

Appendix A

Statistical Analysis

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Statistical Analysis (Appendix A)

The statistical tests performed as a part of this study depended on the size of the available data sets and an evaluation of statistical assumptions. For all tests, the null hypothesis was that the metric-defined standard is met. The alternative was one-sided and the Type I error level (α level) was set at 5%.

It has been common in various jurisdictions when establishing methods for metrics hypothesis testing to set a particular z-score threshold rather than a specific percentage. Each threshold implies a percentage and the threshold of 1.645 implies 5%. KPMG Consulting does not exclusively use z-scores. Instead, KPMG Consulting sets a percentage rather than a numerical cut-off value for the α level. An α level of lower than 5% may be reasonable if repeated testing is done (to lower the rate of false positives). Significance results listed here are available to 4 decimal places, should such re-testing be necessary or if other Type I error tolerances are considered.

A discussion of the statistical tests used for the usual two types of metrics (metrics that test averages and metrics that test proportions) can be found below. If Verizon PA met the standard according to the test data, the analysis did not determine or report the significance level.

Tests on Averages

Prior to the statistical testing, basic assumptions were checked to ensure no extraordinary outliers or abnormalities exist that would affect the comparison. Assuming no data problems, a standard t-test for differences in means was performed. KPMG Consulting used the standard test to individually verify assumptions and to manage statistical bias.

KPMG Consulting performed a permutation test on any data set with fewer than 100 orders. A permutation test is generally preferable to the standard t-test because it carries no assumptions about the underlying probability distribution of the data. However, once the number of observations in both data sets exceeds 100, the permutation test becomes computationally difficult. In addition, the t-test results and permutation test results are almost exactly equivalent once the number of observations for both data sets is greater than 100, assuming other test assumptions are met. The cut-off of 100 was used for the permutation test because KPMG Consulting determined that the permutation test was more appropriate, and in-house computational capabilities allowed for a permutation test with samples of approximately 100 or fewer.

Tests on Proportions

A Binomial test was used for all comparisons with only one proportion. This test allows for an exact p-value computation when comparing one proportion to an absolute standard. Alternative tests only approximate this value. The p-value determines whether a statistical result is significant. For comparisons involving two proportions, a Hypergeometric test was used when the higher of the counts was fewer than 10,000. This test allows for an exact computation of the p-value when comparing two proportions. If the higher of the counts was greater than 10,000, a Binomial (with the percentage of the higher count considered fixed) test was used. KPMG Consulting also has the in-house capability to compute the exact p-value for such Binomial tests.

Other Statistical Analyses and Considerations

Statistical analysis conducted in October, November, and December 1999. Provisioning data shows that the z-score calculations as used by Verizon PA may lead to inappropriate statistical conclusions.

Verizon PA's z-test calculates ILEC and CLEC variance using ILEC data. KPMG Consulting tests estimate ILEC variance using ILEC data and CLEC variance using CLEC data. If we do not assume, under the Null Hypothesis, that the variances are the same, KPMG Consulting's method is more appropriate. Also, Verizon PA z-tests assume a normal distribution for the ILEC and CLEC means. This is appropriate if sample size is sufficiently large. When sample size is small, this assumption can lead to elevated error levels.

KPMG Consulting's permutation tests assume the ILEC and CLEC distribution are the same under the Null Hypothesis. However, they do not assume a particular probability distribution. The permutation test is more powerful when sample size is small enough that the normality assumption may be incorrect. Thus, KPMG Consulting uses the permutation test for CLEC sample sizes under 100.

Limitations

The Statistical Analysis has a number of limitations. Since KPMG Consulting is primarily using data collected during the test period, it cannot be determined, in any definitive way, whether test period conditions are different than conditions outside the test period. This limitation includes some differences out of Verizon PA's control, such as seasonality, as well as some differences within the control of Verizon PA, such as level of service provided. For purposes of these comparisons, it is assumed that these differences do not exist. Verizon PA has been relied upon to provide accurate test period data.