One-way ANCOVA: A BASIC program for minicomputers

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The analysis of covariance (ANCOVA) is a fairly straightforward statistical procedure (cf. Bruning & Kintz, 1968, pp. 173-177; Keppel, 1973, pp. 477-500), but its calculation by hand or by hand calculator is made tedious by the extended number of sums and cross-products needed—particularly in its factorial versions. A number of programs exist for such purposes. However, a review of the last 6 years of *Behavior Research Methods & Instrumentation* indicates that all of the programs require at least 16K memory. By contrast, the present program (implemented on a WANG 2200-A) requires only 2.97 bytes of core and, hence, should operate on virtually any system that employs BASIC as a language.

Input. Initially, one inputs the number of cells. After the initial response, the user inputs the number of item pairs in each cell, followed by the cell data (the data is printed as output). After each cell, the user is given an opportunity to correct any data pair before proceeding to the next cell.

Output. Sample output is presented in Table 1. After each cell data set has been input and corrected, means for the covariate and dependent variables are printed. The ANCOVA is performed after all input is completed. Initial output includes adjusted treatment and error terms with associated F and an adjusted total. In addition, the program reports deviation from linearity (if there are more than two cells), homogeneity of the between and within regression, and the precision index (within-groups correlation). Thus, the user is given not only the results of regression, but also tests for the applicability of ANCOVA to the given problem.

Program Language and Requirements. The program is written in a form of BASIC that allows INPUT and PRINT USING statements and permits optional specification of LET. At present, a CRT and printer are used as output units, but that can be altered. Including REM statements, the program is 82 statements long. Any number of cells or data pairs per cell may be entered, provided the grand sums and cross-products do not exceed the capacity of the machine in question to represent real numbers. A weighted-means solution accounts

Table 1
Sample Output

	Group 1		Group 2		Group 3	
	Control	Treat- ment	Control	Treat- ment	Control	Treat- ment
	10.00	15.00	4.00	6.00	7.00	14.00
	12.00	13.00	9.00	15.00	8.00	6.00
Mean	7.87	7.00	8.00	11.00	6.62	12.00

Analysis of Covariance					
Source	SS	df	MS	F	
ANCOVA					
Adjusted Treatment	165.79	2	82.89	4.961	
Adjusted Error	334.17	20	16.70		
Adjusted Total	499.96	22			
Checks for:					
Linearity					
Y Deviation from Linearity	72.97	1	72.97	4.367	
Homogeneity of Regression					
Between Regression	30.80	2	15.40	.913	
Within Regression	303.36	18	16.85		
Precision Index (Within-Groups Correlation) = .573					

Note—These are sample data taken from Keppel (1973, p. 487).

for unequal ns (Li, 1964).¹ Execution time is virtually completely dependent on input/output.

Availability. Program listings will be provided at no cost on request to either author, Department of Psychology, Clark University, Worcester, Massachusetts 01610.

REFERENCES

- BRUNING, J. L., & KINTZ, B. L. *Computational handbook of statistics*. Glenview, Ill: Scott Foresman, 1968.
- KEPPEL, G. *Design and analysis*. Englewood Cliffs, N.J: Prentice-Hall, 1973.
- LI, J. C. R. *Statistical inference*. Ann Arbor, Mich: Edwards, 1964.

NOTE

1. A virtually identical program incorporating an unweighted means solution is also available from the authors. However, review of a substantial collection of statistical references failed to turn up a worked example of an unequal ns solution against which the output of the unweighted solution could be verified. Any assistance that can be provided in locating such examples would be greatly appreciated.

(Accepted for publication May 14, 1979.)