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Minimizing Losses When Choosing Confidence Levels

Frequently researchers become set in their ways when it comes to their approach to research. They will use the same number of observations and the same statistical tests repeatedly. This rigidity is especially present when it comes to choosing a level of confidence from statistical testing.

Students in statistics classes are frequently told that choosing a 95% level of confidence is the preferred standard of the industry. A 95% confidence level is frequently chosen simply because it is habit to do so. Decisions that are based on high levels of confidence may result in large losses when a decision is made in error. When possible, the confidence level should be selected in an effort to minimize losses. We explore the confidence level decision in this paper.

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Example

Suppose the management of Life Insurance Company A (Life A) wants to test the preference levels between their product and their largest competitor Life Insurance Company B (Life B). A 95% confidence level is chosen as the criterion for deciding whether Life B is preferred to Life A. A survey is developed where the likelihood to purchase is measured with a 5-point scale where 5 represents "definitely will purchase" and 1 represents "definitely will not purchase."

A random sample of 500 people are surveyed to test the two life insurance companies. Half of the respondents have purchased Life A and the other half have purchased Life B. The survey results are summarized below in **Table One**.

The difference between the means is .19 in favor of Life B. A t-test (one tailed) is used to test the difference between the two means. The resulting t-statistic is 1.50 which yields a confidence level of .93. As a result, Life A's management team cannot positively conclude that Life B is superior to Life A with respect to purchase intent.

[Table 1]

	Life A	Life B
N	250	250
Mean	2.90	3.09
Variance	1.96	2.04
S.D.	1.40	1.43

The management team of Life A feels satisfied that their product is just as desirable as Life B and continues on with their current marketing plans. However, a 93% chance that Life B is more desirable than Life A is substantial. A gambler would definitely take a bet with those odds. But the management team at Life A chose a 95% confidence level as their decision threshold so they cannot conclude that Life B is preferred to Life A.

Let's review some basic statistics. In our life insurance example, our null hypothesis is that the average score of Life A is the same as Life B. When hypothesis testing you can make two types of errors:

- **Type I Error** – rejecting the null hypothesis when it is true.
- **Type II Error** – failing to reject the null hypothesis when it is false.

A high confidence level protects the management of Life A from concluding that the obtained difference is real when, in fact, no difference exists because the obtained difference is due to random fluctuation. This type of error is referred to as a Type I error. The probability of this type of error is equal to one minus the confidence level, in this case 1 - .95 = .05.

Now let us assume that Life A will lose $5 million if this type of error is committed. This loss is a result of capital expended to change product features, modify marketing campaigns, and launching a new media initiative. The expected loss (the average loss over time) associated with this type of error is .05 X $5 million = $250,000.

In order to minimize the loss for a Type I error, the management team will set a high confidence level. But another type of error should also be considered. If the management team of Life A concludes that Life B is not preferred to Life A when, in fact, Life B is preferred in the marketplace, then a Type II has been committed. In business situations, Type II errors are often more costly than Type I errors. Let us assume that the preferability of Life B results in a decreased net profit of $10 million for Life A over the next 5 years. The probability of a Type II error is .55848 (which is based on the actual difference of .19, or observed effect size, between the average Life A and Life B scores). The expected loss to Life A associated with this type of error is $5.584 million. In our example, committing a Type II error is considerably more expensive than committing a Type I error.

If the Life A management were willing to select a lower level of confidence, they would decrease the chance of a Type II error and the associated loss from the Type II error would be decreased. If a 90% confidence level were assumed, the expected losses would be $500,000 for a Type I error and $4.134 million for a Type II error. The result is that the expected loss from a Type II error is decreased by $1.45 million while the expected loss for the Type I error is increased by only $250,000.

Choosing a Confidence Level

Selecting a level of confidence should consider both the null and the alternative hypothesis. Selecting a confidence level should be done in an informed manner by estimating the costs of both types of errors (Type I and Type II) in an effort to reduce the probability of losses.

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As we have seen in our life insurance example, having a high confidence level is not a good decision rule. The reason for this is that the losses associated with a Type II error are large. In this type of situation, the confidence level should be lowered. How low should the confidence level be dropped? One method of selecting the optimal decision rule is to minimize the maximum loss potential (also known as the minimax criterion).

In our example, a decrease in the confidence level from .95 to .90 resulted in smaller losses. If the confidence level is decreased further, smaller losses can be obtained. Losses and error probabilities associated with different confidence levels are shown in Table Two. According to the minimax criterion, the optimal level would be a confidence level of 69%.

[Table 2]

Confidence Level	Probability of Error		Expected Dollar Loss	
	Type I	Type II	Type I	Type II
0.99	0.01	0.79772	$50,000	$7,977,157
0.95	0.05	0.55848	$250,000	$5,584,821
0.90	0.10	0.41336	$500,000	$4,133,607
0.85	0.15	0.32067	$750,000	$3,206,717
0.80	0.20	0.25397	$1,000,000	$2,539,655
0.75	0.25	0.20315	$1,250,000	$2,031,499
0.74	0.26	0.19440	$1,300,000	$1,943,998
0.73	0.27	0.18605	$1,350,000	$1,860,482
0.72	0.28	0.17807	$1,400,000	$1,780,699
0.71	0.29	0.17044	$1,450,000	$1,704,422
0.70	0.30	0.16314	$1,500,000	$1,631,443
0.69	0.31	0.15616	$1,550,000	$1,561,573
0.68	0.32	0.14946	$1,600,000	$1,494,637
0.67	0.33	0.14305	$1,650,000	$1,430,476
0.66	0.34	0.13689	$1,700,000	$1,368,943
0.65	0.35	0.13099	$1,750,000	$1,309,903

As we can see above, the confidence level of 69% is optimal because the maximum loss possible would be $1,561,573.

Conclusion

The example demonstrated here is enlightening because the optimal confidence level for this type of risk minimization problem is substantially lower than what would typically be used in a normal market research case. This example serves to demonstrate the relationship between confidence levels and potential loss. The losses in our example are heavily weighted for a Type II error. If the potential losses are changed such that the potential losses from a Type II error are lower, then the confidence level can be adjusted upward. A high level of confidence may not be appropriate for business decisions in situations where potential losses associated with Type II errors is great. Before deciding on a level of confidence, market researchers should examine losses that might result if an error (Type I or Type II) is made and select a confidence level accordingly.