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# A SAS PROGRAM FOR TESTING THE HYPOTHESIS OF THE EQUAL MEANS UNDER HETEROSCEDASTICITY: JAMES'S SECOND-ORDER TEST

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A SAS program is presented which computes James's second-order procedure for testing the hypothesis of the equality of J means under heteroscedasticity.

VARIOUS alternatives to ANOVA have been proposed for testing the hypothesis that the means of J groups are equal when the assumption of equal variances is violated (Brown and Forsythe, 1974; James, 1951; Welch, 1951; Wilcox, 1988). Wilcox (1988) showed that James's second-order test had the actual Type I error rate much closer to the nominal Type I error rate than do either the Welch or the Brown-Forsythe tests when the largest to smallest standard deviation was equal to or greater than 4. Wilcox (1988), therefore, recommended James's second-order test for general use. A disadvantage of James's second-order test is computational difficulties. Currently, there is no statistical package which includes this procedure. The purpose of this paper is to present a SAS program for James's second-order procedure.

## *Program*

The program is written in SAS using PROC IML and runs on IBM VM/CMS mainframe. A PC-version is also available.

*Input*

The program reads in a data file which contains sample sizes, means, and variances. For example, a user needs to make a file called MY DAT as follows:

```
24 11.375 5.027
12 12.417 3.902
24 12.625 6.322
```

In the data file, the first variable is the sample size, the second the mean, and the third the variance. Each row presents a different group. The program can handle up to 10 groups.

*Output*

The output contains the data the user created, the critical values for $\alpha$ = .01, .05, and .10, and a statistic U. When U is greater than a critical value, the null hypothesis is rejected.

*Program Availability*

The program may be obtained at no charge by sending a formatted 5.25- or 3.5-inch diskette and a self-addressed, stamped mailer to: T. C. Oshima, Dept. of Educational Foundations, Georgia State University, University Plaza, Atlanta, GA 30303.

## REFERENCES

Brown, M. B. and Forsythe, A. B. (1974). The small sample behavior of some statistics which test the equality of several means. *Technometrics*, 16, 129–132.

James, G. S. (1951). The comparison of several groups of observations when the ratios of the population variances are unknown. *Biometrika*, 38, 324–329.

Welch, B. L. (1951). On the comparison of several mean values: An alternative approach. *Biometrika*, 38, 330–336.

Wilcox, R. R. (1988). A new alternative to the ANOVA F and new results on James's second-order method. *British Journal of Mathematical and Statistical Psychology*, 41, 109–117.