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ABSTRACT

Researchers persist in using stepwise regression in spite of problems with this approach. As noted by B. Thompson (1995), three problems accompany the use of stepwise applications. The first is that computer packages may use incorrect degrees of freedom in their computations, resulting in a greater likelihood of obtaining a spurious statistical significance. In the Statistical Package for the Social Sciences, although all the predictor variables explained in the analysis are examined for the initial step, the computer package only shows the degree of freedom corresponding to one predictor variable. Secondly, stepwise methods do not identify the best variable set of a given size correctly. Finally, stepwise methods tend to capitalize on sampling error and tend to produce results that are not replicable. This problem is caused by the uniqueness of sample data and the fact that sampling error in a given sample is not likely to occur in another sample. Researchers should consider and select other available methods for research. (Contains one table and five references.) (SLD)

Stepwise Analyses Should Never Be Used by Researchers

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ABSTRACT

Despite problems with using stepwise regression, researchers persist in using this analytical method. As Thompson (1995) noted, three problems accompany the use of stepwise applications:

> First, computer packages use incorrect degrees of freedom in their stepwise computations, resulting in artificially greater likelihood of obtaining spurious statistical significance. Second, stepwise methods do not correctly identify the best variable set of a given size. Third, stepwise methods tend to capitalize on sampling error and thus tend to yield results that are not replicable. (p. 525)

Stepwise Analyses Should Not Be Used By Researchers

Frequent use is made of analytical procedures involving stepwise regression. In fact, stepwise methods are among the most commonly used investigative procedures (Snyder, 1991). The popularity enjoyed by stepwise regression among researchers may be due, at least in part, to the relatively uncomplicated nature of the procedures. The ease with which stepwise analyses can be conducted belies the compound and complex problems which arise from having conducted such studies (Beasley & Leitner, 1994). Beasley and Leitner (1994) registered criticism of stepwise regression procedures for their statistical distortions and misinterpretation of results.

Despite sharp criticism (Beasley & Leitner,1994; Snyder, 1991; Thompson, 1995) of the use of stepwise regression analyses, there is no shortage of researchers who continue to rely on the results of this method. Perhaps researchers are not aware of three serious problems with the use of stepwise regression.

As Thompson (1995) noted, three specific problems accompany the use of stepwise applications:

> First, computer packages use incorrect degrees of freedom in their stepwise computations, resulting in artificially greater likelihood of obtaining spurious statistical significance. Second, stepwise methods do not correctly identify the best variable set of a given size. Third, stepwise methods tend to capitalize on sampling error and

thus tend to yield results that are not replicable. (p. 525)

Problems With Stepwise Regression Analyses

Problem one manifests itself in the fact that computer packages use incorrect degrees of freedom. A predictor variable, once examined, is like the sword a matador thrusts into the bull. The researcher who in the first step of the stepwise analysis records one degree of freedom when several or all predictor variables were actually examined is like that matador who thrusts the sword into the bull, decides that another area of the now wounded animal would be a more vulnerable target, quickly extracts the sword, and strikes again. As if the series of thrusts is not bad enough, the matador adds insult to injury by pretending that the first thrust never occurred. The animal's wounds are the result of two (or more) sword strikes, not just one as the matador pretends. In a given step of stepwise, the matador or researcher reaps the benefits of all the thrusts or degrees of freedom while being charged with the use of only one.

Computer programs likewise fail to display the correct number of degrees of freedom for stepwise analyses. In SSPS, despite the fact that all predictor variables explained in the analysis were examined for step one, the computer package incorrectly shows only one degree of freedom recording only the predictor variable with the largest R^2 instead of the number of predictors actually examined (Snyder, 1991).

The second problem with stepwise methods is that they <u>do not</u>

correctly identify the best variable set of a given size. Stepwise regression was one of a group of analyses used to compare data on Tennessee's school district report cards. The focus of each initial study was to determine the impact of predictor variables on the dependent variable of student outcome. Bobbett and French (1993) compared the percentage of variance for the original studies using Pearson Product Moment (PPM), Guttman's Partial Correlation (GPC), Stepwise Regression (Forward) (SR), and the probability of the Multiple Regression (MR). The researchers examined three of the eight variables from the original Tennessee studies. One purpose of the study was to determine how the use of different analyses impacted conclusions.

These findings illustrated among other things that stepwise does not necessarily pick the predictor set of a given size yielding the highest R^2. A snapshot of the impact of three variables, A,B,C, on the dependent variable student outcome, at the elementary, middle, high school and system levels is found in Table 1.

Table 1
Comparison of Outcomes for Three Analyses

Variable A

	Elementary School	Middle School	High School	System
PPM	26%	24%	28%	33%
GPC	7%	2%	0%	5%
SR	25%	0%	0%	32%

Variable B

	Elementary School	Middle School	High School	System
PPM	19%	28%	19%	27%
GPC	1%	0%	3%	0%
SR	>1%	>1%	>1%	>1%

Variable C

	Elementary School	Middle School	High School	System
PPM	21%	26%	30%	31%
GPC	2%	6%	5%	7%
SR	none	minor	large	minor

In the original Tennessee studies, predictors four through eight sometimes yielded higher R^2s than the three variables in the Bobbett and French study. Since only three predictors were considered in this study, the researchers might have over emphasized their contribution to the impact on student outcomes.

It is also apparent from the table that depending on the method of comparison, certain predictor variables will show a higher correlation to the dependent variable.

The third problem with stepwise methods is that they tend to capitalize on sampling error and thus tend to yield results that are _not_ replicable. The uniqueness of sample data is the cause of this third problem with using stepwise procedures. Sampling error in a given sample is not likely to occur in another sample. Thompson (1995) reasoned that sampling error makes stepwise applications a bad idea: "Sampling error is variability in sample data unique to that given sample and therefore cannot be reproduced in subsequent samples" (p. 532). Because of the uniqueness of sampling error, results are not replicable from one sample to the next making valid generalizations to the population, unlikely. For more valid generalizations to the population Huberty (1989) presented this strategy for the researcher who insists on using stepwise methods:

> Inferences about "best" subsets and variable importance to other units should be made with great caution. The "best" variable subset for one sample of units may be far from the best for other samples. The greater the ratio of sample size to number of response variables, the more reasonable are the implied generalizations. A large such ratio alone, however does not insure valid generalizations. Valid generalizations may be

obtained only to the extent that the pattern of response variable intercorrelations for non-design sample experimental units follow the pattern present in the design sample. (p. 63)

As illustrated by Snyder (1991) in a set of elaborate tables, sampling error tends to yield results that are not replicable. Huberty (1989) suggested various resampling strategies such as bootstrapping or jackknifing as ways to get around sampling error problems.

Summary

Since stepwise methods not only fail to accomplish the goals set forth by researchers but also compound inaccurate findings and further invalidate results, other forms of analysis should be explored. The "simple" problems are first that computer packages use incorrect degrees of freedom in their stepwise computations; the second problem, is that stepwise procedures do not correctly identify the best variable set of a given size; and finally, stepwise methods tend to capitalize on sampling error and thus tend to yield results that are not replicable. These "simple" problems are just the beginning of what usually leads to more complex statistical abberations. To prevent these "molehills" from becoming mountains, the resourceful researcher should consider and select other available methods for research.

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