

# How to Test for Equal Variances Using Levene's Test in Stata

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## Introduction to Levene's Test

The Levene's test stands as a fundamental statistical procedure designed to assess the equality of population variances across two or more independent groups. This test is indispensable in statistical analysis because many parametric methods, such as the Analysis of Variance (ANOVA) or independent samples t-tests, rely on the crucial assumption of homoscedasticity--the homogeneity of variances. Failure to meet this assumption can lead to inaccurate test statistics and misleading conclusions regarding treatment effects or group differences. By employing the Levene's test, researchers can formally determine whether the observed differences in variability across groups are likely due to chance or represent a genuine, statistically significant disparity.

Unlike simpler methods that might only check the ratio of the largest to smallest standard deviation, the Levene's test provides a robust inferential framework. It operates by performing an ANOVA on the absolute differences between the observations and the group means (or medians/trimmed means, depending on the variant chosen). The resultant test statistic, along with its associated p-value, allows for a formal decision. If the calculated p-value falls below a pre-specified alpha level (typically 0.05), we reject the null hypothesis of equal variances, indicating that the assumption of homoscedasticity has been violated.

In Stata, although older documentation might recommend the `oneway var1 var2, equal` command for a basic variance test, modern practice often favors the more robust `robvar` command. The `robvar` command is particularly valuable as it simultaneously provides the results for three critical variations of the Levene's test, increasing the robustness and reliability of the variance assessment, especially when dealing with data that may exhibit non-normality or skewness.

## Why Test for Homoscedasticity?

Homoscedasticity, or the homogeneity of variances, is a foundational assumption underpinning a vast array of common inferential statistical tests. When analyzing data, we often wish to compare the average response (means) between different populations or treatment groups. However, if the spread of the data (the variance) differs substantially between these groups, standard methods designed for equal variances can yield biased results. Specifically, when variances are unequal (heteroscedasticity), the Type I error rate of tests like ANOVA can be inflated or deflated, compromising the trustworthiness of the statistical inference.

If the Levene's test indicates a violation of the equal variance assumption, researchers must adjust their analytical approach. This might involve using a modified statistical test that does not rely on this assumption, such as Welch's ANOVA, or transitioning to a suitable non-parametric alternative that is inherently less sensitive to distributional assumptions. Conversely, confirming homoscedasticity allows researchers to proceed with standard, more powerful parametric tests,

ensuring that the results are reliable and the conclusions drawn about the population means are valid.

Therefore, integrating Levene's test into the exploratory data analysis phase is not merely a formality; it is a critical step in methodological integrity. By rigorously testing the underlying assumptions before proceeding to the primary analysis, statisticians ensure that the statistical tools applied are appropriate for the data structure at hand, leading to robust and defensible scientific conclusions.

## Prerequisites and Preparation in Stata

Performing Levene's test efficiently requires the use of specialized statistical software like Stata. In this environment, the preferred command for conducting a robust comparison of variances across groups is `robvar`. This utility is pre-installed in most recent versions of Stata and provides a more comprehensive output than older, simpler commands, making it ideal for thorough diagnostic checking of model assumptions.

The general syntax for executing the `robvar` command in Stata is straightforward, requiring two fundamental components: the continuous measurement variable (the outcome whose variance is being tested) and the categorical grouping variable (the factor defining the groups being compared). Ensuring that these variables are correctly specified and loaded into the active memory session is the necessary prerequisite before running the analysis.

The ability of the `robvar` command to produce results centered around the mean, median, and trimmed mean addresses potential issues arising from non-normal data distributions. This flexibility is a key advantage, especially in applied research settings where data rarely perfectly conform to theoretical assumptions. The subsequent steps will detail the specific implementation of this command using a real-world dataset.

## Case Study: Analyzing Patient Length of Stay

To illustrate the application of Levene's Test, we will examine a case study concerning patient length of stay in a medical facility. We aim to statistically determine whether the variability (or dispersion) in the length of hospitalization differs between male and female patients undergoing a specific medical procedure. Understanding this variability is essential for optimizing hospital resource planning, budgeting, and patient care pathways.

For this analysis, we utilize the dataset *stay*, which contains records for 1,778 distinct patients. The dataset is balanced, featuring 884 male patients and 894 female patients. The core research question is focused squarely on the homogeneity of variances: Is the spread of the continuous variable, length of stay, significantly different when patients are stratified by their sex?

If the Levene's test ultimately concludes that the variances are homogeneous (i.e., not statistically significant), we can confidently proceed with an independent samples t-test or ANOVA, relying on the assumption that the groups share a common variance structure. Conversely, a rejection of the null hypothesis would necessitate using alternative statistical methods robust to heteroscedasticity.

## Step 1: Loading and Inspecting the Data

The first practical step in Stata is to load the necessary data file. For instructional purposes, we load the dataset *stay* directly from the Stata Press repository using the `use` command, which streamlines the process and ensures that the dataset is immediately available for analysis without requiring local file storage.

To load the dataset into the Stata environment, execute the following command:

```
use http://www.stata-press.com/data/r13/stay
```

Once the dataset is loaded, it is crucial to inspect the structure to verify that the key variables are correctly identified. We use the `list` command to display a subset of the observations, confirming that the columns align with the expected variables: the continuous variable measuring length of stay and the categorical variable indicating sex.

View the first ten rows of data using the following command:

```
list in 1/10
```

The visual output confirms the data structure. The first column represents `lengthstay` (the measurement variable, in days), and the second column represents `sex` (the grouping variable). This confirms the data integrity and readiness for the variance test.

```
. use http://www.stata-press.com/data/r13/stay
. list in 1/10
```

	length~y	sex
1.	6.6	male
2.	4.4	male
3.	3.3	male
4.	3.3	male
5.	5.5	male
6.	16.5	male
7.	9.9	male
8.	6.6	male
9.	7.7	male
10.	4.4	male

## Step 2: Executing the Levene's Test Command

The execution of the Levene's Test for homogeneity of variances is performed using the `robvar` command in Stata. This command is structured to first list the continuous variable being tested, followed by the grouping variable specified within the `by()` option. This ensures that the variance comparison is correctly partitioned across the relevant categories (male and female).

The general structure applied is: `robvar measurement_variable, by(grouping_variable)`.

For our specific case study comparing the variability of patient length of stay across genders, we specify `lengthstay` as the measurement variable and `sex` as the grouping variable. This specific command instructs Stata to compute the three robust Levene's test statistics necessary to draw a definitive conclusion about variance equality.

Execute the following command:

```
robvar lengthstay, by(sex)
```

The resulting output provides a detailed comparison, showing not only the descriptive statistics for each group but also the test statistics (W0, W50, W10) and their corresponding p-values. This comprehensive output is the foundation upon which the statistical interpretation must be built.

```
. robvar lengthstay, by(sex)
```

sex	Summary of Length of stay in days		
	Mean	Std. Dev.	Freq.
male	<b>9.0874434</b>	<b>9.7884747</b>	<b>884</b>
female	<b>8.800671</b>	<b>9.1081478</b>	<b>894</b>
Total	<b>8.9432508</b>	<b>9.4509466</b>	<b>1,778</b>

W0 = **0.55505315** df(1, 1776) Pr > F = **0.45635888**

W50 = **0.42714734** df(1, 1776) Pr > F = **0.51347664**

W10 = **0.44577674** df(1, 1776) Pr > F = **0.50443411**

## Interpreting the Stata Output

The output begins with a summary table detailing the mean, standard deviation, and sample size for both male and female groups. We observe a numerical difference in standard deviations: males have a standard deviation of 9.7884747, while females show 9.1081478. While a difference exists descriptively, the Levene's test formally assesses whether this difference is large enough to be considered statistically significant at the chosen alpha level (e.g., 0.05).

The three critical test statistics provided by the `robvar` command are:

**W0 (Centered at the Mean):** This is the standard Levene's test. The calculated test statistic is **0.55505315**. The associated p-value is **0.45625888**. Since this p-value is significantly larger than 0.05, we retain the null hypothesis.

**W50 (Centered at the Median):** This variant, often recommended by statistical authorities like Conover, Johnson, and Johnson (1981) for asymmetric data due to its increased robustness against outliers, yields a test statistic of **0.42714734**. The corresponding p-value is **0.51347664**. For symmetric data, the W0 and W50 results typically converge, but the median test offers added reliability when data normality cannot be assumed.

**W10 (Centered at the 10% Trimmed Mean):** This robust version uses the 10% trimmed mean to minimize the influence of extreme values (trimming the top and bottom 5% of observations). The test statistic is **0.44577674**, resulting in a p-value of **0.50443411**.

Since all three calculated p-values (0.456, 0.513, and 0.504) are substantially greater than the conventional significance level of 0.05, we conclude that there is no statistically significant difference in the standard deviation (and thus variance) of the length of stay between male and

female patients. The assumption of homogeneity of variances is met, allowing for the appropriate use of standard parametric comparative tests moving forward.

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