経済学研究 *69−1*
北海道大学 2019. 6

Reasonable Estimation of the Amount of Loss in ASC 450-20, "Loss Contingencies"*

Junji Kubo・Jun Hiyama

I. Introduction

In this study, we examine the estimated loss of loss contingencies that existing US accounting standards (ASC 450-20, *Loss Contingencies*) require to report. ASC 450-20-25-2 stipulates the accrual of an estimated loss from a loss contingency if both of the following two conditions are met: probability criterion [1] and "the amount of loss can be reasonably estimated" (measurability criterion). The measurability criterion requires an accrual if the reasonable estimate of the loss is a range, assuming recording a loss should not be delayed until a single amount can be estimated. Because the measurability criterion requires an accrual even if the range could be reasonably estimated, accounting standards stipulate that "[i]f some amount within a range of loss appears at the time to be a better estimate than any other amount within the range, that amount shall be accrued", "[w]hen no amount within the range is a better estimate than any other amount, however, the minimum amount in the range shall be accrued" (ASC450-20-30-1). Thus, even amounts that are not estimated as a single numerical value are accrued as an estimated loss.

Accordingly, when the estimate lies within a range, what does "some amount within a range of loss appears at the time to be a better estimate than any other amount within the range" mean? Moreover, it is difficult to ascertain the relationship between this amount and the single number that has been reasonably estimated. In this study, we will focus on these two points to substantiate "the amount that is a better estimate than any others," and interpret what it means.

II. The Estimate is a Range, and One Amount in the Range is the Amount that is a Better Estimate Than Any Others

1. Case 1

According to ASC 450-20, an amount that is a better estimate than any others assumes an estimate within a range. When we refer to an estimate within a range, we assume (as a natural interpretation within accounting terms instead of a strict statistical discussion) a process where estimates are made

---

* This work was supported by JSPS KAKENHI Grant Number 15K03759.

1) The probability criterion is specifically described as, "[i]nformation available before the financial statements are issued or are available to be issued indicates that it is probable that an asset had been impaired or a liability had been incurred at the date of the financial statements" (ASC 450-20-25-2-a).

using statistical methods, probabilities, and losses are depicted using a statistical distribution, and a representative value (mean, mode, median, minimum, maximum) is selected from the statistical distribution as a numerical value to be accrued as a loss contingency. These assumptions allow specification of an amount that is a better estimate than any other amount as depicted in ASC 450-20, by verifying the statistical distribution related to the estimation of a loss contingency and its representative values, and investigating which of these representative values should be accrued in the financial statements as the loss contingency.

There are various types of statistical distributions, but those related to the estimation of a loss contingency are largely limited to triangular, binomial, Poisson, normal, multimodal, and uniform distributions. We use the following illustrative cases depicted in ASC 450-20 as the key to considering the values in these distributions that are better estimates than any other amount.

Case 1[2)] : Range of Loss and One Amount Is a Better Estimate than Any Others (ASC450-55-32-35)

An entity is involved in litigation at the close of its fiscal year and information available indicates that an unfavorable outcome is probable. Subsequently, after a trial on the issues, a verdict unfavorable to the entity is handed down, but the amount of damages remains unresolved at the time the financial statements are issued or are available to be issued. Although the entity is unable to estimate the exact amount of loss, its reasonable estimate of loss is a range between $3 million and $9 million but a loss of $4 million is a better estimate than any other amount in the range.

In this Case, ASC450-20-30-1 requires accrual of $4 million. ASC450-20-50-3 thorough 50-8 require disclosure of the exposure to an additional amount of loss of up to $5 million.

We will examine the distributions listed above, focusing on the following three values used in this illustrative case: the range spanning from the minimum ($3 million) to the maximum ($9 million), and the value that is a better estimate than any others in that range ($4 million).

2. Triangular Distribution[3)]

Triangular distribution is a distribution defined by the (a) minimum, (b) maximum, and (c) mode. The distribution is used for simple economic decision making using the three numerical values pertaining to profit and loss, the maximum value, minimum value, and most likely value. It is also used to estimate loss contingencies that do not occur frequently. In a triangular distribution, it is clear from the definition of the distribution that the minimum, maximum and mode are represented by a, b, and c, respectively. The expected value (mean) is calculated using the arithmetic average of the minimum, maximum, and mode ((a + b + c) / 3). Further, the median can be calculated as the point on the base

2) In the ASC450-20, this case is designated as Case D.

3) The explanations related to the statistical distributions mainly depend on Catherine Forbes, Merran Evans, Nicholas Hastings and Brian Peacock, *Statistical Distributions, fourth edition*, John Wiley & Sons, 2011, K. Krishnamoorthy, *Handbook of Statistical Distributions with Applications, second edition*, Chapman and Hall, 2015, and Nick T. Thomopoulos, *Statistical Distributions: applications and parameter estimates*, Springer, 2017.

that bisects the area of the triangle.

In Case 1, the minimum amount is $3 million, the maximum amount is $9 million, and the amount that is a better estimate than any others is $4 million. It is easy to understand what the minimum and maximum pertain to, but more difficult to ascertain what is meant by the amount that is a better estimate than any others. Thus, assuming each of the values—mean, median, and mode—is a better estimate than any others, we consider a scenario most consistent with the accounting approach[4).]

When we assume that the mode is a better estimate than any others, a simple arithmetic calculation shows that the mean is $5.33 million and the median is $5.13 million, depicting a distribution similar to that in Figure 1-1[5)].

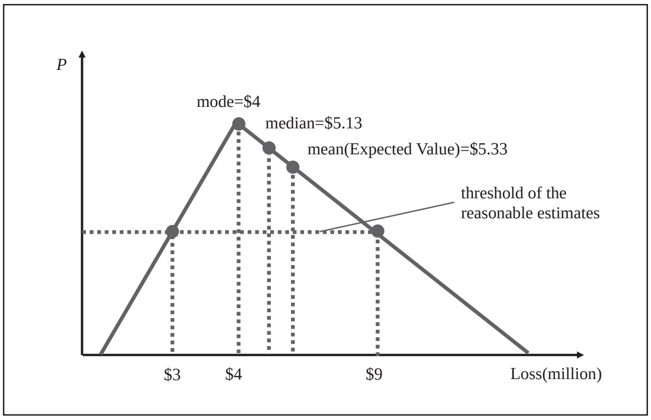


Figure 1-1 Triangular Distribution: Mode as the amount that is a better estimate than any others

The expected value (mean) is the arithmetic mean of $3 million, $9 million, and the mode, so the mode becomes zero in Case 1, which assumes the expected value (mean) to be an amount that is a better estimate than any others. If the mode is smaller than the minimum, this is a violation of the definition, as the mean is assumed to be an amount that is a better estimate than any others. Therefore, in Case 1, the mean cannot be a better estimate than any others.

The mode will become smaller than $3 million if we assume the median to be an amount that is a better estimate than any others (see Figure 1-2). This is also a violation of the definition in that the mode is smaller than the minimum; thus, in Case 1, the median also cannot be an amount that is a better estimate than any others.

---

4) Theoretically, it may be possible to set the minimum or maximum to be a better estimate than any other amount in the range. However, the Standard does not require changing the reference to the minimum or maximum to the amount that is a better estimate than any others. Thus, in this study we infer that the minimum or maximum are not an amount that is a better estimate than any others, as depicted in ASC 450-20.

5) In Case 1, the $3 million and $9 million figures are not the minimum and maximum of the triangular distribution. We must note that the mean and median of the triangular distribution vary from the mean and the median of the interval estimated as the reasonable range, except when the distribution is symmetrical.

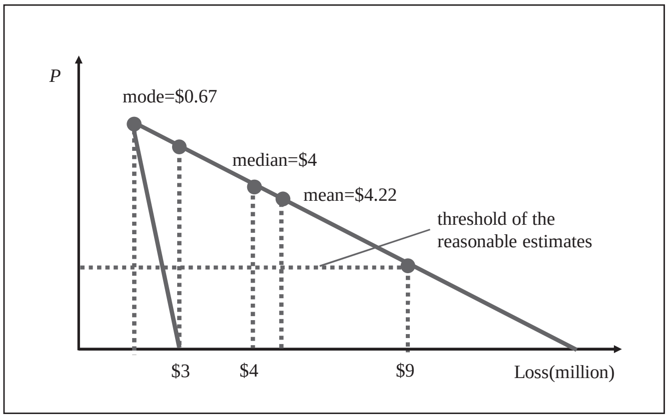


Figure 1-2 Triangular Distribution: Median as the amount that is a better estimate than any others

In addition to the above, in a triangular distribution, it is quite unlikely that a value other than the mean, median, or mode would be a better estimate than any others. Thus, in Case 1, if we assume a triangular distribution, it is natural to infer that the mode is an amount that is a better estimate than any others.

Next, we slightly change the conditions of Case 1 and examine a case where the distribution is shaped like that in Figure 1-3.

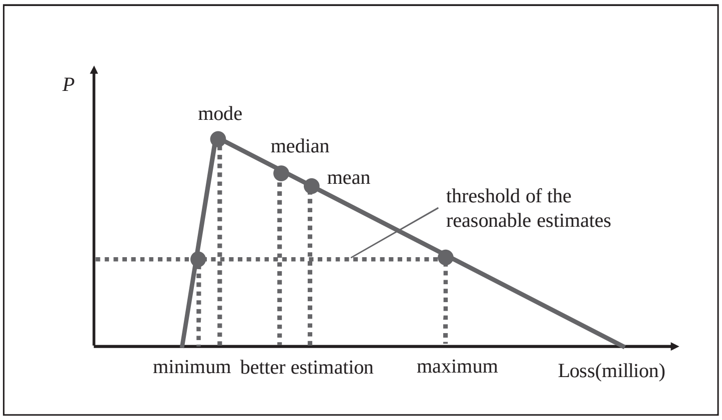


Figure 1-3 Triangular Distribution: No value other than the mode can be an amount that is a better estimate than any others

The difference between this distribution and the conditions in Case 1 is that the mode is within the range of reasonable estimates even though the mean or median is assumed to be a better estimate than any others. The two scenarios have in common the distribution skews to the minimum-value side[6).

Figure 1–3 shows that it is inconceivable that a value other than the mode (including the mean and median) would be selected when a triangular distribution is assumed, and a single amount must be selected from the range[7). In other words, even in a scenario that is not bound by the conditions of Case

6) The following consideration holds even when the distribution skews to the maximum-value side.
7) See Note 2 for the minimum and maximum values.

1, it is natural when assuming a triangular distribution to interpret that the amount that is a better estimate than any others refers to the mode[8) 9)].

3. Binomial Distribution and Poisson Distribution

The second distribution assumed in Case 1 is a binomial distribution. A binomial distribution is a discrete probability distribution where the number of successes during n independent Bernoulli trials is taken as a random variable. A Bernoulli trial is an experiment where each trial results in one of two possible outcomes, such as success ($x = 1$) and failure ($x = 0$) or heads ($x = 1$) and tails ($x = 0$) of a coin toss. If the probability of $x = 1$ is represented by p, then $P\ (x = 1) = p$, $P\ (x = 0) = 1 - p$.

Case 1, as mentioned previously, assumes a distribution that skews to the right, that is, the reasonable estimate of loss is a range between $3 million and $9 million but a loss of $4 million is an amount that is a better estimate than any others in that range. Because the binomial distribution function depends on n and p[10)], the shape of the distribution changes with the size of n and p. For example, when the value of p is varied while n is held constant at 10, the shape of the distribution changes as shown in Figure 2-1[11)].

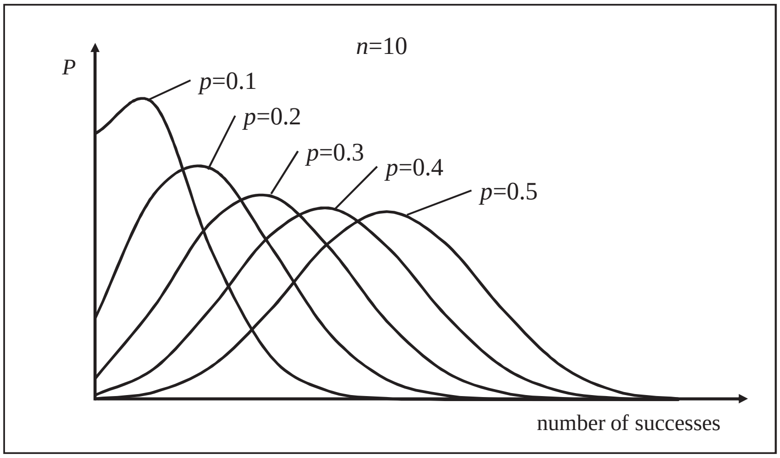


Figure 2-1 Changes in the shape of the binomial distribution

8) If the triangular distribution becomes an isosceles triangle, that is, if the mode is at the midpoint of the minimum and maximum, then the mode, mean, and median are equal. Thus, it is possible to interpret that the mode is selected in general but as an exception, the mean (or median) is selected instead of the mode when the triangular distribution is an isosceles triangle. However, a better interpretation in line with the principle of Occam's razor is that the mode is always selected.

9) However, the expected value (mean) will be used if the accounting standards specify the mean as the measurement basis (*e.g.* ASC 410-20-30-1 and ASC 420-10-30-2), and the median will be used if accounting standards specify the median as the measurement basis (*e.g.* ASC 740-10-30-7).

10) The distribution function of the binomial distribution is:

$$\sum_{k=0}^{x} \binom{n}{k} p^k (1-p)^{n-k}$$

11) Figure 2–1 depicts a continuous distribution, but the binomial distribution is a discrete distribution. In the following, we depict the discrete distribution in a continuous distribution to help with visualization.

Figure 2-2 shows the shape of the statistical distribution when a binomial distribution is assumed for Case 1 and is applicable when np is small to a certain degree[12]. Therefore, we interpret scenarios where a binomial distribution is assumed for Case 1 to be those with a low number of trials and low probability, such as failure to recover a debt that has default risk, enforcement of another party's debt guarantee, loss of a dispute, and additional correction[13].

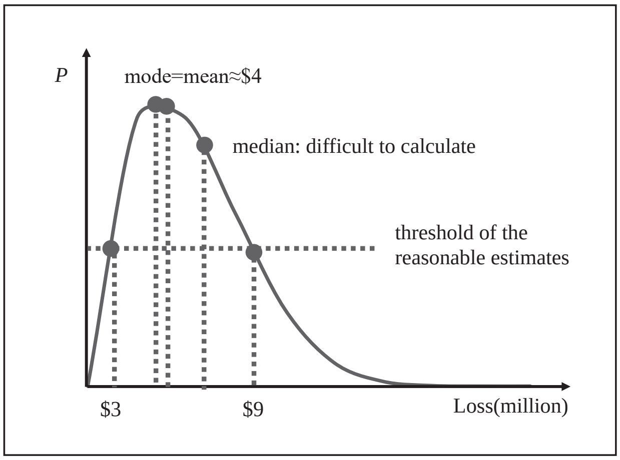


Figure 2-2 Case 1: Binomial distribution

The mode of a binomial distribution is an integer x that satisfies $p\ (n+1)\ -\ 1 < x \leqq p\ (n+1)$, and the mean is np. There is no general expression for the median, and, as seen in Figure 2–2, it is natural to interpret the mode or mean as the amount that is an amount that is a better estimate than any others in the range. Although mode x and mean np are numerical values that somewhat differ as statistical figures, they are regarded as nearly the same from an accounting perspective. Therefore, when we assume a binomial distribution for Case 1, the natural interpretation is that the mode or mean represents an estimated value better than any other amount. However, we can interpret the mode and mean as possessing the same numerical value in actuality[14].

The same applies to the Poisson distribution, the third distribution assumed in Case 1. The Poisson distribution is a limiting case of a binomial distribution when the number of trials, n, gets very large and p, the probability of success, is small; it is a probability distribution of X number of events occurring in a given time period, given λ, the average number of times the event occurs over that time period,

12) In ASC 450-20, the probability criterion guarantees a high probability of event occurrence. We must note that the low probability observed in this study is not the probability of event occurrence but the probability of loss that may occur with the occurrence of the event.

13) The conditions for Bernoulli trials are that the probability of success remains constant from trial to trial, that the trials are independent, and that each trial results in one of two possible outcomes. An incremental correction with no guarantee of constant probability, a debt guarantee with the same counterparty, and lawsuits with a possibility of settlement are not consistent with a Bernoulli trial; thus, these may not be targets of a binomial distribution.

14) Generalized discussions related to binomial distributions other than Case 1 are referenced later in Section 5.

when $np = \lambda$. It is a statistical distribution that applies when the probability is low (p is very small), and the number of trials (n) is large (n is sufficiently large), such as failure to recover general accounts receivable and warranties for manufactured products.

The mode of the Poisson distribution is the largest integer less than or equal to λ, and the mean is equal to λ; thus mode and mean are nearly equal in value.[15] Moreover, since the median cannot be expressed formally, we believe that the mode or mean is selected as the amount that is an amount that is a better estimate than any others when the Poisson distribution is assumed for Case 1 (see Figure 3). However, in actuality, the two values are regarded as equal concerning the level of loss contingency estimates.

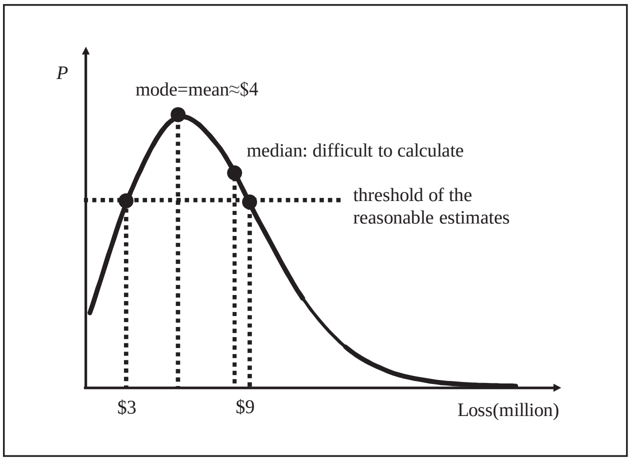


Figure 3 Case 1: Poisson distribution

4. Multimodal Distribution

The fourth type of distribution assumed in Case 1 is a multimodal distribution with two or more modes. An example of this is the estimation of loss in a trial where the amount of money paid in the event of a lose, settlement, or win each take on a probabilistic distribution. If we assume a multimodal distribution for Case 1 (see Figure 4)[16], the natural interpretation from an accounting perspective would be that if there is an amount that is a better estimate than any others, this value refers to the mode. In other words, we can interpret this to mean that even if a multimodal distribution is assumed in Case 1, ASC 450-20 requires the mode to be recognized as a loss. Furthermore, apart from Figure 4, a multimodal distribution takes various shapes with respect to the number of peaks, skew, and arch. In any case, it is natural to interpret the mode as a better estimate than any others; in fact, this is a natural interpretation for multimodal distributions in general and not just limited to Case 1.

---

15) If λ is an integer, the mode and the expected value (mean) are equal. If λ is a non-integer, the mode is λ or λ-1, so the mode and mean are equal or differ by 1.

16) Figure 4 is the distribution that combines the three normal distributions.

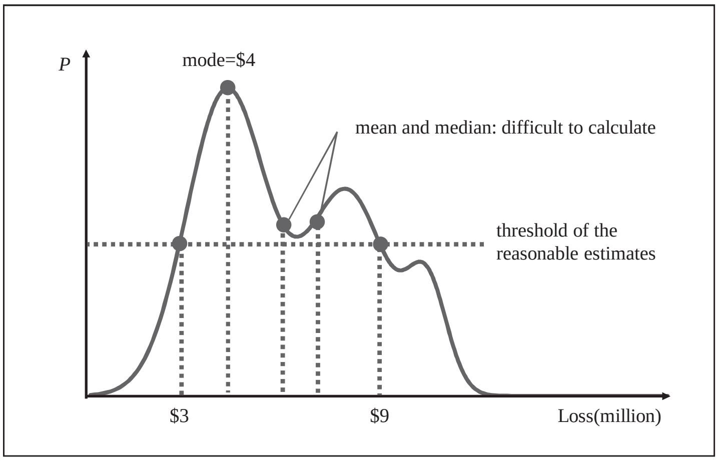


Figure 4 Case 1:Multimodal distribution

5. Symmetric Distribution

As we have stated above, Case 1 is characterized by a distribution that is skewed to the right. Aside from Case 1, let us consider a value that is an amount that is a better estimate than any others in a distribution with no (or little) skew, where the reasonable estimate of loss is a range[17]. We can consider the following statistical distributions to estimate the loss contingency: a binomial distribution with large *np*, a Poisson distribution with large λ, or a normal distribution.

In a symmetric distribution, the mode, mean, and median occur at the same point (see Figure 5). The range is estimated, and if there exists an amount in the range that is an amount that is a better estimate than any others, it is where the mode, mean, and median are equal.

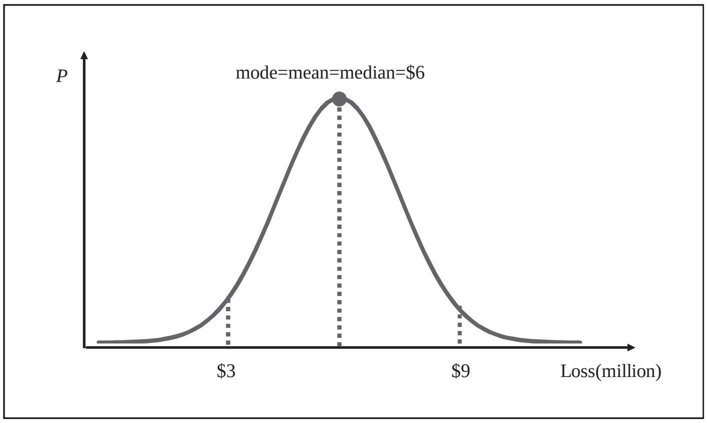


Figure 5 Symmetric Distribution

---

17) Skewness is a statistical measure that expresses how much the distribution deviates from the normal distribution. It is zero in a symmetrical distribution, and becomes positive in a distribution skewed to the left (longer tail on the right side) as in Case 1. Therefore, we can say this section examines a distribution as the skewness moves away from a large distribution and approaches zero.

In Section 3, we stated that either the mode or mean, which are equal in value, is selected as an amount that is a better estimate than any others when Case 1 assumes a binomial distribution with small *np* or a Poisson distribution with small λ. As we can gather from the discussions here, it is natural to interpret that the amount that is a better estimate than any others signifies the mode, mean, or median, which are actually equal in value, if we generalize and assume a binomial distribution, Poisson distribution, or normal distribution.

As above, we primarily focused on Case 1 to examine the meaning of an amount that is a better estimate than any others, when assuming a triangular, binomial, Poisson, multimodal, or normal distribution. Table 1 summarizes the results of the study.

Table 1 Representative values in each distribution

	mode	mean (expected value)	median	note
Triangular	natural	unnatural	unnatural	
Binomial (*np* is small)	natural	natural	difficult to calicurate	mode and mean are approximately the same
Poisson (λ is small)	natural	natural	difficult to calicurate	mode and mean are approximately the same
Multimodal	natural	unnatural difficult to calicurate	unnatural difficult to calicurate	
Binomial	natural	natural	natural	mode, mean and median are approximately the same
Poisson	natural	natural	natural	mode, mean and median are approximately the same
Normal	natural	natural	natural	mode, mean and median are approximately the same

As Table 1 makes clear, the mode is always natural, while the mean and median are unnatural or difficult to calculate. Note 8, which discusses a triangular distribution in the shape of an isosceles triangle, observes the general interpretation that it is natural to always select the mode, as the superior interpretation according to Occam's razor principle. That is, although not clearly stated in ASC 450-20, the natural interpretation from an accounting perspective is that an amount that is a better estimate than any others as described in ASC 450-20 signifies the mode in a statistical distribution.

III. The Estimate is a Range, and No Amount in the Range is a Better Estimate Than Any Others

1. Case 2

Thus far, we have verified that it is natural to interpret that the mode signifies an amount that is a better estimate than any others in ASC 450-20. However, there is a major downfall in that the mode may not necessarily exist. For example, the probability of rolling a number on a dice is equally 1/6 for all faces from 1 to 6. A natural interpretation is to select the mode as an amount that is a better estimate than any others in statistical distributions that have sharp shapes[18), like Figures 1 to 5. However, it is necessary to consider cases where the mode does not exist separately.

The following illustrative case from ASC 450-20 provides clues for this consideration.

---

18) Kurtosis is a concept that measures the weight of the tail compared to a normal distribution; a positive value indicates a heavy-tailed distribution and a negative value represents a light-tailed distribution relative to a normal distribution. It should be noted that this study describes the shape of the section with the highest probability, and thus, there is no straightforward relationship to kurtosis, which indicates the property of the entire distribution.

Case 2[19] : Trial Is Complete but Damages Are Undetermined (ASC 450-20-55-23-26)

An entity is involved in litigation at the close of its fiscal year and information available indicates that an unfavorable outcome is probable. Subsequently, after a trial on the issues, a verdict unfavorable to the entity is handed down, but the amount of damages remains unresolved at the time the financial statements are issued or are available to be issued. Although the entity is unable to estimate the exact amount of loss, its reasonable estimate at the time is that the judgment will be for not less than $3 million or more than $9 million. No amount in that range appears at the time to be a better estimate than any other amount.

In this case, ASC 450-20-30-1 requires accrual of the $3 million (the minimum of the range) at the close of the fiscal year.

2. Uniform Distribution

We can consider a uniform distribution to be the statistical distribution suited to a scenario like Case 2 where the range of loss can be reasonably estimated, and there is no single amount within that range that is an amount that is a better estimate than any others.

A uniform distribution is such that all intervals of the same length in the distribution's support are equally probable, and is expressed as U (a, b) when using the two parameters, a and b, which are the minimum and maximum values of the interval[20]. By definition, a mode does not exist in a uniform distribution, but the mean and median can be calculated by taking the average of the maximum and minimum values ((a + b) /2). Therefore, in a uniform distribution, apart from the mode, it is easy to calculate the representative values of a statistical distribution, that is, the mean, median, maximum, and minimum values. There are various criteria to select one numeric value from among these representative values (or any other numeric value). However, ASC 450-20 requires the accrual of the minimum of the range as signified by Case 2, which clearly selects the minimum ($3 million) from among the values, maximum, $9 million; mean and median, $6 million; and minimum, $3 million (see Figure 6-1).

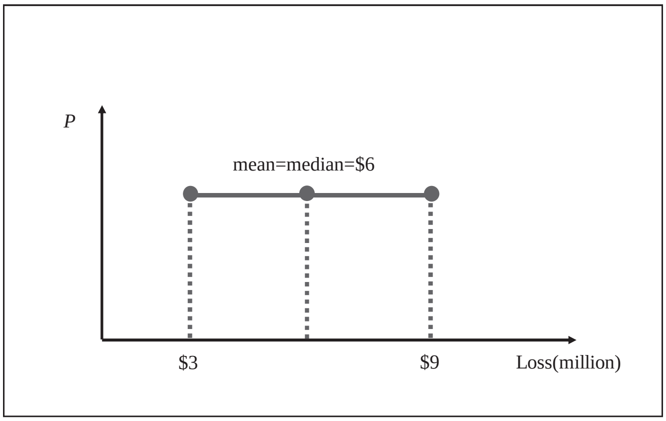
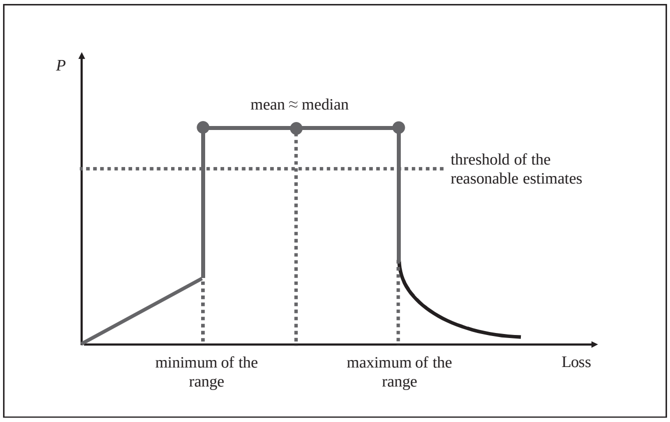


Figure 6-1 Case2:Uniform distribution

19) In the ASC 450-20, this case is designated as Case A.

20) Uniform distribution refers to both a continuous uniform distribution and a discrete uniform distribution. The definition used in this study is for a continuous uniform distribution. For the focus of this study, there is no need to distinguish between a continuous uniform distribution and a discrete uniform distribution, including in the discussions that follow.

Even in cases like Figure 6-2 with an overall (approximately) symmetrical distribution containing a uniform range of the highest probability, ASC 450-20 stipulates, similar to a uniform distribution, the selection of the minimum value in the range that exceeds the threshold as a reasonable estimate.



Source: Created by the authors based on Figure 2 in Takeda Ryuji, "Hosyusyugi no Kisoriron" [The Basic Theory of Conservatism], *Kigyou Kaikei* [*Corporate Accounting*], 27 (7), July 1975, 18-28 (in Japanese).

Figure 6-2 Overall symmetrical distribution containing a uniform range of the highest probability

3. Distribution Containing a Uniform Range of the Highest Probability

We consider a distribution that contains a uniform range of the highest probability but is not symmetrical, as in Figure 6–2, but rather it is skewed to either the right or left as in Figure 6-3.

There are two potential values that could be selected as the loss contingency in a distribution shaped like that in Figure 6–3: the minimum as a threshold of reasonable estimates (*i.e.*, the minimum amount in the range B) and the minimum amount in a uniform interval A. If we had to select one numerical value from the distribution seen in Figure 6–3 to represent the estimated loss from a loss contingency,

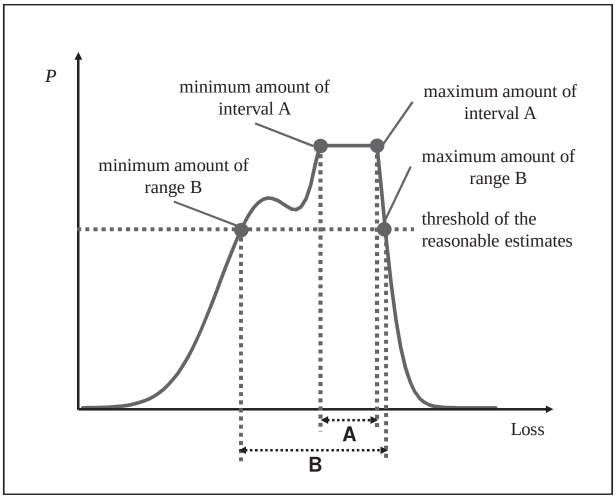


Figure 6-3 Overall skewed distribution containing a uniform range of the highest probability

it would be natural to select a value from the uniform range with the highest probability (from an accounting perspective, which is the premise of this study). To make this selection, we must interpret interval A in Figure 6–3 as the "range of loss" referenced in ASC 450-20. That is, if the estimate of loss referenced in ASC 450-20 is a range and no amount in that range appears to be an amount that is a better estimate than any others, we must interpret this to signify that there is a uniform interval in the distribution that contains the highest probability. In other words, this signifies that even if a mode does not exist, the amount selected as the estimated loss contingency should be one of the values with the highest probability in the distribution, and there should be no other values in the distribution with a higher probability. That is to say, as an orientation, the mode is preferred even if there is no amount that is a better estimate than any others.

4. Reasons to Stipulate the Minimum Amount

ASC 450-20 stipulates that the minimum value in the range be set as the estimated loss contingency when no value in the range is an amount that is a better estimate than any others. ASC 450-20, which requires early recognition of losses, is regarded as the standard for conservative accounting. To be consistent with conservative accounting, the maximum of the range should be stipulated, or at the very least be the mean and/or median of the neutral range. Although ASC 450-20, which stipulates the minimum of the range, is not regarded as an accounting standard that embodies conservatism, why does it use the minimum value?

Improvements in estimation accuracy are considered desirable for accounting standards (or the accounting standard-setting bodies) as they are directly tied to improvements in the faithful representation of financial statements. Therefore, it can be said that accounting standards reflect the path to improving estimation accuracy. On the other hand, the estimation range tightens as the accuracy of estimated loss contingencies improves; a narrower range generally leads to increases in amounts accrued as loss contingencies[21]. Since costs are necessary to improve estimation accuracy, we can say that ASC 450-20 regards increases in accrued loss contingencies to be benefits that offset costs. From the above, we observe that ASC 450-20 stipulates the minimum of the range to be accrued as a loss contingency when there is no amount that is a better estimate than any others to encourage companies to improve the accuracy of their estimations, assuming that companies wish to accrue large loss contingencies.

In the above sections, we primarily focused on Case 2 to consider the amount to be accrued as a loss contingency in a uniform or general distribution that contains a uniform range with the highest probability when no value is an amount that is a better estimate than any others. As a result, we verified that, as an orientation, the mode is preferred even when no amount is an amount that is a better estimate than any others, and that the minimum of the range is specified in such cases to encourage

21) ASC 450-20-30-1 also states that "the minimum amount in the range is not necessarily the amount of loss that will be ultimately determined, it is not likely that the ultimate loss will be less than the minimum amount."

companies to improve the accuracy of their estimations.

IV. Conclusion

In the previous sections, we verified the measurability criterion and measurement values referenced in ASC 450-20. Below we summarize the amounts accrued as a loss contingency under the requirements of ASC 450-20 if the loss contingency is estimated by applying statistical methods:

i) There is a range of loss, and one amount is an amount that is a better estimate than any others. In this instance, this estimate is accrued as the loss contingency. This amount signifies the mode in the statistical distribution.

ii) The loss is calculated in a range, but no amount in that range is an amount that is a better estimate than any others. In this case, the minimum value in this range is accrued as the loss contingency. If the portion of the statistical distribution with the highest probability is a uniform interval, this signifies the minimum value of this interval. The mode is preferred in the sense that there is no other value with a higher probability in the statistical distribution, and improvements in the accuracy of estimation affect an approximation to the mode.

Finally, we verify the relationship between these amounts and a single amount that is reasonably estimated. The amounts described in (i) and (ii) above are calculated by first estimating a range using a statistical method, then selecting from within that range. On the other hand, the "single amount" referenced in ASC 450-20 is a value that is obtained without applying a statistical method and is conceptually different from the amounts described in (i) and (ii). For the value to be obtained without using statistical methods represents a situation where the loss can be assessed without calculating the probability. That is, it is possible to estimate the loss subjectively without applying statistical methods. In other words, the single amount referenced in ASC 450-20 signifies an estimate that is a subjective representation.

The measurements referenced in ASC 450-20 can be summarized as follows. If the company reasonably estimates a single amount as a subjective representation, then the figure is accrued as a loss contingency. If the company reasonably estimates a range by applying objective statistical methods, depending on the statistical distribution, the mode or minimum in the range is accrued as a loss contingency.