improving ratemaking accuracy. Once the third stage described above is reached, a suitable mathematical model would be made available to insurers for transfer from underwriters to a computer of the determining of PML's for individual risks of any degree of complexity. Such a model would also permit the complex retention guides or line sheets of property insurers to be based directly and precisely on factual data.

(1) Average Clause Percentage (Insured's Commitment)	(2) Value of Property	(3) Amount of Insurance	(4) Amount of Loss	(5) Percentage of Insurance to Average Clause Commitment	(6) Amount of Claim	(7) Percentage of Claim	(8) Percentage of Claim x Average Clause Percentage
80	10,000	8,000	5,000	100.0	5,000	62.5	50.0
90	10,000	9,000	5,000	100.0	5,000	55.6	50.0
100	10,000	10,000	5,000	100.0	5,000	50.0	50.0
80	10,000	6,000	5,000	75.0	3,750	62.5	50.0
90	10,000	6,000	5,000	66.7	3,333	55.6	50.0
100	10,000	6,000	5,000	60.0	3,000	50.0	50.0
80	10,000	4,000	5,000	50.0	2,500	62.5	50.0
90	10,000	4,500	5,000	50.0	2,500	55.6	50.0
100	10,000	5,000	5,000	50.0	2,500	50.0	50.0

Table I. — Adjustment of Average — Clause Results to a Full-Insurance Basis

Judging Underwriters' Performance in Estimating PML

Only if there is feedback to underwriters that shows them which estimates are good and which are poor can they and their superiors hope for improvement in PML estimates. Also, the superiors cannot soundly judge this aspect of job performance without such information. For these two internal

purposes it is therefore useful for an insurer to secure regularly from its statistical records a summary of PML performance for each underwriter, yearly or perhaps more often.

This can be accomplished by recording the insurance PML percentage for each risk estimated by an underwriter, by similarly recording the actual percentage of loss to insured amount for each claim on such risks during a unit time period, by calculating the error of estimate (actual percentage minus estimated percentage) for each claim, and by calculating the mean and statistical variance of the whole group of these errors of estimate for each time period.

It might be desirable to weight the errors of estimate by the amounts of insurance involved, since a small percentage error on a large risk could affect an insurer's results as much as large percentage errors on several small risks. Although errors in both directions are to be avoided (too conservative PML's lead to wastefully high reinsurance purchases and excessive reinsurance processing costs, while too liberal PML's lead to an excessive number of unstabilizing large claims) any error would preferably be in a conservative direction. It is therefore important to consider the arithmetic sign of the mean error as well as its size.

For each time period, the mean error and statistical variance of each underwriter could be compared with the over-all company mean and variance, or with the overall mean and variance of underwriters handling the same types of risks. Separate consideration of results with family risks and with business risks would be the minimum split needed if underwriters are specialized on that basis in the company. A review and analysis of the largest percentage errors from each underwriter's results could lay the foundation for better results in succeeding periods. A comparison of the mean

errors and variances over time, both for individuals and for the company as a whole, could keep management abreast of whether the desirable downward trend was present in each case and of which underwriters needed help in improving their results.

Les cahiers de l'office de la langue française. Québec, N° 3: vocabulaire bilingue des assurances sur la vie, par Jean-Paul de Grandpré.

Le plus récent est l'étude que M. de Grandpré consacre au vocabulaire de l'assurance sur la vie. Il allie bien la connaissance de la langue à celle des termes que l'on emploie dans le domaine où il travaille. A cause de cela, son texte est précis et bien documenté. Il rendra service dans un milieu où la pratique américaine a tendance à mêler un peu les choses, parce qu'elle laisse les assureurs créer un jargon d'autant plus imprécis qu'il cherche à s'adapter aux besoins publicitaires de chacun. C'est ce que l'on a constaté, par exemple, au moment où le comité de linguistique de l'American Risk and Insurance Association s'est formé aux Etats-Unis.

L'Office s'est intéressé également à un petit « Dictionnaire correctif du français au Canada », qui a paru à Québec grâce à une subvention du Ministère des Affaires culturelles. Bien présenté par les Presses Universitaires de l'Université Laval, il se propose « d'apporter (une) modeste contribution à l'amélioration de notre français parlé et écrit ». L'auteur, Gaston Dulong, se livre à un patient travail d'épuration. Il est précieux pour ceux qui veulent que leur langue corresponde à leur personnalité. Les fautes vont de certains canadianismes tirés de la langue populaire à d'autres que les gens les plus instruits n'hésitent pas à employer. Avec raison, l'auteur en conserve d'autres, comme *poudrerie, banc de neige, bordée de neige,* qui sont jolis, utiles et irremplaçables.

L'Office s'intéresse aussi aux études de linguistique franco-canadienne, qui sont présentées à l'Acfas, chaque année. J'ai sous les yeux, celles de 1967, publiées par les Presses de l'Université Laval sous la double direction de MM. Jean-Denis Gendron de Québec et Georges Staka de Strasbourg. Je reviendrai sur cette publication qui est extrêmement intéressante. Pour l'instant, je veux simplement noter l'effervescence qui se manifeste actuellement autour de la linguistique et de la langue parlée ou écrite au Canada français. Il y a là un désir d'étude, d'amélioration, de recherche extrêmement intéressant. Il indique comme le milieu est vivant, quoi qu'on dise. G.P.