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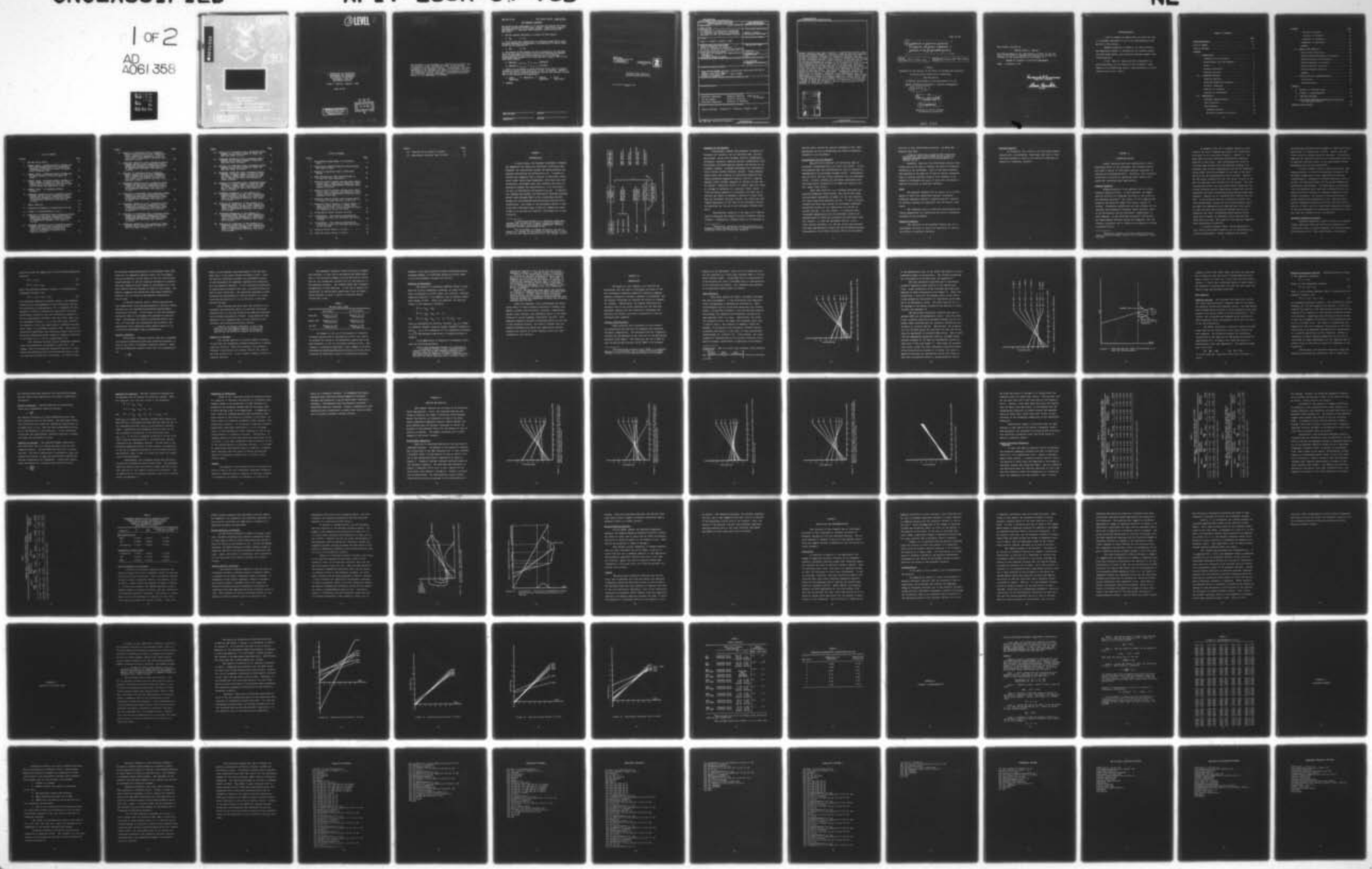

3 LEVEL II

A COMPARISON OF STATISTICAL
TECHNIQUES FOR ASSESSING
THE EFFECTS OF MODERATOR
VARIABLES IN THE JOB
ENRICHMENT PROCESS

Homer L. Tackett, Captain, USAF

LSSR 34-78B

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Research efforts have used a variety of statistical analysis techniques--moderated regression analysis, subgroup analysis, analysis of variance (ANOVA), analysis of covariance (ANCOVA), and the Ghiselli technique--to assess the effect of moderator variables in the job enrichment process. Since analysis of the same set of data by various techniques has tended to produce different results, this research effort was designed to investigate the power of these five techniques to identify the effects of moderator variables. Monte-Carlo simulation was employed to generate data sets which either exhibited a moderator effect at a prespecified level or were devoid of such an effect. The simulated data were subjected to analysis with each of the techniques. Comparative results evidenced that the Ghiselli technique is not appropriate when the measurement of primary variables is based on a common scale; moderated regression analysis is always superior to ANOVA, ANCOVA, and subgroup analysis when the moderator variable is continuous; and a change in explained variation due to interaction of a moderator variable as small as two percent may be a good indicator of the presence of a moderator effect.

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READER

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CHAPTER I

INTRODUCTION

In recent years, job redesign (enrichment) research has emphasized the search for individual differences that moderate[1] the relationship between job characteristics and employee satisfaction and productivity (5). A number of writers have suggested that a variety of individual differences (urban versus rural background, work values and work orientation, and higher order need strength) may serve as moderators between the characteristics of an individual's job and his satisfaction and productivity (5). In particular, Hackman and Oldham's job enrichment[2] strategy considers growth needs strength (GNS) to be a moderating variable between the job characteristics-satisfaction/productivity relationship. This model of job enrichment (Figure 1) predicts that individuals high in GNS will respond more positively to an enriched job than will individuals low in GNS (15:55-71).

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[1]A moderating variable is a secondary independent variable that is believed to have a strong contingent or contributory effect on an original independent variable-dependent variable relationship (9:95).

[2]Job enrichment is a means by which a job can be changed to increase the motivation and satisfaction of people at work and improve productivity in the bargain (15:57).

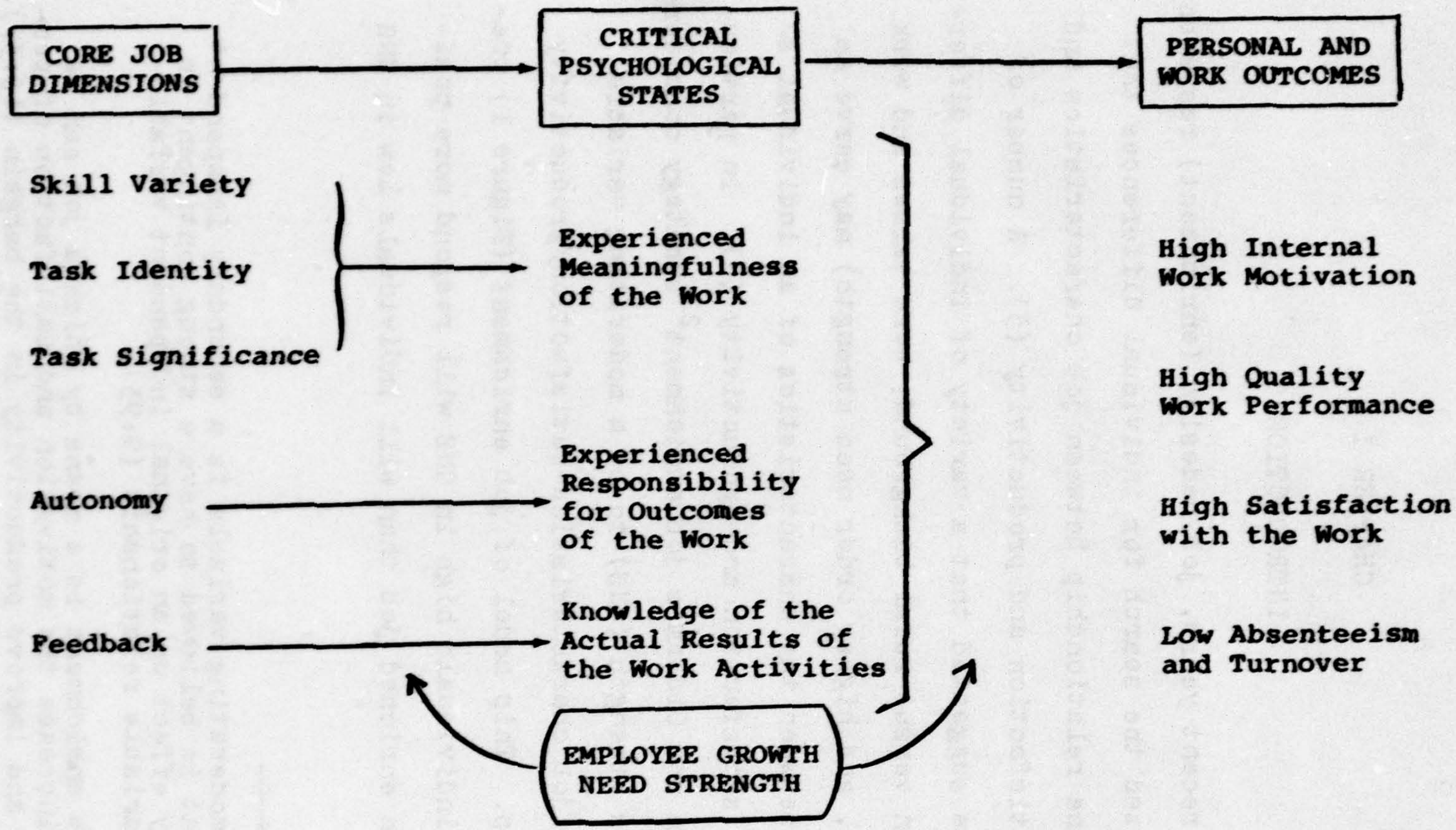

Figure. 1. The Hackman-Oldham Model of Job Enrichment (15:58)

Statement of the Problem

Considerable research has attempted to explain or determine how variables such as individual GNS, need for achievement, social need strength, need for independence, alienation, education, employee ability, organization level, environment, and participation moderate the desired job enrichment outcomes: increased performance and satisfaction (19:7; 23:159; 25:678; 28:39-40; 29:269). These research efforts have used a variety of statistical analysis techniques--moderated regression analysis (26:163), subgroup analysis (18:2; 25:680), analysis of variance (17:59) and the Ghiselli technique[3] (28:38)--to analyze data and, thereby, attempt to determine if a moderator effect exists. A fifth technique, analysis of covariance, has been used to identify the effect of moderator variables in areas other than job enrichment (21:139); however, the author and individuals experienced in the area of job enrichment believe the potential for its use in job enrichment research does exist.

Unfortunately, analysis of the same set of data by various techniques has tended to produce different results (30:295). Consequently, research needs to be conducted to

---

[3]The Ghiselli technique involves prediction of a moderator effect through the use of standardized absolute difference scores and correlation analysis.

identify which statistical analysis technique is the most appropriate for use in determining the effect of moderator variables on job enrichment.

Justification for the Research

Many Air Force personnel are exhibiting signs of discontent (dissatisfaction) with their jobs (8:58). It has been proposed that this dissatisfaction could be reduced by implementing a job enrichment program (8:58). Consequently, many Air Force jobs are likely candidates for job enrichment (8:58). In fact, orthodox job enrichment experiments have been successfully conducted at the Ogden Air Logistics Center, Ogden, Utah (16:40).

While many benefits, e.g. increased efficiency and improved managerial effectiveness, were acrued from these job enrichment experiments at Ogden, not all such projects have been unqualified successes (16:42). In fact, existing research has found that similar job enrichment techniques may produce success in one organization and failure in another (12:130). For this reason, it is believed that successful implementation of job enrichment involves the identification of those job situations and individuals that will benefit most from the enrichment process (19:9). Since certain variables, e.g. GNS and social need strength, have been hypothesized to effect the job enrichment process, determination of how these variables effect job enrichment will aid in this identification process. As Jones and Ridenour have said,

> If the Air Force can accomplish this identification process, then the Air Force should be able to maximize investment while minimizing prospects of failure [19:9].

Presently, there are five statistical analysis techniques that can be used to identify the effect of moderator variables on job enrichment. Since it has been evidenced that analysis of the same set of data by various techniques tends to produce different results, this research is designed to investigate the power of these five techniques to identify the effect of moderator variables.

Scope

The proposed research will be limited to an investigation of these five statistical analysis techniques: moderated regression analysis, subgroup analysis, analysis of variance, analysis of covariance, and the Ghiselli technique.

The techniques will be viewed as methodological procedures appropriate for identifying the action of moderator variables on job enrichment.

Research Objective

The objective of the proposed research will be to investigate the power of these five techniques to identify the effects of moderator variables.

Research Question

To accomplish this objective the following research question will be considered: What power does each of these techniques possess in terms of its ability to identify the effects of a moderator variable?

CHAPTER II

LITERATURE REVIEW

Several variables have been hypothesized to have a moderating effect on job enrichment, and research efforts have used a variety of statistical analysis techniques to identify this moderating effect. Therefore, this literature review will be devoted to explaining these various techniques and discussing their applications.

Subgroup Analysis

Subgroup analysis is one approach used to conduct moderator analysis (18:2). In this approach, the sample data are divided into subgroups according to the values of the moderator variable.[4] Two, three, or four subgroups are formed by splitting the sample into halves, thirds, or fourths. Correlation coefficients are then obtained for the dependent and independent variables (these variables could be job satisfaction and job enrichment, respectively) in each subgroup. If the resulting correlation coefficients are significantly different across the subgroups, then the variable originally used to identify the subgroups is termed a moderator (18:2).

---

[4]Moderator variable values are usually scores obtained from an instrument such as the Job Diagnostic Survey (14:259).

An example of the use of subgroup analysis is provided by the test of Hackman and Oldham's job characteristics model of work motivation (Figure 1, Chapter I). The model specifies that individual GNS moderates employees' reaction to their work. This relationship was tested by utilizing data obtained from 658 employees working on 62 different jobs in seven organizations via the Job Diagnostic Survey (JDS), which was designed to test each of the variables in the job characteristics model (14:259). Based on the GNS scores obtained from the "job choice" section of the JDS, the employees were divided into four groups. Then the correlations between the three psychological states and the outcome variables and the correlations between the core job dimensions and their corresponding psychological states were computed. Measures of all variables were obtained from the JDS. It was predicted that the correlations between the three psychological states and the outcome variables would be higher for employees with a high GNS than those with a low GNS, and that the correlations between the core job dimensions and their corresponding psychological states would also be higher for employees with a high GNS than those with a low GNS. The results of the analysis supported these predictions (14:269-274).

In another research effort, Steers hypothesized that need for achievement moderates the job performance-job attitude relationship. Steers' hypothesis was tested utilizing data collected from a sample of female first-level supervisors in a large public utility. Analysis was performed using the subgroup analysis technique. The analysis supported the hypothesis that need for achievement does have an important moderator effect on the relationship between performance and attitude (25:678-682).

A recent research effort by Gross and Kissler used subgroup analysis to test the moderating influence of six variables--organization level, opportunity for growth, instrumentality, leadership initiating structure, locus of control, and need achievement--on the job performance-job satisfaction relationship. Job performance, job satisfaction, and moderator score data were collected from 103 research scientists working in a research component of the Federal Government. The results of Gross and Kissler's study indicated that organization level, opportunity for growth, leadership initiating structure, and need achievement do, in fact, exhibit a significant moderating influence on the job performance-job satisfaction relationship, while the other two variables do not (11:380-382).

Moderated Regression Analysis

Moderated regression, which is based on the general linear regression model and involves the computation of interaction terms, is another approach for conducting moderator analysis (18:2). More specifically, this approach involves fitting the sample data to the following regression equations:

$$\hat{y} = a + b_1x \tag{1}$$

$$\hat{y} = a + b_1x + b_2z \tag{2}$$

where the potential moderator variable z is treated as an independent variable, and

$$\hat{y} = a + b_1x + b_2z + b_3xz \tag{3}$$

(the moderated regression equation) where z, the moderator variable, acts through/appears in the interaction term xz. The coefficient of determination, R^2, is computed for each equation; if the R^2's obtained for equations 2 and 3 are significantly different from that obtained for equation 1, but not significantly different from each other, then z is an independent variable. If, on the other hand, the R^2's for equations 2 and 3 are significantly different from each other, then z is a moderator variable (2:2). These test of statistical significance are essentially direct tests on the additional explanatory power (change in explained variation) of the model due to z and xz, sequentially (20).

This technique has been used in behavioral research since its presentation by Saunders in 1956 (2:1). For example, Stone used moderated regression analysis to investigate the moderating effect of work-related values on the job scope-job satisfaction relationship. In Stone's study, the potential moderating effects of a Protestant ethic (PE) index and its components (pride in work, job involvement, activity preference, social status of the job, and attitude toward earnings) on the job scope-job satisfaction relationship were examined using a sample of 594 workers in 13 jobs that differed from one another in terms of their scope. His analysis suggests that PE may have some small moderating effect on the job scope-job satisfaction relationship (26:147-164).

In another research effort, Schuler hypothesized that organization level and participation in decision making moderated the role perceptions-satisfaction/performance relationship (23:159). In his study, he used the moderated regression model to investigate the hypothesized relationships. The analysis did detect a moderating effect; however, he found that role perceptions, participation, and organization level explained a much smaller amount of the variation in performance than in satisfaction.

Ghiselli Technique

The Ghiselli technique involves the use of standardized absolute difference scores and correlation analysis to predict the effect of moderator variables (30:297). Dependent and independent variable scores are first standardized by:

$$z = \frac{x-\bar{x}}{s}$$

where x is an original score measurement, $\bar{x}$ is the score mean, and s is the score standard deviation (3:35). Next, the absolute differences between the standardized scores of the independent and dependent variables are correlated with the moderator variable. If the correlation coefficient is significantly different from zero, a moderator effect is said to exist (28:39-42). The potential usefulness of this technique was demonstrated in 1956 by Ghiselli in a study involving the prediction of job proficiency of taxi-cab drivers (30:298).

This technique has since been used by White to investigate the moderating effect of individual difference characteristics on the job situation and employee responses such as worker satisfaction (28:38). Using data from 2431 employees in 14 research sites, he found relatively few variables that exhibited moderating effects.

> However, of greater importance to this study [White's] was the dramatic failure of any of the variables to consistently moderate the relationship across the different research sites [28:41].

Analysis of Variance

The two-way analysis of variance (ANOVA) technique is used when two independent variables measured on a nominal scale are involved. With this technique, the moderator variable is partitioned into classes such as low, medium, and high (22:243-244). In this respect, ANOVA is similar to subgroup analysis.

The moderator variable, along with another independent variable, is cast into a two-dimensional ANOVA table. Table 1 illustrates an example in which GNS and job enrichment are the independent variables and job satisfaction is the dependent variable. The standard ANOVA sum of squares decomposition is then effected. If the sum of squares for interaction is statistically significant, then the partitioned variable is said to exhibit a moderator effect (22:245-247; 17:59).

TABLE 1

TWO-WAY ANOVA TABLE

	Enrichment	No Enrichment
High GNS	Measure of Job Satisfaction	Measure of Job Satisfaction
Medium GNS	Measure of Job Satisfaction	Measure of Job Satisfaction
Low GNS	Measure of Job Satisfaction	Measure of Job Satisfaction

An example of the use of the analysis of variance technique was provided by Horstman and Kotzun, who used it to indicate the action of the moderators, growth and social need strengths, on the job enrichment process (17:59). This research, a laboratory experiment, used a sample of students attending the Continuing Education Division of the Air Force Institute of Technology's School of Systems and Logistics.

Analysis of the data collected revealed moderating effects, although marginal, of individual growth and social needs on the job enrichment outcomes (17:123-124).

Analysis of Covariance

The analysis of covariance (ANCOVA) design is used when two or more independent variables, at least one of which is measured on a ratio scale, are involved. Multiple regression analysis is one approach used to analyze covariance designs (1:409). Under this approach, the data are fitted to the regression equations:

$$\hat{y} = a + b_{D_T} \cdot x_{D_T} ,$$

$$\hat{y} = a + b_{D_T} \cdot x_{D_T} + b_C \cdot x_C ,$$

and $$\hat{y} = a + b_{D_T} \cdot x_{D_T} + b_C \cdot x_C + b_I (x_{D_T} \cdot x_C)$$

where x_C represents the moderator variable, x_{D_T} is a dummy or indicator variable encoding nominal variable information, and $x_{D_T} \cdot x_C$ is the interaction of the independent variables. If b_I is statistically significant, a moderator effect is present.

In an application of analysis of covariance, Lloyd used the following procedure:

> First, each moderating variable is investigated . . . to determine whether it has a prerequisite correlation with one or more dependent measures sufficiently strong to warrant a covariance analysis . . . . The author [Lloyd] employed a rather liberal arbitrary decision rule which required that a covariate have a

> significant ($p \leq .05$) r value $\geq .50$ with one or more dependent variables to justify further investigation.
>
> Second, if the relationship between a covariate and a criterion variable generated an $r \geq .50$, then an analysis of covariance was performed. The reader is reminded that in an ANCOVA the amount of variance in a particular dependent variable that is predicted by the covariate is removed and an ANOVA is performed on the remaining residuals (i.e., that amount of variance in a dependent variable that is not predicted by the covariate).
>
> Finally, the ANOVA performed before the covariate was removed is compared with the ANOVA performed after it is removed. If main effects and/or interaction effects are not altered, then it cannot be argued that the covariate is substantially affecting the relationship between the independent variable and criterion measures [21:138-139].

Using this approach, Lloyd investigated the moderating effect of seven variables (education, feedback from agents, internal work motivation, autonomy, communication pattern, peer cohesion, and leadership style) on the effectiveness of survey feedback intervention (21:138). This analysis technique detected a moderating effect in only two of the variables studied. The results indicate that the measures feedback from agents and communication pattern moderate the effects of survey feedback, while the other variables do not (21:xvii).

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CHAPTER III

METHODOLOGY

The purpose of this chapter is to describe the methodology that was used to investigate the power of the five techniques--moderated regression analysis, subgroup analysis, analysis of variance, analysis of covariance, and the Ghiselli technique--to identify the action of a moderator variable. Specifically, the chapter identifies the variables used in the study; describes how the data were generated; explains how the statistical techniques were employed; and finally, provides a description of how the techniques were compared.

Variable Identification

Three variables were considered in this research. Job satisfaction and GNS were the dependent and moderator variables, respectively. Job enrichment was the independent variable and was measured as the cube root of the Motivating Potential Score (MPS3). The reason for the use of MPS3 is that the Motivating Potential Score[5] (MPS) is an accepted

[5]The Motivating Potential Score (MPS) is a composite measure of job enrichment and is computed from the scores obtained for the five job characteristics of the Hackman-

measure for job enrichment, while the use of MPS3 will permit the reduction of a third order variable (MPS) to a first order variable (MPS3). A high MPS3 score is representative of an enriched job, while a low MPS3 score is representative of an unenriched job (19:32). All variables were measured on a seven-point Likert scale (5; 13:267).

Data Simulation

Data bases compiled by Umstot, Rosenbach, and Hackman were investigated. It was anticipated that regression lines corresponding to hypothetical satisfaction - MPS3 relationships could be constructed based upon this investigation. As depicted in Figure 2, the hypothesized relationship between the dependent and independent variables for each moderator level is linear. Additionally, the closer the regression lines, the weaker the moderator effect that is said to exist. The research of Champoux, Peters and Hackman, in conjunction with information obtained through interviews with Umstot, is the basis of these hypothetical relationships (6; 15:66-67; 27). Unfortunately, the investigation of existing data did not provide sufficient information to permit construction of regression lines similar

---

Oldham Model. MPS is a third order variable, being computed as follows:

$$\text{MPS} = \left[\frac{\text{Skill Variety} + \text{Task Identity} + \text{Task Significance}}{3}\right] \times \text{Autonomy} \times \text{Feedback}$$

(14:258).

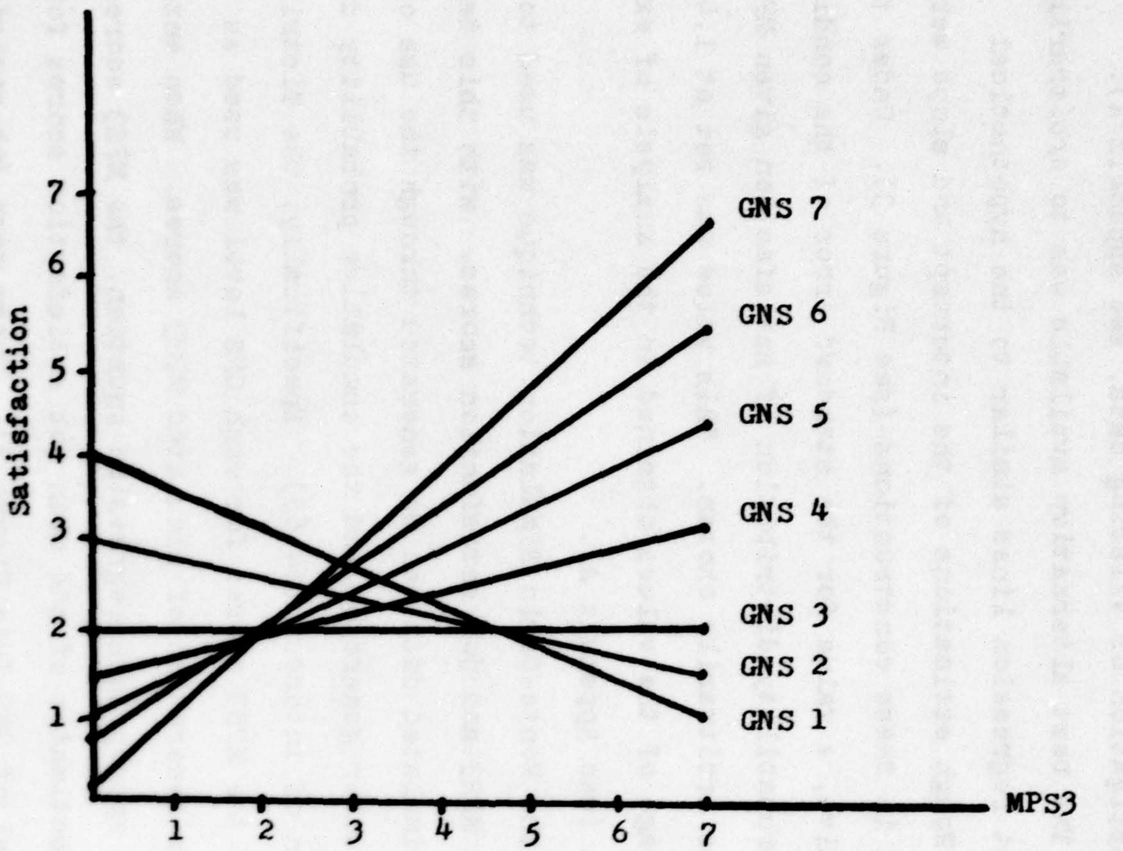

Figure 2. Hypothetical MPS3-Satisfaction Relationship per Level of GNS

to the hypothetical ones, so the author was forced to use an alternative means of construction. (For details concerning the investigation of existing data, see Appendix A).

The best alternative available was to arbitrarily construct regression lines similar to the hypothetical lines. Rough estimations of the intercept and slope were employed in these constructions (see Figure 3). Under this alternative, a value for the standard error of the conditional probability distribution of satisfaction given MPS3 had to be arbitrarily chosen. This value was set at 1.4--the average of the values obtained in the analysis of existing data (see Appendix A).

The Monte-Carlo Simulation technique was used to generate MPS3 and job satisfaction scores. With this technique, simulated data can be generated through the use of a random number generator and the cumulative probability distribution of interest (24:65). Specifically, the distribution for the MPS3 scores for each GNS level was used as the basis for generation of simulated MPS3 scores. When entered into the appropriate regression equation, the MPS3 scores yielded estimates of the mean job satisfaction scores for each level of GNS (see Figure 3). These mean job satisfaction scores, along with their associated conditional probability distributions, assumed to be normal, were used to generate simulated job satisfaction scores (see Figure 4). Data with no moderator effect; a strong moderator effect;

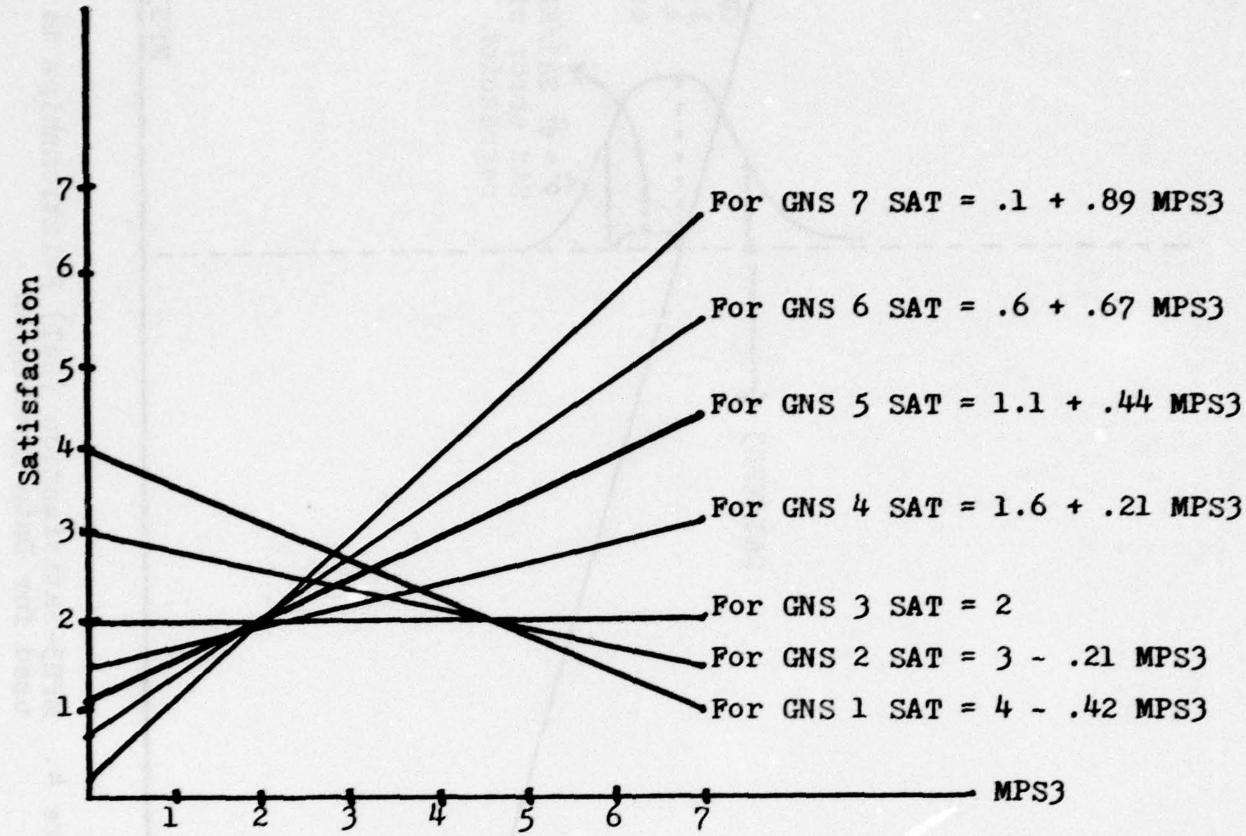

Figure 3. Regression Equations used in Data Simulation

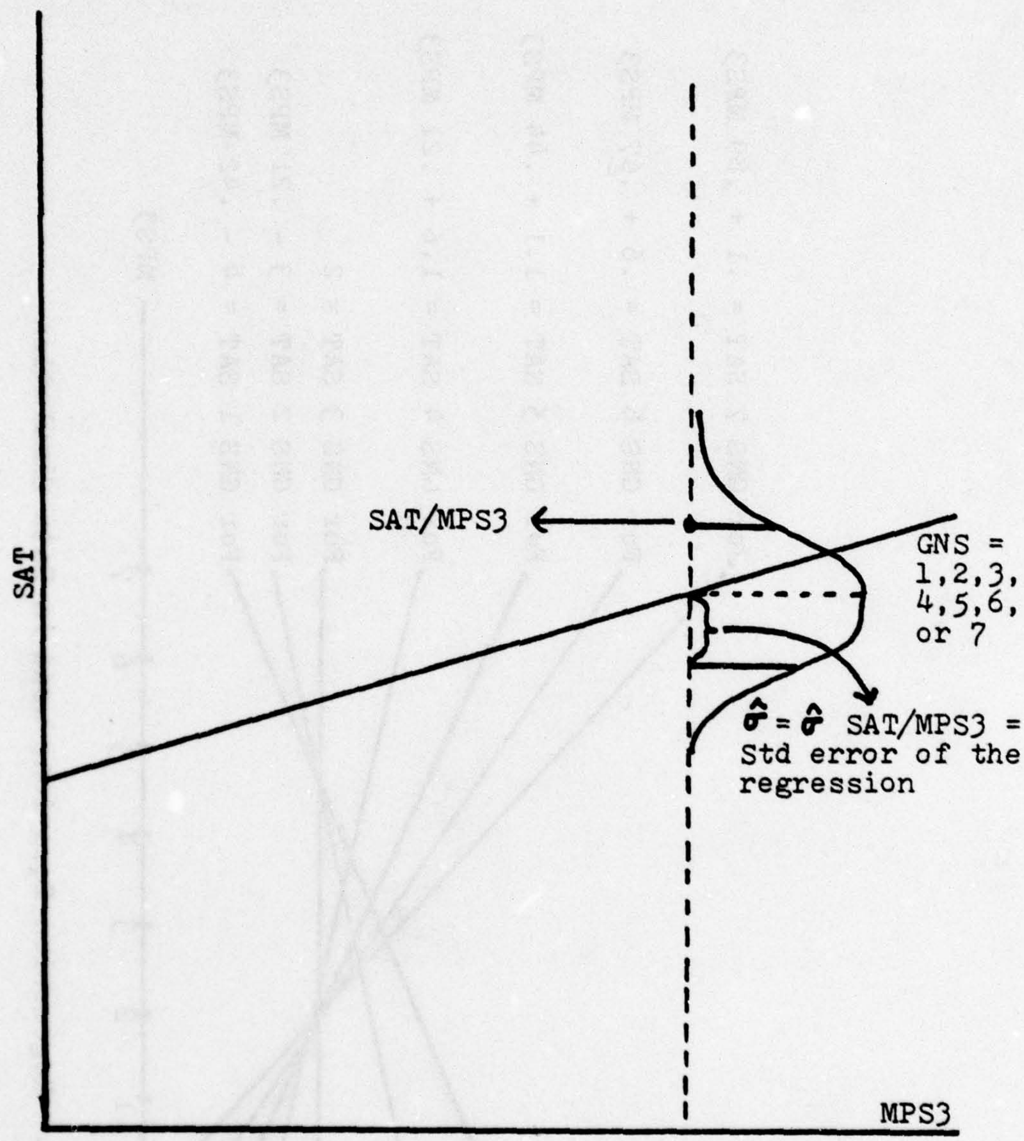

Figure 4. MPS3-Satisfaction (SAT) Relationships to be used for Data Simulation

n equal to 1000, 2500, 5000, 7500, and 10000; an equal number of cases for each GNS level (7 levels each with 1072 cases, overall n = 7504; and 7 levels each with 1429 cases, overall n = 10003) and a differing number of cases (based on the analysis of existing data) for each GNS level were simulated through the procedure described.

Data Analysis

Subgroup analysis. The simulated data bases were divided into three equal-as-possible subgroups based on the moderator variable (Growth Need Strength) scores. The high growth need strength group consisted of those simulated scores that placed in the top one third of the GNS distribution. Conversely, the low growth need strength group consisted of those simulated scores that placed in the bottom one third of the GNS distribution.

The sample correlation coefficient between the MPS3 scores and the job satisfaction scores were computed for each subgroup. The difference between the correlation coefficients of the high and low GNS groups was tested for significance at a .05 alpha level using the Fisher's z transformation test (see Appendix B). The hypotheses that were tested are:

$$H_0: \rho_1 = \rho_3 \qquad H_1: \rho_1 \neq \rho_3$$

If H_0 was rejected, a moderator effect was considered to exist.

<u>Moderated regression analysis</u>. Simulated data were fitted to the regression equations:

$$\hat{y} = a + b_1x \tag{1}$$

where x is the independent variable,

$$\hat{y} = a + b_1x + b_2z \tag{2}$$

where z, the potential moderator--GNS, is treated as an independent variable, and

$$\hat{y} = a + b_1x + b_2z + b_3xz \tag{3}$$

the moderated regression equation. The coefficient of determination, R^2, for each equation was computed. If the computed R^2 for equation 2 was significantly different from the computed R^2 for equation 3, then GNS was considered a moderator variable. Significance was determined from an F-test on the net or marginal contribution of the interaction term xz at a .05 alpha level. The reader is reminded that the magnitude of the net or marginal contribution of the interaction term is an important consideration for significance in a specific application of this technique. However, a subjective criterion regrading magnitude was not used in this study to judge significance; but the magnitude was reported, since it was used as a basis for comparison of the techniques.

Additionally, the moderated regression design was modified by allowing the interaction term to enter first.

The simulated data were analyzed with this modified design, and the results were reported for the reader's additional information.

Ghiselli technique. Simulated MPS and job satisfaction scores were standardized using the formula:

$$z = \frac{x-\bar{x}}{s} \quad .$$

The absolute difference of these standardized scores was then correlated with the GNS scores. The resulting correlation coefficient was tested for statistical significance at an alpha level of .05. This test was accomplished with the use of the Students' t-test statistic. If the correlation coefficient was significantly different from zero, a moderator effect was considered to exist.

Analysis of variance. The simulated sample observations were stratified into low, medium and high scores as with subgroup analysis. Two-way ANOVA was then used to analyze the data. The sum of squares due to interaction, SS_{RC}, was computed and tested; if SS_{RC} was statistically significant, GNS was considered to be a moderator. Statistical significance was tested at a .05 alpha level with the F ratio

$$F = \frac{MS_{RC}}{MS_E} \quad .$$

Analysis of covariance. Multiple regression analysis was the approach used to analyze the covariance design. Under this approach, the data were fitted to the equations:

$$\hat{y} = a + b_{D_T} \cdot x_{D_T},$$

$$\hat{y} = a + b_{D_T} \cdot x_{D_T} + b_C \cdot x_C,$$

and

$$\hat{y} = a + b_{D_T} \cdot x_{D_T} + b_C \cdot x_C + b_I \, (x_{C_T} \cdot x_C)$$

where x_{D_T} is a dummy or indicator variable which equals one when the job is considered enriched and zero when the job is not considered enriched, and x_C is the moderator variable (GNS). Significance was determined from an F-test on the net or marginal contribution of the interaction term $x_{D_T} \cdot x_C$. If the net or marginal contribution of the interaction term was significant at a .05 alpha level, GNS was indicated to be a moderator variable. As discussed in the Moderated Regression section of this chapter, the magnitude of the net or marginal contribution of the interaction term was reported, since it was to be used as a basis for comparison of the techniques.

Additionally, the covariance design was modified by allowing the interaction term to enter first. The simulated data were analyzed with the modified design, and the results were reported for the reader's additional information. (For an explanation of the computer programs used in this research effort see Appendix C.)

Comparison of Techniques

Three of the techniques--moderated regression analysis, analysis of variance, and analysis of covariance--were compared based on the proportion of total variation explained by the moderator variable GNS and the alpha level at which GNS was found to be significant. A comparison of these three with subgroup analysis and the Ghiselli technique reduces to the question of whether or not either of these latter two evidences a moderator effect against a pre-established criterion. If the Ghiselli technique yielded a significant correlation coefficient, r, at a .05 alpha level, it was considered a viable technique for use in the identification of a moderator variable. Additionally, if subgroup analysis yielded a Δr which was significant at the .05 level, it also was considered a viable technique for use in the identification of a moderator variable. A .05 level of significance was selected based on extensive literature which indicates that this value is widely accepted and applied in behavioral research (5; 6; 11:382; 14:270; 25:681; 28:40).

Summary

The purpose of this research was to investigate the power of each of the five techniques--moderated regression analysis, subgroup analysis, analysis of variance, analysis of covariance, and Ghiselli's technique--to identify the action of a moderator variable. To accomplish this goal, simulated data exhibiting varying degrees of moderator strength were generated using the Monte-Carlo Simulation technique. The generated data was analyzed using each statistical analysis technique. Finally, comparisons of the techniques were accomplished to assess their relative abilities to evidence moderator variable effects.

CHAPTER IV

RESULTS AND ANALYSIS

This chapter explores the outcomes of the data simulation and analysis. First, the simulated data are discussed in terms of the degree of moderator effect present. Second, the ability (or inability) of each of the techniques--moderated regression analysis, ANOVA, ANCOVA, subgroup analysis and the Ghiselli technique--to detect the presence of the moderator effect (or the absence of such an effect) is examined. The chapter concludes with a brief summary of the overall results.

Results-Data Simulation

Each set of simulated observations was subjected to regression analysis. The purpose of the regression analysis was to determine if the data simulated did, in fact, possess a moderator effect (or the absence of such an effect) similar to the hypothetical effect represented in Figure 2, Chapter I. Figures 5 through 9 present selected results of the regression analysis. The data that were generated to exhibit a moderator effect did, in fact, exhibit the desired effect (See Figures 5 through 8). However, one problem was encountered: the data generated using a proportioned GNS distribution possessed too few observations at

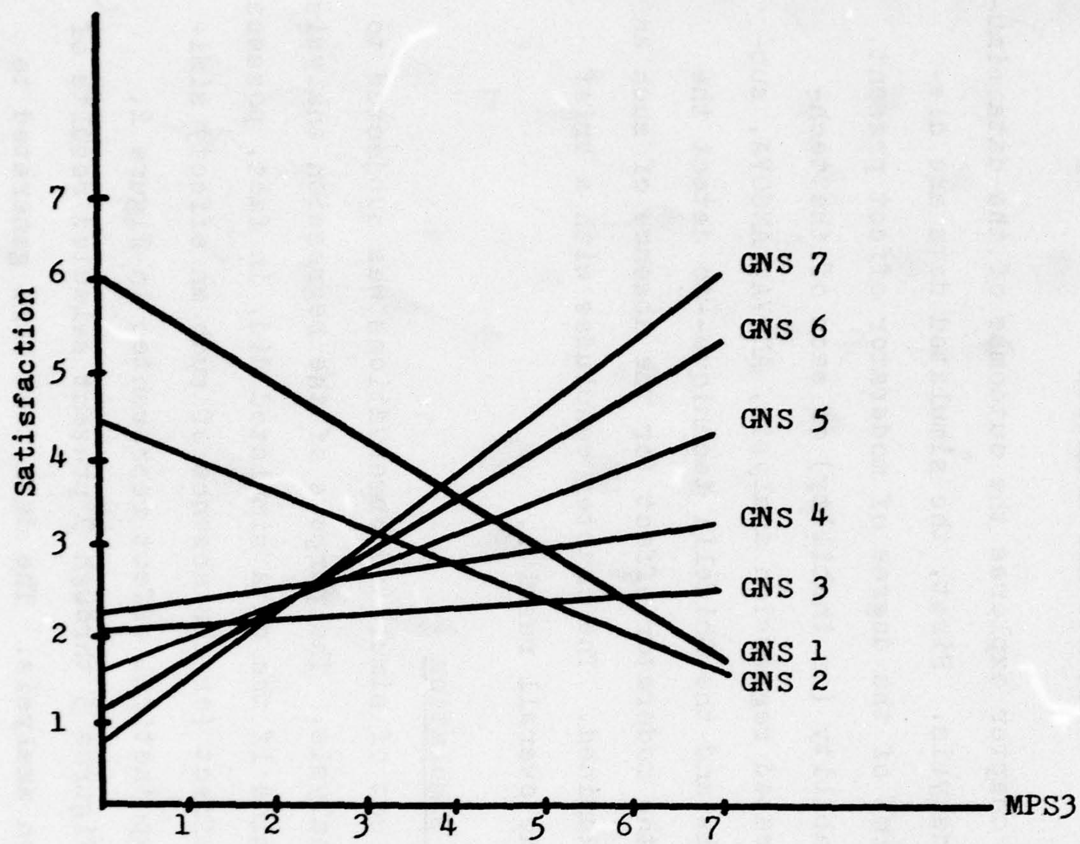

Figure 5. Moderator Effect Present and GNS Level Generations from a Cumulative Probability Distribution Based on Maintenance Personnel Data Analysis (n=1000)

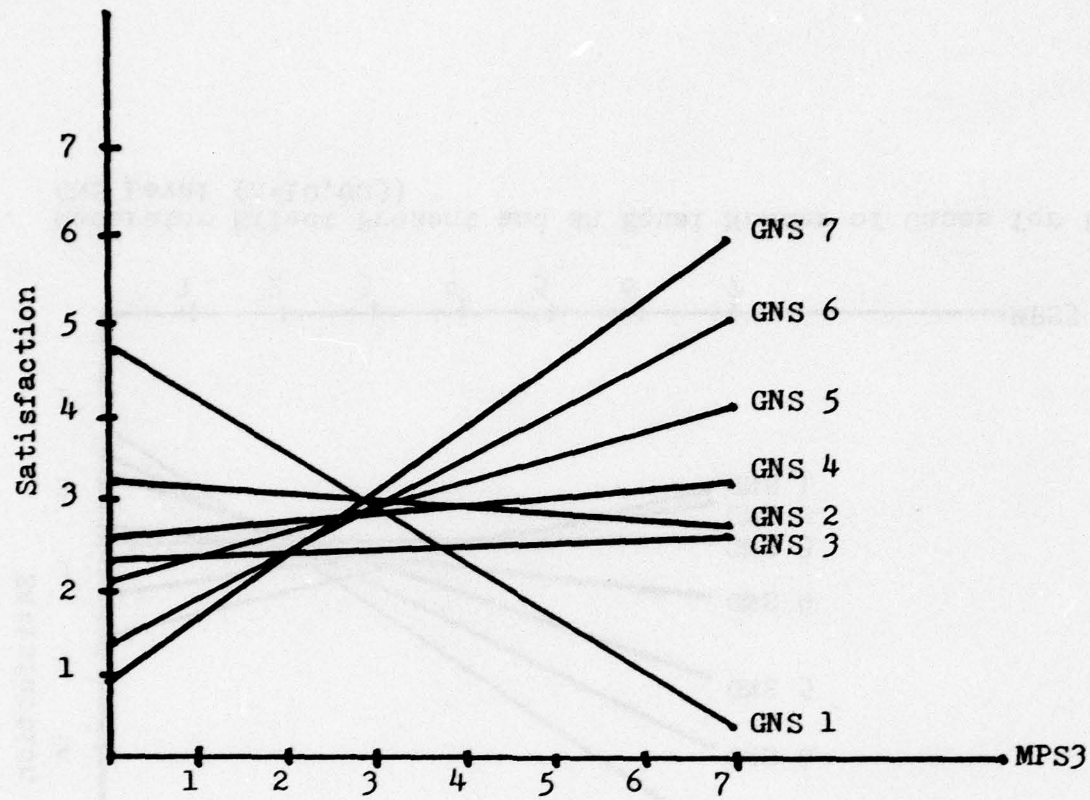

Figure 6. Moderator Effect Present and GNS Level Generations from a Cumulative Probability Distribution based on Maintenance Personnel Data Analysis (n=10,000)

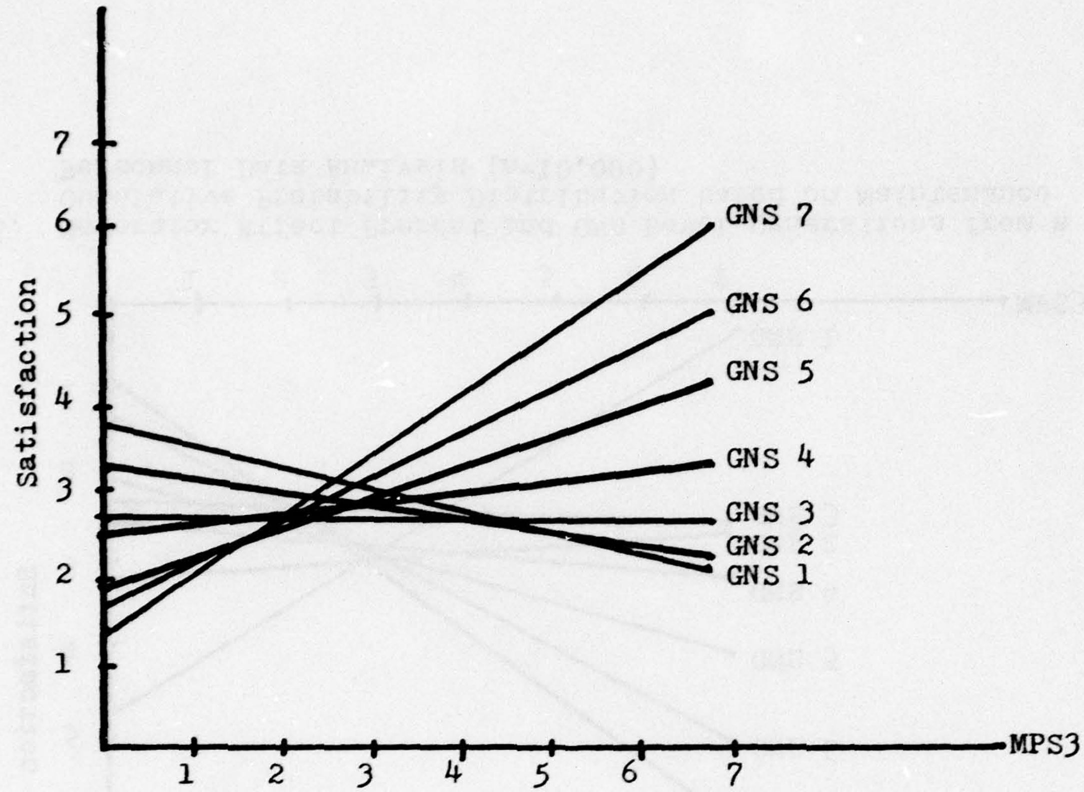

Figure 7. Moderator Effect Present and an Equal Number of Cases for Each GNS Level (n=10,003)

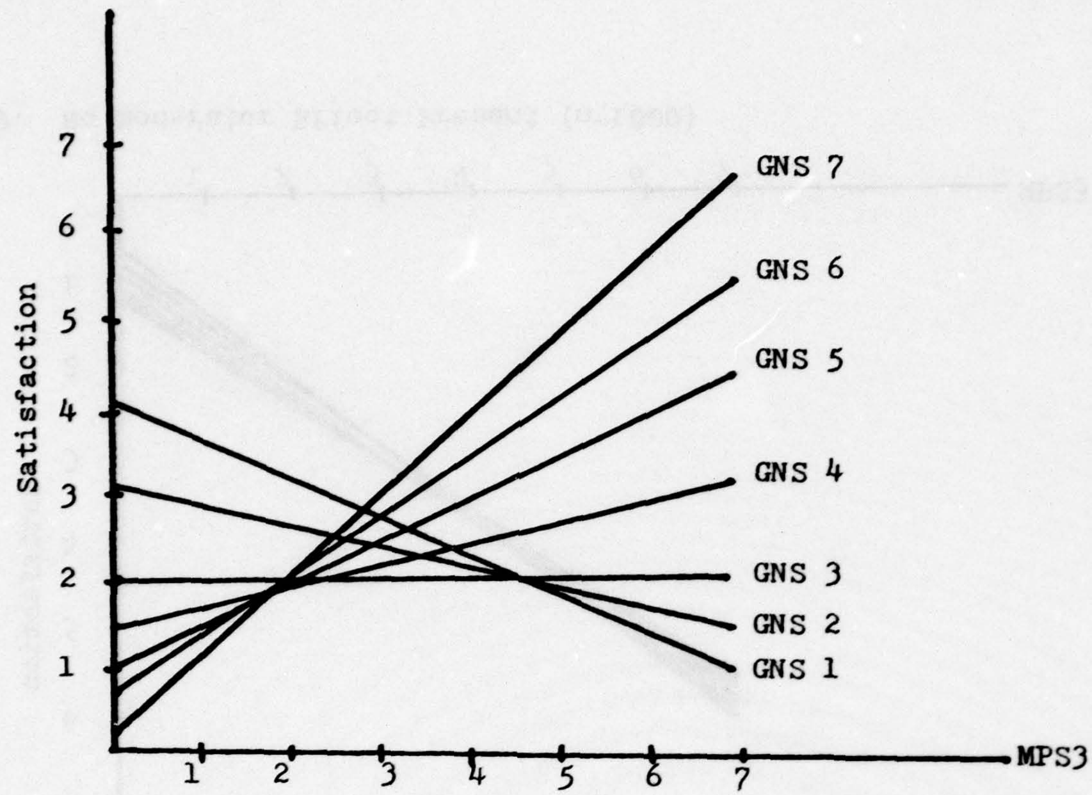

Figure 8. Moderator Effect Present, an Equal Number of Cases for Each GNS Level, Overall MPS3 Distribution Used, and No Variability About the Regression Lines (*n*=10,003)

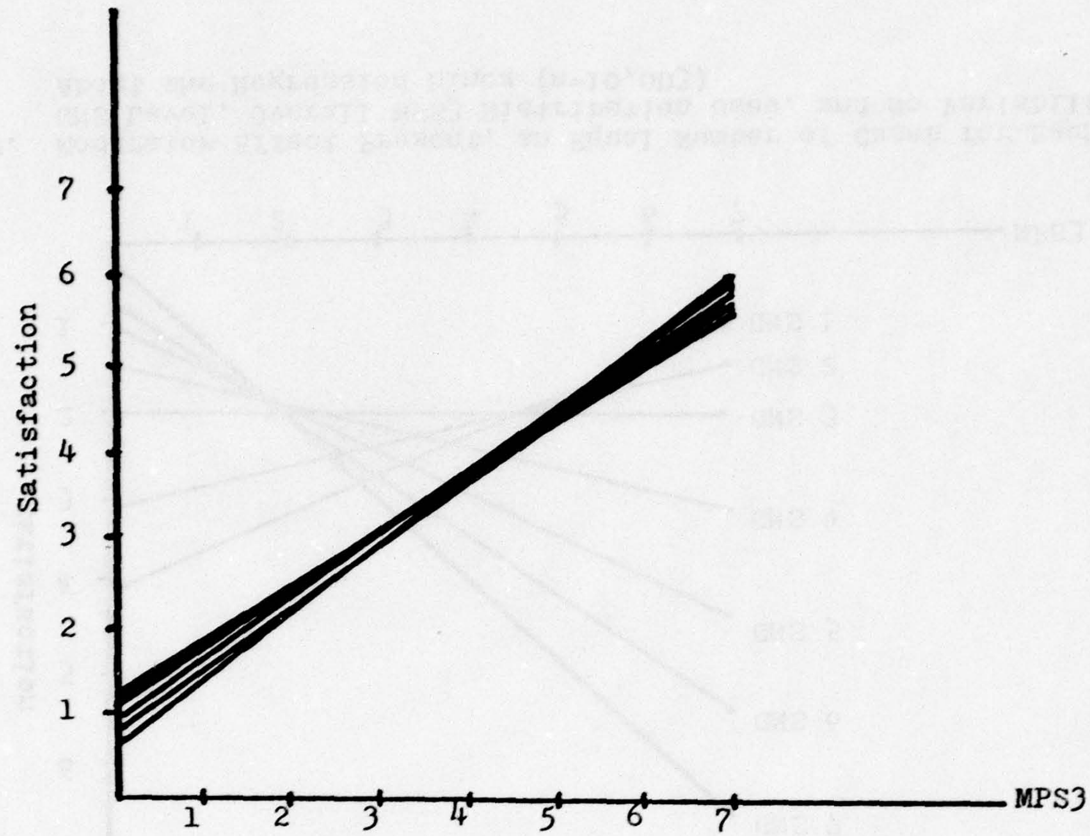

Figure 9. No Moderator Effect Present (n=1000)

the lower GNS levels (1 through 3) to clearly model the moderator effect at these lower levels. This was true even for the data sets with 10,000 observations (see Figures 5 and 6). However, since there were relatively few observations at these lower GNS levels, it was assumed that the consequential inability to clearly discern the moderator effect at these lower levels would have little, if any, influence on the subsequent comparisons of the statistical techniques.

Additionally, Figure 9 illustrates that the data analyzed in that case do not exhibit a moderator effect. Data generation was successful in producing data sets which both exhibited a moderator effect and which failed to exhibit a moderator effect.

Results-Moderated Regression Analysis

In each case where a moderator effect was present, the moderated regression technique was able to detect the effect at a .001 significance level. Tables 2 through 4 report these results. It should be noted, however, that in the majority of these cases the magnitude of the change in explained variance was relatively small. The only exception was experienced when the data were generated in such a way that the moderator effect was exaggerated--no variability about the regression line was allowed. Table 4 reports

TABLE 2

SUMMARY TABLE - MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA

	ANOVA		Moderated Regression		ANCOVA		Ghiselli Technique		Subgroup Analysis	
	$\frac{\Delta EV}{TV}$	Alpha*	$\frac{\Delta EV}{TV}$	Alpha	$\frac{\Delta EV}{TV}$	Alpha	r	Alpha	Δr	Alpha
n=1,000	0.014	0.001	0.034	0.001	0.014	0.001	-0.162	0.001	0.282	0.0002
n=2,500	0.008	0.001	0.020	0.001	0.009	0.001	-0.065	0.001	0.221	0.0001
n=5,000	0.014	0.001	0.029	0.001	0.012	0.001	-0.109	0.001	0.276	0.0001
n=7,500	0.011	0.001	0.024	0.001	0.009	0.001	-0.098	0.001	0.244	0.0001
n=10,000	0.014	0.001	0.029	0.001	0.012	0.001	-0.010	0.001	0.282	0.0001

* Alpha level at which computed results were significant.

TABLE 3

SUMMARY TABLE - MODERATOR EFFECT PRESENT AND AN EQUAL NUMBER OF CASES FOR EACH GNS LEVEL

	ANOVA		Moderated Regression		ANCOVA		Ghiselli Technique		Subgroup Analysis	
	$\frac{\Delta EV}{TV}$	Alpha*	$\frac{\Delta EV}{TV}$	Alpha	$\frac{\Delta EV}{TV}$	Alpha	r	Alpha	Δr	Alpha
n=7,504	0.031	0.001	0.058	0.001	0.024	0.001	-0.106	0.001	0.512	0.0001
n=10,003	0.027	0.001	0.062	0.001	0.029	0.001	-0.090	0.001	0.482	0.0001

* Alpha level at which computed results were significant.

TABLE 4

SUMMARY TABLE - MODERATOR EFFECT PRESENT, AN EQUAL NUMBER OF CASES FOR EACH GNS LEVEL, OVERALL MPS3 DISTRIBUTION USED AND NO VARIABILITY ABOUT THE REGRESSION LINES

	ANOVA		Moderated Regression		ANCOVA		Ghiselli Technique		Subgroup Analysis	
	$\frac{\Delta EV}{TV}$	Alpha*	$\frac{\Delta EV}{TV}$	Alpha	$\frac{\Delta EV}{TV}$	Alpha	r	Alpha	Δr	Alpha
n=10,003	0.162	0.001	0.223	0.001	0.130	0.001	-0.070	0.001	1.713	0.0001

* Alpha level at which computed results were significant.

the results. Further, the moderated regression technique did not detect any moderator effect in the absence of such an effect. Table 5 reports the results.

According to the research of Champoux and Peters, investigators, when confronted with a small change in explained variation, have generally concluded that there is no moderator effect present (5). The results of this analysis suggest that possibly this should not be the conclusion drawn. A comparison of the results reported in Table 2 through 4 with that in Table 5 indicates that a change in explained variation as small as two percent is a good indicator that a moderator effect is present.

Additionally, when moderated regression analysis indicates that the interaction term is significant, one may wish to consider the aggregate change in explained variation due to the moderator variable acting both as a legitimate independent variable as well as through the interaction term. When viewed in this manner, the moderator variable explains a considerably greater amount of the total variation in the model. Table 6 evidences that the moderator variable (GNS) explains approximately 13 percent of the total variation when viewed in the manner just described; whereas the interaction term, when considered alone, only explains 3.4 percent of the total variation in the model.

TABLE 5

SUMMARY TABLE - NO MODERATOR EFFECT PRESENT

	ANOVA		Moderated Regression		ANCOVA		Ghiselli Technique		Subgroup Analysis	
	$\frac{\Delta EV}{TV}$	Alpha*	$\frac{\Delta EV}{TV}$	Alpha	$\frac{\Delta EV}{TV}$	Alpha	r	Alpha	Δr	Alpha
n=7,500	0.0008	0.14	0.0004	0.1	0.0001	>0.1	-0.025	0.027	0.038	0.095
n=10,000	0.0006	0.13	0.0000		0.0001	>0.1	-0.014	0.175	0.016	0.407

* Alpha level at which computed results were significant.

TABLE 6

MODERATED REGRESSION WITH A MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=1000)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
MPS3 Entered First			
MPS3	0.14267	0.14267	0.37772
GNS	0.24204	0.09936	0.36817
Interaction	0.27639	0.03435	0.51444
Interaction Entered First			
Interaction	0.26465	0.26465	0.51444
GNS	0.26516	0.00051	0.36817
MPS3	0.27639	0.01123	0.37772

Results-Analysis of Covariance

As with the moderated regression technique, the ANCOVA technique did detect a moderator effect in each case in which an effect was present. Also, the ANCOVA technique failed to detect a moderator effect in the absence of such an effect. These results are reported in Tables 2 through 5. In each case, however, the ANCOVA technique yielded a smaller change in explained variation than was evidenced by the moderated regression technique. This result is reasonable, since some information is usually lost when ratio level data are grouped into nominal classes. Since these

ANCOVA technique analyses were performed using the regression approach, the comments to the moderated regression results section concerning the magnitudes of components of explained variation are applicable.

Results-Analysis of Variance

As the results reported in Tables 2 through 5 indicate, the ANOVA technique also detected a moderator effect in every case in which an effect was present and failed to detect an effect in the absence of one. As with the ANCOVA technique, the ANOVA technique yielded a smaller change in explained variation than did the moderated regression technique. Again, this result is reasonable, since information is lost when ratio level data are grouped into nominal classes.

Results-Ghiselli Technique

The Ghiselli technique appears to lack the power to distinguish between a situation where no moderator effect is present and one where a moderator effect is present. A comparison of the results reported in Tables 2 through 4 with those in Table 5 indicates that in all cases the Ghiselli technique yielded a correlation coefficient of essentially the same magnitude which was relatively close to zero. This inability to detect a moderator effect (or the absence of such an effect) could be a function of the measurement scale used in this research effort. (In this research, the variables satisfaction and MPS3 were both measured on a seven-point Likert scale.)

In Ghiselli's orginal article, he used variables that were measured on two markedly different scales. For example, some variables were measured on a scale of 0 to 1.2, while other variables were measured on a scale of 0 to 100 (10:376). Ghiselli was able to detect the presence of some moderator effects through his technique, because the disparate variable scaling prevented the same values of the absolute standardized difference from arising from more than one level of the moderator variable.

Figure 10 illustrates possible overlap of the values of the absolute standardized difference score for the different levels of the moderator variable (GNS) when the same measurement scales are used. When the same values of the absolute standardized difference score can be related to different levels of the moderator variable, one would expect results such as those presented in Tables 2 through 5, which indicate the inability of the Ghiselli technique to detect a moderator effect, since the correlation between the absolute standardized difference scores and the moderator levels is approximately equal to zero. Conversely, Figure 11 illustrates that when different scales are used for variable measurement, this overlap of values can be

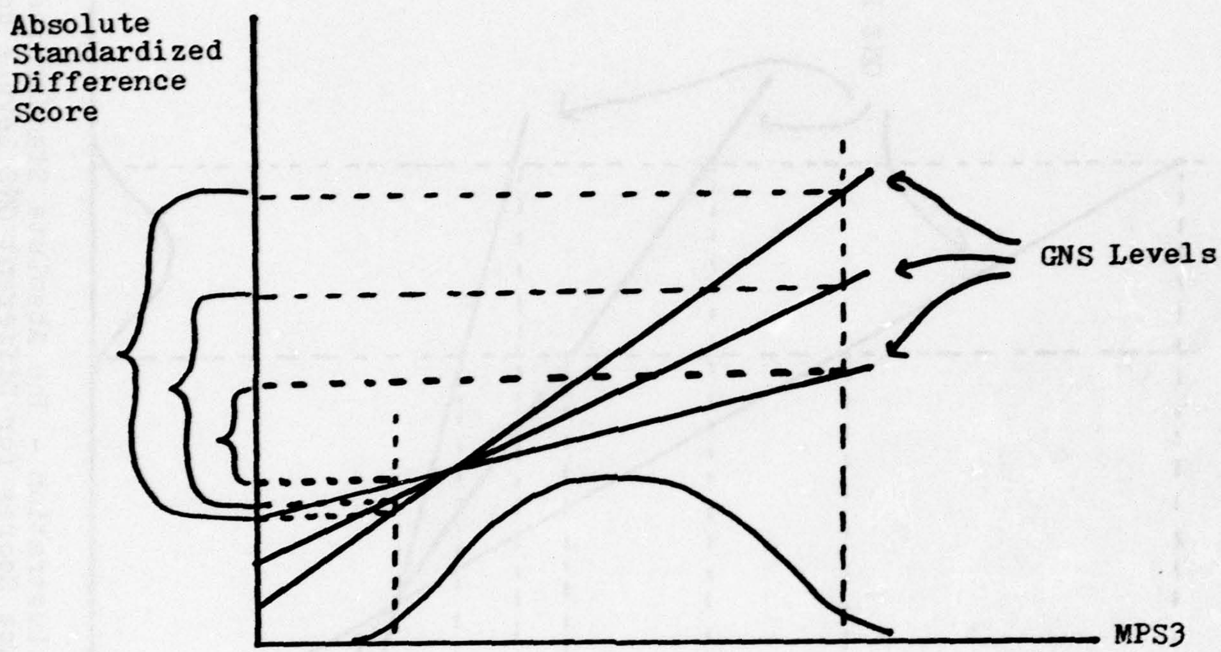

Figure 10. Illustration - The Absolute Standardized Difference Scores for Different GNS Levels overlap

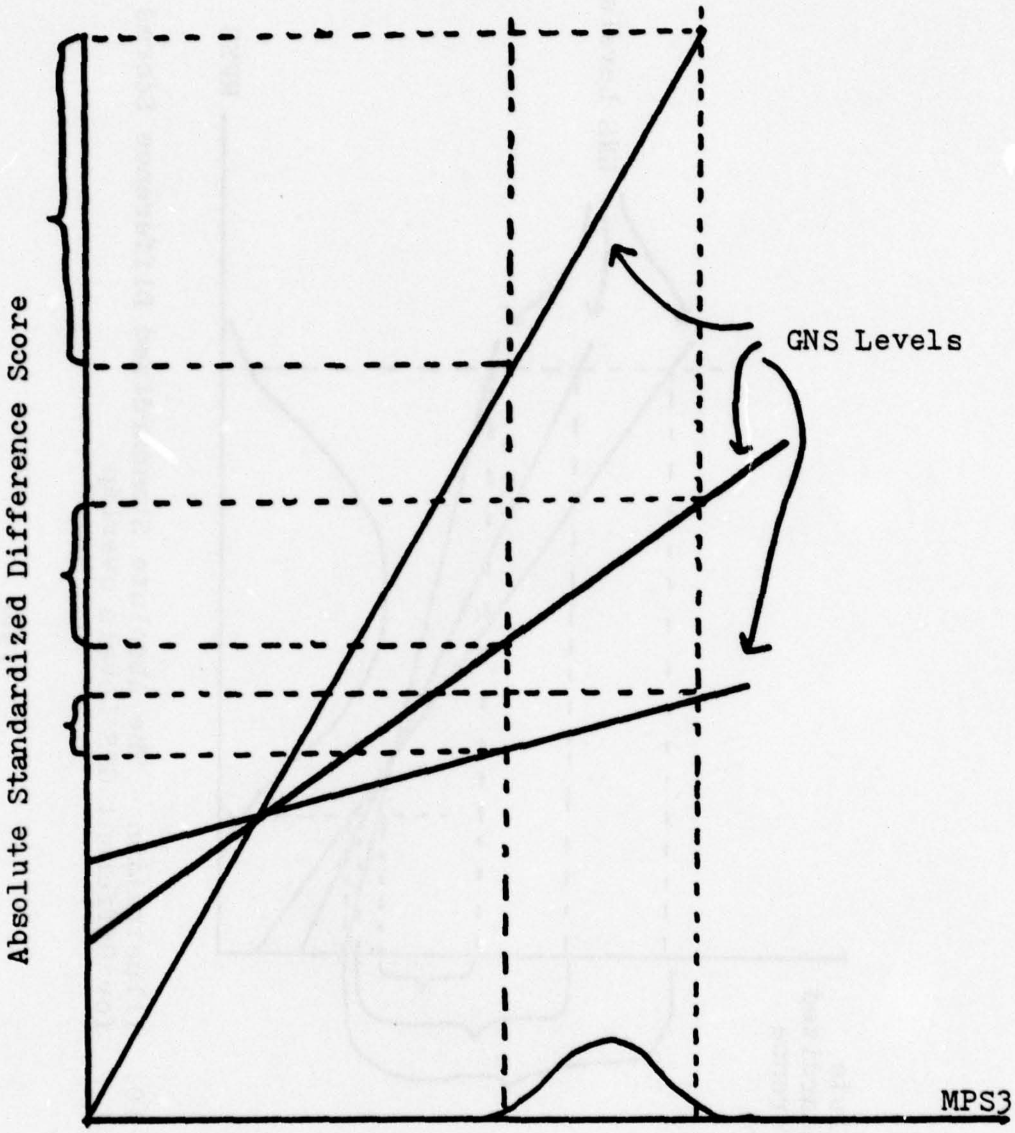

Figure 11. Illustration - The Absolute Standardized Difference Scores for Different GNS Levels do not Overlap

avoided. Under the conditions depicted, the Ghiselli technique should yield a higher correlation coefficient when a moderator effect is, indeed, present.

Results-Subgroup Analysis

As with ANOVA, ANCOVA, and moderated regression analysis, the subgroup analysis technique detected a moderator effect in every case in which such an effect was present and failed to detect an effect in the absence of one. These results are presented in Tables 2 through 5.

Even though a direct comparison of subgroup analysis with the other techniques can not be made, it can be inferred that the use of subgroup analysis is less appropriate than moderated regression analysis when ratio level data are involved. Again, this may be reasoned because some information is lost when ratio level data are grouped into nominal level classes.

Summary

The Monte-Carlo simulation technique was successfully used to generate test data sets which both exhibited a moderator effect and which were devoid of such an effect. The generated data were then subjected to analysis with each of the five statistical techniques. Four of the statistical techniques investigated--ANOVA, ANCOVA, moderated regression analysis, and subgroup analysis--possess the power to detect the presence of a moderator effect (or the absence of such an effect). The remaining technique, the Ghiselli technique, does not, and it was suggested that this could be a function of the measurement scales used in the research. Also, the results of the analysis indicate that moderated regression analysis explains more of the total variation than ANOVA and ANCOVA in those cases which were considered.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The objective of this research was to investigate the power of five techniques to identify the effect of moderator variables in the job enrichment process. The results reported in Chapter IV point to three general conclusions and suggest several recommendations for the conduct of future research.

Conclusions

As reported in Chapter IV, the magnitude of the change in explained variation evidenced by the moderator variable interaction term was largest when moderated regression analysis was used as opposed to ANOVA or ANCOVA. Since the data were ratio level, this was to be expected and was, in fact, the occurrence in every case investigated. It can be concluded, therefore, that when conducting research that involves ratio level data, moderated regression analysis should be the technique used to identify the possible presence of a moderator effect. ANOVA, ANCOVA, and subgroup analysis are more appropriate for use when nominal level data are encountered, and ratio level data should not be reduced to nominal level data solely for the purpose of applying one of the techniques. This conclusion is supported by

Champoux and Peters; in their research, they "concluded that the use of moderated regression analysis is always superior to subgroup analysis when the moderator variable is continuous [5]." Since the magnitude of the change in explained variance was relatively small--as little as two percent in the majority of the cases, it can also be concluded that even a small, significant change in explained variation may be a good indicator that a moderator effect is present.

Finally, it is concluded that the Ghiselli technique lacks the ability to detect the presence of a moderator effect when the primary variables employed in the research are measured on a common scale. This phenomenon is a consequence of possible overlaps of the absolute standardized differences of the values of the primary variables associated with the levels of the moderator variable.

Recommendations

On the basis of this research, four recommendations are advanced.

As suggested in Chapter IV, when the moderated regression technique indicates that the interaction term is significant, the researcher may consider the aggregate change in explained variation due to the moderator variable, acting both as a legitimate independent variable and through the interaction term, as an alternate absolute measure of the explanatory power of the moderator variable to its net or marginal contribution from the interaction alone. When viewed in this manner, the moderator variable of course explains a greater amount of the total variation in the model. As such, a criterion test may be based on this aggregated change in explained variation as opposed to the change in explained variation based on only the interaction. If the latter is the case, and the moderator variable is eliminated from the model because the change in explained variation is small, then the explanatory power of the overall model would be reduced, sometimes by as much as one-half.

The complete answer to the question: "How much of an increase in explained variation or change in correlation coefficients is required for a researcher to conclude that a moderator effect is present?" is not known, although the results of this research indicate that the expected change in explained variation can be small. Until this question is resolved, it is recommended that a preliminary analysis similar to that conducted in this research be considered for accomplishment before any subjective criteria are applied upon which to base the conclusion that a moderator effect is present or absent. That is: (1) the moderator variable should be clearly defined, (2) the distribution of each variable, along with its corresponding parameters, should be identified, (3) the distributions identified for each variable and the defined moderator should be used to simulate data with varying degrees of the moderator, and (4) these simulated data should be subjected to analysis with those statistical techniques deemed appropriate and preferred by the researcher. This analysis will suggest the different magnitudes of change in explained variation or change in the correlation coefficients for each level of moderator effect which can be expected if a moderator effect is present. The actual field data should then be subjected to analysis with the same statistical techniques and the resulting changes in explained variation or changes in the correlation coefficients compared to those obtained from the simulated data. This comparison will provide a basis for determining the degree of moderator effect actually present in the field data.

The results presented in Tables 2 through 5, Chapter IV, suggest that the magnitudes of changes in explained variation and correlation coefficients are sensitive to (1) the distribution of levels of GNS, (2) the distributions of MPS3 scores for the various GNS levels, and (3) the parameters of the satisfaction-MPS3 regression lines, i.e. the degree of separation between the regression lines, and the conditional probability distribution of satisfaction values given MPS3 scores centered on these regression lines. Additional research, specifically sensitivity analyses, should be conducted to determine the effects of changes in these attributes to the abilities of the statistical techniques to assess moderator effects. Such an effort may enable broader, more definitive conclusions concerning the power of each technique to identify the effect of a moderator variable.

Finally, it is recommended that similar research be conducted employing MPS instead of the cube root of MPS (MPS3). Since scale overlap would not be a problem encountered in this case (MPS3 is measured on a scale of 1 to 343, while a satisfaction variable could continue to be measured on a scale of 1 to 7), the Ghiselli technique should be expected to be more effective in evidencing the presence of a moderator effect. This expectation could be readily tested through research patterned after this effort.

This chapter has presented four recommendations. It is suggested that: first, the aggregate change in explained variation due to the moderator variable, acting both as a legitimate independent variable and through the interaction term, should be considered as an alternate absolute measure of the explanatory power of the moderator variable. Second, the preliminary generation of simulated data and subsequent analysis with the moderator detection techniques should be performed in conjunction with research in which the involvement of moderator variables is suspected. Third, sensitivity analyses should be conducted to determine the effects of changes in data attributes to the abilities of the statistical techniques to assess moderator effects. And, fourth, the Ghiselli technique should be investigated in a research effort employing MPS instead of MPS3. While not allinclusive, these recommendations should enhance researchers' abilities to detect and control for moderator effects in the job enrichment process and provide potentially fruitful areas for further research.

APPENDIX A

ANALYSIS OF EXISTING DATA

In order to gain additional information concerning the variables employed in this research effort, data collected by Umstot and Rosenbach (professors at the Air Force Institute of Technology's School of Systems and Logistics and the Air Force Academy, respectively) were analyzed using regression analysis and the curve-fitting program, SIMFIT, developed by Don T. Phillips. The SIMFIT program

> . . . allows the user to test quickly a set of n observations against 10 common theoretical probability density functions using chi-square (χ^2) Kolmogorov-Smirnov (K-S), Cramer-Von Mises, or Moments (normality) goodness of fit tests [25:80].

Two different sets of data were analyzed. One set of data was collected from Air Force Security Police personnel stationed at Ellsworth AFB; the other set was collected from maintenance personnel stationed at three bases--Seymour-Johnson AFB, Homestead AFB, and Hill AFB. Each individual involved was administered an attitudinal survey, a modified form of the Job Diagnostic Survey, developed by Umstot and Rosenbach. Four time-phased attitudinal surveys were administered to the Security Police personnel stationed at Ellsworth; therefore, that data set was subdivided into four subsets of data. However, data from the second administration was omitted from subsequent analysis, since the intention was to measure the Hawthorne effect.

The results of regressions of satisfaction scores on MPS3 for GNS levels 1 through 7 are presented in Figures 12 through 15. It is evident that GNS is not an active moderator of the satisfaction-MPS3 relationship, if present, in each case depicted. For this reason, further analysis was limited to the maintenance personnel data. Additionally, this data base had a larger sample size (n=1256).

The results of goodness of fit analyses, presented in Table 7, supported the assumption that the MPS3 scores for each level of GNS follow normal distributions. However, no *a priori* assumption concerning the distribution of occurrences within the GNS levels could be made. Therefore, it was decided that the actual GNS scores of the field data would be used as the base for the simulated data generation. The cumulative probability distribution of GNS levels is presented in Table 8.

Similarly, there was no theoretical motivation by which to set the standard deviation of the conditional distribution of satisfaction scores given MPS3. So, from the maintenance personnel data, the average standard error of the estimates from the satisfaction-MPS3 regressions, 1.4, was chosen for use in the simulated data generation.

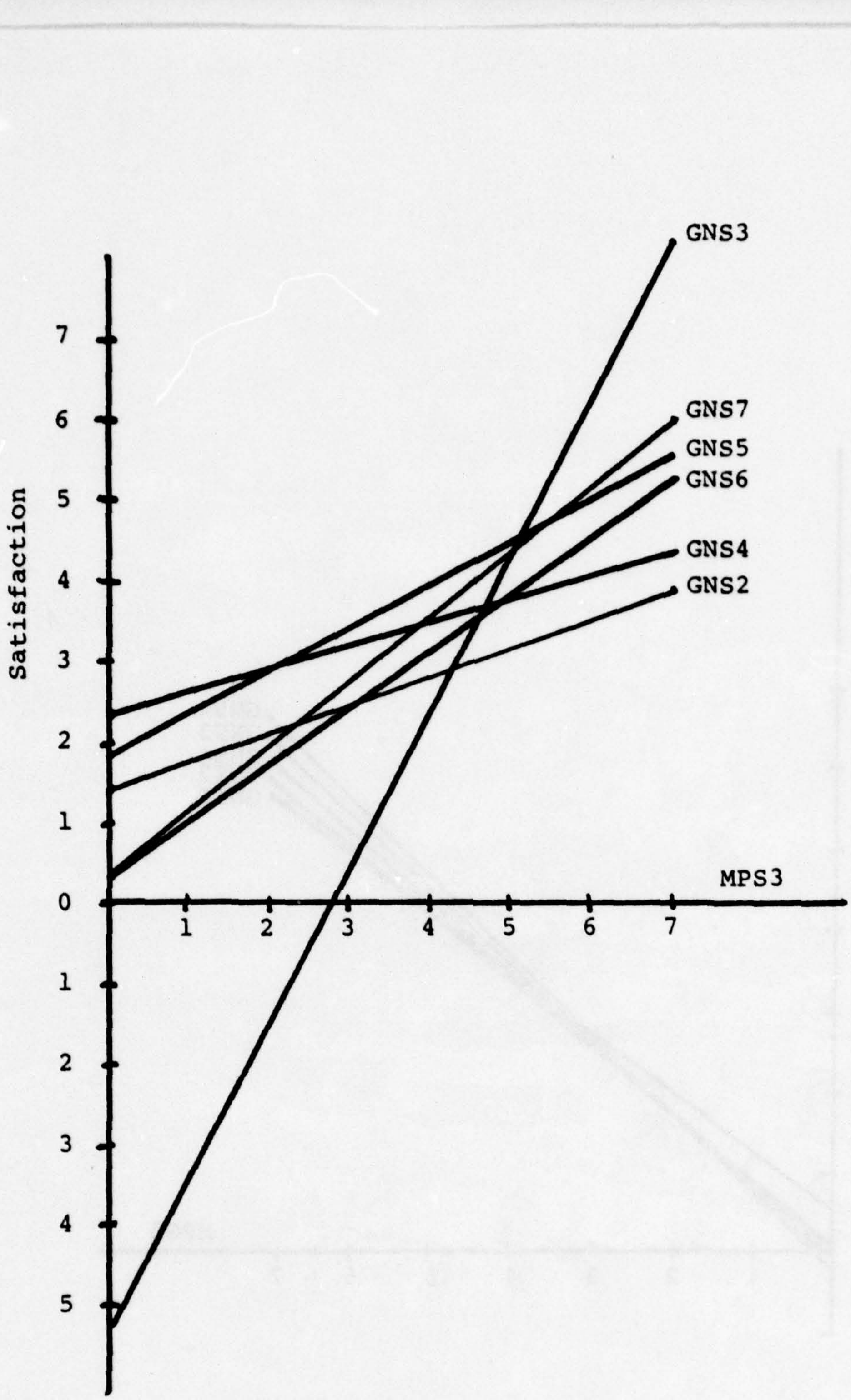

Figure 12. Security Police Survey 1 (n=193)

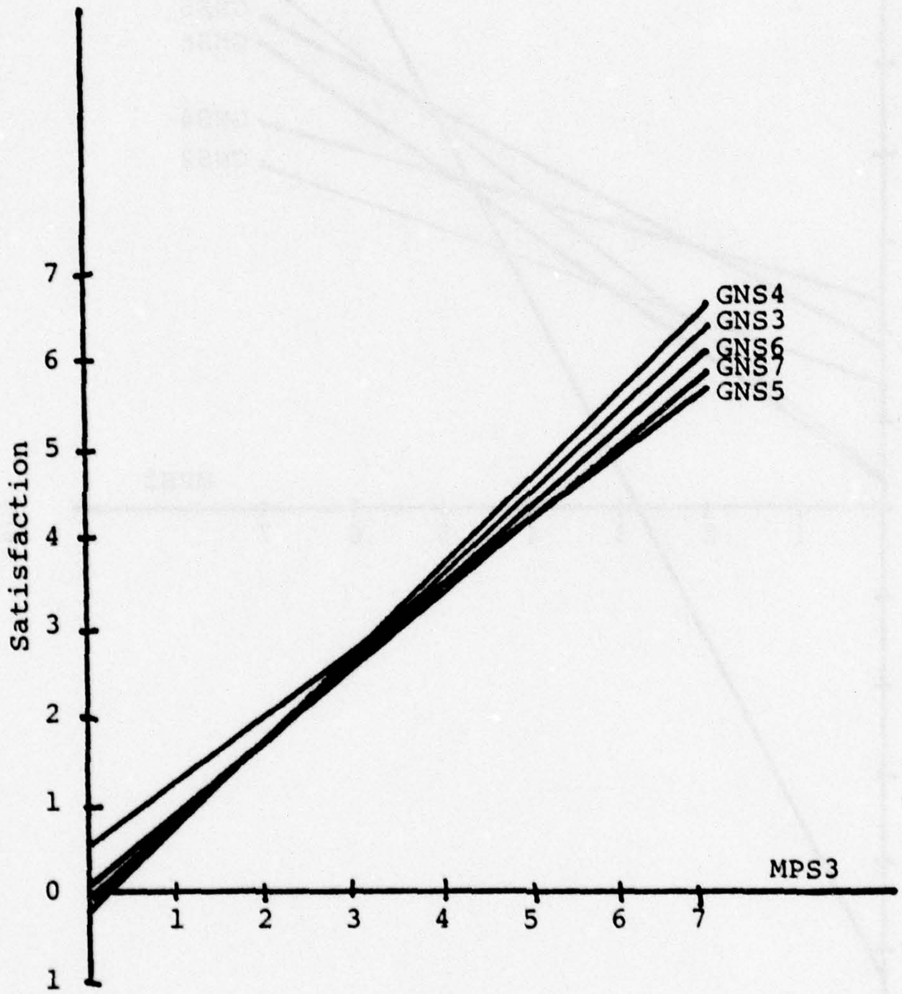

Figure 13. Security Police Survey 3 (n=250)

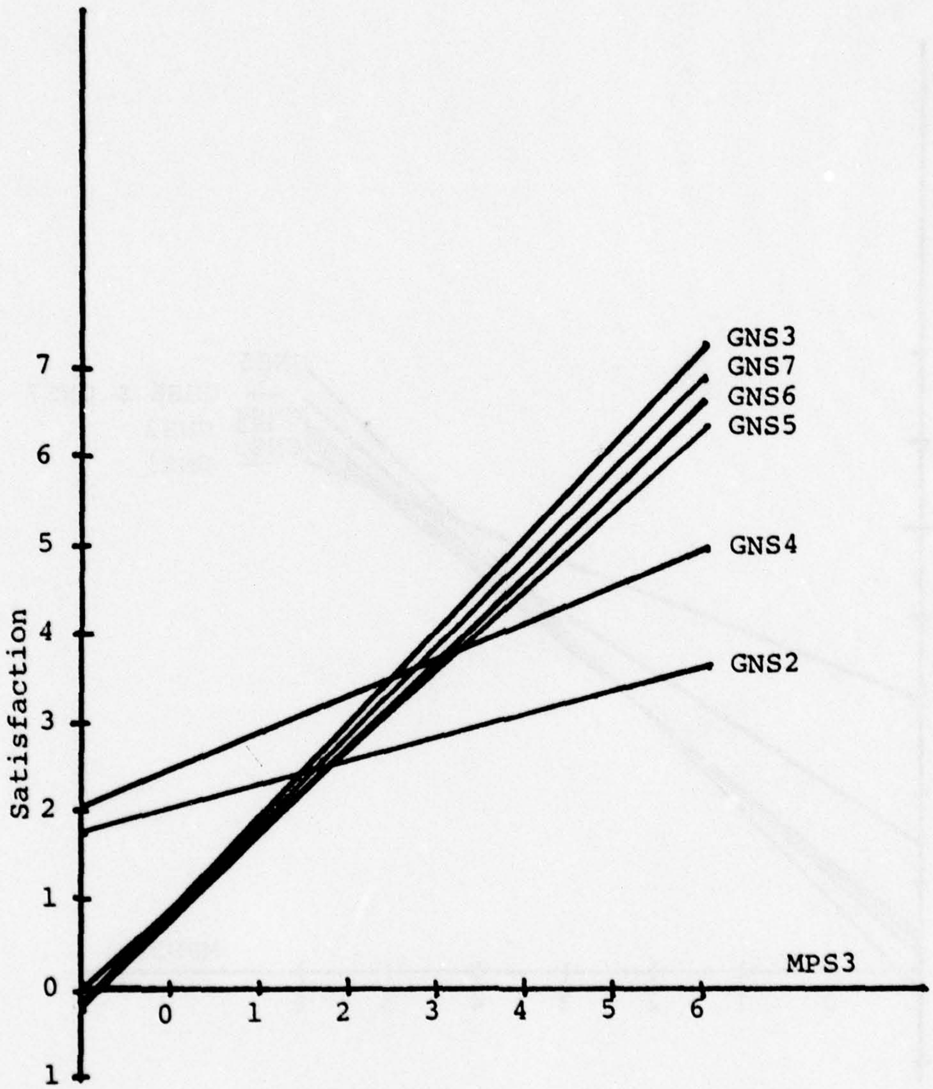

Figure 14. Security Police Survey 4 (n=237)

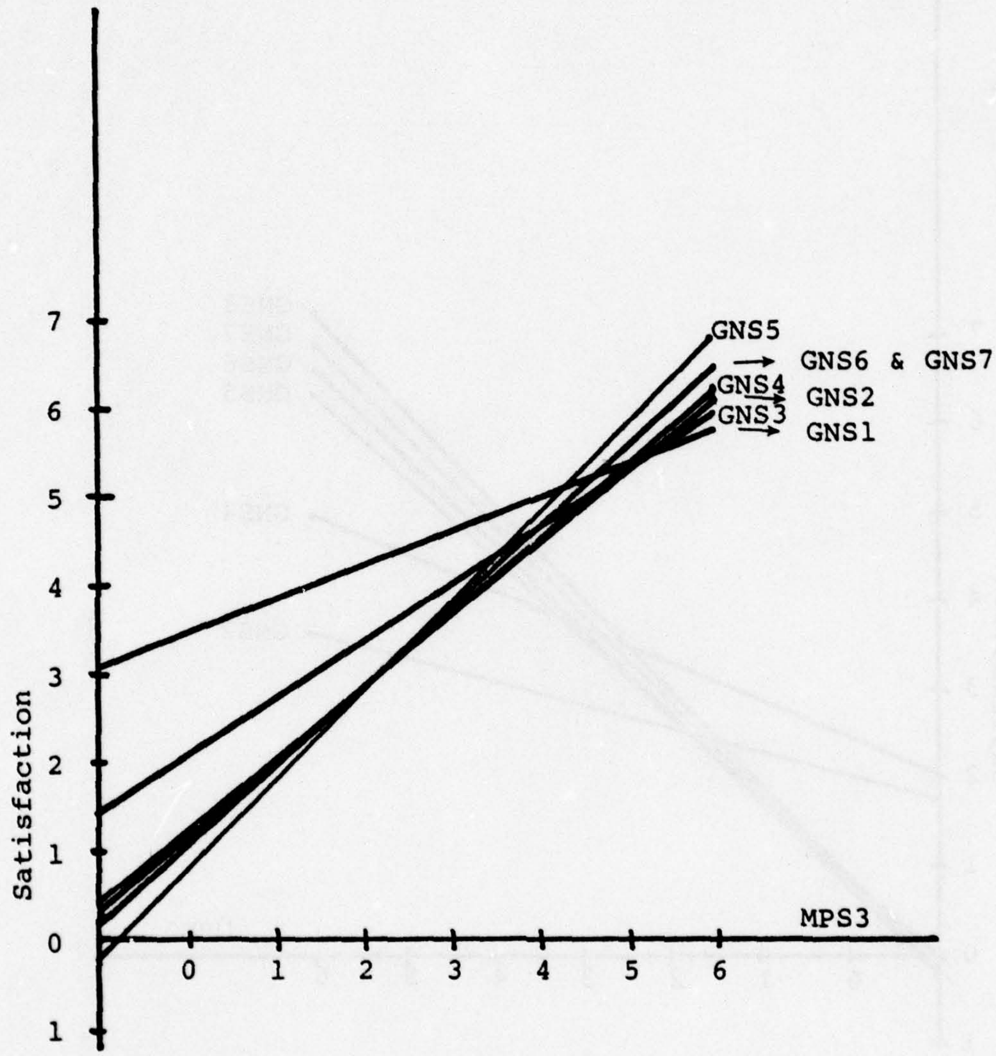

Figure 15. Maintenance Personnel Data (n=1256)

TABLE 7

SIMFIT ANALYSIS

		Tests for a Normal Distribution		Sample Statistics	
		χ^2	K-S	Mean	Std. Dev.
All GNS	Computed Value	270.33	0	5.4	1.3
	Critical Value	42.56	0.025		
		Failed	Passed		
All MPS3	Computed Value	52.40	0.032	4.5[a]	1.0[b]
	Critical Value	54.29	0.025		
		Passed	Failed		
MPS3 for GNS1	Computed Value	DOES NOT PASS		3.6[a]	1.0
	Critical Value				
MPS3 for GNS2	Computed Value	CRITERIA FOR TESTS		4.2	1.0
	Critical Value				
MPS3 for GNS3	Computed Value	1.81	0.046	4.0	1.0
	Critical Value	7.82	0.109		
		Passed	Passed		
MPS3 for GNS4	Computed Value	3.46	0.025	4.4	1.0
	Critical Value	11.07	0.06		
		Passed	Passed		
MPS3 for GNS5	Computed Value	7.51	0.027	4.5	1.0
	Critical Value	11.07	0.056		
		Passed	Passed		
MPS3 for GNS6	Computed Value	48.21	0.048	4.6	1.0
	Critical Value	43.77	0.046		
		Failed	Failed		
MPS3 for GNS7	Computed Value	32.40	0.083	4.7	1.0
	Critical Value	43.77	0.048		
		Passed	Failed		

[a]The average value (4.0) for these three levels was used for data simulation.

[b]The standard deviation rounded to 1.0 in each case.

TABLE 8

CUMULATIVE PROBABILITY DISTRIBUTION FOR GNS

GNS Level	Probability of Occurrence	Cumulative Probability
1	0.005	0.005
2	0.005	0.01
3	0.04	0.05
4	0.15	0.20
5	0.20	0.40
6	0.30	0.70
7	0.30	1.00

APPENDIX B

FISHER'S z-TRANSFORMATION

Test for Difference Between Independent Correlations

If you have two correlations computed from data that were gathered from two different groups of individuals, the correlation coefficients will be experimentally independent. In such a case, you may use the following procedure to test for significance of the difference between the correlations.

EXAMPLE

Suppose we have a correlation coefficient of +.68 that was computed between grades in an English class and IQ scores for thirty-eight people. Suppose further, that we have a correlation coefficient of +.36 between grades in a similar English class and IQ scores for a different group of seventy-three people. We wish to know whether these coefficients are different.

Step 1. First, change the two correlations into Fisher z scores. This can be done by means of any table of such transformation (see Table 9):

Correlation of .68 = z of .829
Correlation of .36 = z of .377

Step 2. Subtract either z score of Step 1 form the other.

$$.829 - .377 = .452$$

Step 3. Subtract 3 from the number of people in the group for which the first correlation was computed (38 in this example). (Note: The number 3 is always used.)

$$38 - 3 = 35$$

Step 4. Divide the result of Step 3 into the number 1 (ie., take the reciprocal of 35). Carry the answer to four decimal places.

$$\frac{1}{35} = .0286$$

Step 5. Subtract 3 from the number of people in the group for which the second correlation was computed (73 in this example).

$$73 - 3 = 70$$

Step 6. Divide the result of Step 5 into the number 1 (i.e., take the reciprocal of 70). Carry the answer to four decimal places.

$$\frac{1}{70} = .0143$$

Step 7. Add the result of Step 4 to the result of Step 6.

$$.0286 + .0143 = .0429$$

Then take the square root of the sum.

$$\sqrt{.0429} = .207$$

Step 8. Divide the result of Step 2 by the result of Step 7. This yields a z statistic.

$$z = \frac{.452}{.207} = 2.18$$

A z larger than 1.96 is significant at the .05 level using a two-tailed test (see any Standard Normal Distribution Table). A significant z tells us that the two correlation values are very likely really different [4:214-215].

Fisher's z-Transformation Function for Pearson's r Correlation Coefficient:

$$z = \tfrac{1}{2}[\log_e(1 + r) - \log_e(1 - r)]$$

To read Table 9, simply find the correlation coefficient value in the r column and then read the corresponding Z value from the adjacent column. For example, if the r value were .46, the Z would be .497 [4:250].

TABLE 9

FISHER'S z TRANSFORMATION [4:251]

r	Z	r	Z	r	Z	r	Z	r	Z
.000	.000	.200	.203	.400	.424	.600	.693	.800	1.099
.005	.005	.205	.208	.405	.430	.605	.701	.805	1.113
.010	.010	.210	.213	.410	.436	.610	.709	.810	1.127
.015	.015	.215	.218	.415	.442	.615	.717	.815	1.142
.020	.020	.220	.224	.420	.448	.620	.725	.820	1.157
.025	.025	.225	.229	.425	.454	.625	.733	.825	1.172
.030	.030	.230	.234	.430	.460	.630	.741	.830	1.188
.035	.035	.235	.239	.435	.466	.635	.750	.835	1.204
.040	.040	.240	.245	.440	.472	.640	.758	.840	1.221
.045	.045	.245	.250	.445	.478	.645	.767	.845	1.238
.050	.050	.250	.255	.450	.485	.650	.775	.850	1.256
.055	.055	.255	.261	.455	.491	.655	.784	.855	1.274
.060	.060	.260	.266	.460	.497	.660	.793	.860	1.293
.065	.065	.265	.271	.465	.504	.665	.802	.865	1.313
.070	.070	.270	.277	.470	.510	.670	.811	.870	1.333
.075	.075	.275	.282	.475	.517	.675	.820	.875	1.354
.080	.080	.280	.288	.480	.523	.680	.829	.880	1.376
.085	.085	.285	.293	.485	.530	.685	.838	.885	1.398
.090	.090	.290	.299	.490	.536	.690	.848	.890	1.422
.095	.095	.295	.304	.495	.543	.695	.858	.895	1.447
.100	.100	.300	.310	.500	.549	.700	.867	.900	1.472
.105	.105	.305	.315	.505	.556	.705	.877	.905	1.499
.110	.110	.310	.321	.510	.563	.710	.887	.910	1.528
.115	.116	.315	.326	.515	.570	.715	.897	.915	1.557
.120	.121	.320	.332	.520	.576	.720	.908	.920	1.589
.125	.126	.325	.337	.525	.583	.725	.918	.925	1.623
.130	.131	.330	.343	.530	.590	.730	.929	.930	1.658
.135	.136	.335	.348	.535	.597	.735	.940	.935	1.697
.140	.141	.340	.354	.540	.604	.740	.950	.940	1.738
.145	.146	.345	.360	.545	.611	.745	.962	.945	1.783
.150	.151	.350	.365	.550	.618	.750	.973	.950	1.832
.155	.156	.355	.371	.555	.626	.755	.984	.955	1.886
.160	.161	.360	.377	.560	.633	.760	.996	.960	1.946
.165	.167	.365	.383	.565	.640	.765	1.008	.965	2.014
.170	.172	.370	.388	.570	.648	.770	1.020	.970	2.092
.175	.177	.375	.394	.575	.655	.775	1.033	.975	2.185
.180	.182	.380	.400	.580	.662	.780	1.045	.980	2.298
.185	.187	.385	.406	.585	.670	.785	1.058	.985	2.443
.190	.192	.390	.412	.590	.678	.790	1.071	.990	2.647
.195	.198	.395	.418	.595	.685	.795	1.085	.995	2.994

APPENDIX C

COMPUTER PROGRAMS

Simulation Program 1 was used to generate the basic data sets possessing a moderator effect. This program employs the cumulative probability distribution of GNS levels based on the maintenance personnel data analysis. The variable list for this program is as follows:

1. ICOUNT is a counter.

2. NVALUE controls the number of iterations of the loop.

3. GNS represents growth need strength.

4. RMPS3 represents the cube root of MPS.

5. RMSAT is the satisfaction score derived from the regression line equation.

6. SAT is the satisfaction score generated using the conditional probability distribution about the satisfaction-MPS3 regression line; the value is retained for subsequent analysis.

The reader is cautioned that certain lines such as 90 to 150, 230, 250, 260, etc. need to be changed as the parameters of the desired simulated data change.

Simulation Program 2 was used to generate data possessing no moderator effect. The variable list and other aspects of the program are the same as that discussed for Simulation Program 1.

Simulation Program 3, like Simulation Program 1, was used to generate data possessing a moderator effect. Unlike Simulation Program 1, however, this program generates an equal number of cases for each GNS level. The variable J represents growth need strength. The remainder of the variable list and other aspects of the program are the same as discussed for Simulation Program 1.

Simulation Program 4 was, also, used to generate data possessing a moderator effect. However, unlike the other simulation programs (1 and 2), Simulation Program 4 employs the same MPS3 distribution for each GNS level and allows no variability about the satisfaction-MPS3 regression line. Again, J represents GNS, and the remainder of the variable list and other aspects of the program are as discussed for Simulation Program 1.

All of these simulation programs are written in such a manner that the variables--GNS, MPS3, and SAT--can only take on values ranging from 1 to 7. This was accomplished through a "truncation" feature which discards those simulated data values of these variables which fall outside these limits. As a discarded value is not counted as a successful generation, the simulation programs continue executing until the prespecified number of acceptable values is produced.

The Difference Program was used to compute the absolute standardized differences between the MPS3 and satisfaction scores. The Ghiselli Program then correlated these differences with their GNS levels with the Statistical Package for the Social Sciences (SPSS) Pearson correlation subprogram. The remaining programs are written in standard format for SPSS. The reader is again cautioned that in these programs certain lines which deal specifically with parameters and/or other data characteristics must be changed to conform to any other particular application. Moderated regression and ANCOVA variable inclusion levels within SPSS may be reset from the default levels. Finally, in the applications of the ANOVA and subgroup analysis techniques, the researcher must determine the precise splits of the data into nominal classes and then corespondingly set the delimiters in their respective analysis programs.

SIMULATION PROGRAM 1

```
*#RUN *=(ULIB)GRADLIB/TSS,R
CALL ATTACH(13,"SIMDATA;",3,0,,)
ICOUNT=0
NVALUE=1000
300 RMPS3=0
RMSAT=0
SAT=0
RN=RND(-1.0)
IF(RN.LE..005)GNS=1
IF((RN.GT..005).AND.(RN.LE..01))GNS=2
IF((RN.GT..01).AND.(RN.LE..05))GNS=3
IF((RN.GT..05).AND.(RN.LE..2))GNS=4
IF((RN.GT..2).AND.(RN.LE..4))GNS=5
IF((RN.GT..4).AND.(RN.LE..7))GNS=6
IF(RN.GT..7)GNS=7
IF(GNS.EQ.1)GO TO 10
IF(GNS.EQ.2)GO TO 20
IF(GNS.EQ.3)GO TO 30
IF(GNS.EQ.4)GO TO 40
IF(GNS.EQ.5)GO TO 50
IF(GNS.EQ.6)GO TO 60
IF(GNS.EQ.7)GO TO 70
10 RMPS3=XNORMAL(4.0,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=4.0-(.42*RMPS3)
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
20 RMPS3=XNORMAL(4.0,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=3.0-(.21*RMPS3)
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
30 RMPS3=XNORMAL(4.0,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=2.0
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
40 RMPS3=XNORMAL(4.4,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=1.6+(.21*RMPS3)
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
50 RMPS3=XNORMAL(4.5,1.0)
```

```
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=1.1+(.44*RMPS3)
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
60 RMPS3=XNORMAL(4.6,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=.6+(.67*RMPS3)
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
70 RMPS3=XNORMAL(4.7,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=.1+(.89*RMPS3)
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
100 ICOUNT=ICOUNT+1
WRITE(13,101)ICOUNT,GNS,RMPS3,SAT
101 FORMAT(I4,1X,F4.2,1X,F4.2,1X,F4.2)
IF(ICOUNT.EQ.NVALUE)GO TO 200
GO TO 300
200 STOP
END
```

SIMULATION PROGRAM 2

```
010*#RUN *=(ULIB)GRADLIB/TSS,R
020 CALL ATTACH(13,"SIMDATA;",3,0,,)
030 ICOUNT=0
040 NVALUE=10000
050 300 RMPS3=0
060 RMSAT=0
070 SAT=0
080 RN=RND(-1.0)
090 IF(RN.LE..005)GNS=1
100 IF((RN.GT..005).AND.(RN.LE..01))GNS=2
110 IF((RN.GT..01).AND.(RN.LE..05))GNS=3
120 IF((RN.GT..05).AND.(RN.LE..2))GNS=4
130 IF((RN.GT..2).AND.(RN.LE..4))GNS=5
140 IF((RN.GT..4).AND.(RN.LE..7))GNS=6
150 IF(RN.GT..7)GNS=7
160 GO TO 70
170 70 RMPS3=XNORMAL(4.7,1.0)
180 IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
190 RMSAT=.1+(.89*RMPS3)
200 SAT=XNORMAL(RMSAT,1.4)
210 IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
220 GO TO 100
230 100 ICOUNT=ICOUNT+1
240 WRITE(13,101)ICOUNT,GNS,RMPS3,SAT
250 101 FORMAT(I4,1X,F4.2,1X,F4.2,1X,F4.2)
260 IF(ICOUNT.EQ.NVALUE)GO TO 200
270 GO TO 300
280 200 STOP
290 END
```

SIMULATION PROGRAM 3

```
*#RUN *=(ULIB)GRADLIB/TSS,R
CALL ATTACH(13,"DATA;",3,0,,)
ICOUNT=0
DO 200 J=1,7
DO 400 I=1,1429
300 RMPS3=0
RMSAT=0
SAT=0
IF(J.EQ.1)GO TO 10
IF(J.EQ.2)GO TO 20
IF(J.EQ.3)GO TO 30
IF(J.EQ.4)GO TO 40
IF(J.EQ.5)GO TO 50
IF(J.EQ.6)GO TO 60
IF(J.EQ.7)GO TO 70
10 RMPS3=XNORMAL(4.0,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=4.0-(.42*RMPS3)
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
20 RMPS3=XNORMAL(4.0,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=3.0-(.21*RMPS3)
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
30 RMPS3=XNORMAL(4.0,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=2.0
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
40 RMPS3=XNORMAL(4.4,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=1.6+(.21*RMPS3)
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
50 RMPS3=XNORMAL(4.5,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
RMSAT=1.1+(.44*RMPS3)
SAT=XNORMAL(RMSAT,1.4)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
60 RMPS3=XNORMAL(4.6,1.0)
```

```
470 IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
480 RMSAT=.6+(.67*RMPS3)
490 SAT=XNORMAL(RMSAT,1.4)
500 IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
510 GO TO 100
520 70 RMPS3=XNORMAL(4.7,1.0)
530 IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
540 RMSAT=.1+(.89*RMPS3)
550 SAT=XNORMAL(RMSAT,1.4)
560 IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
570 100 ICOUNT=ICOUNT+1
580 WRITE(13,101)ICOUNT,J,RMPS3,SAT
590 101 FORMAT(I4,1X,I2,1X,F4.2,1X,F4.2)
600 400 CONTINUE
610 200 CONTINUE
620 STOP
630 END
```

SIMULATION PROGRAM 4

```
*#RUN *=(ULIB)GRADLIB/TSS,R
CALL ATTACH(13,"DATA;",3,0,,)
ICOUNT=0
DO 200 J=1,7
DO 400 I=1,1429
300 RMPS3=0
SAT=0
IF(J.EQ.1)GO TO 10
IF(J.EQ.2)GO TO 20
IF(J.EQ.3)GO TO 30
IF(J.EQ.4)GO TO 40
IF(J.EQ.5)GO TO 50
IF(J.EQ.6)GO TO 60
IF(J.EQ.7)GO TO 70
10 RMPS3=XNORMAL(4.5,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
SAT=4.0-(.42*RMPS3)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
20 RMPS3=XNORMAL(4.5,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO300
SAT=3.0-(.21*RMPS3)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
30 RMPS3=XNORMAL(4.5,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
SAT=2.0
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
40 RMPS3=XNORMAL(4.5,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
SAT=1.6+(.21*RMPS3)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
50 RMPS3=XNORMAL(4.5,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
SAT=1.1+(.44*RMPS3)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
60 RMPS3=XNORMAL(4.5,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
SAT=.6+(.67*RMPS3)
IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
GO TO 100
70 RMPS3=XNORMAL(4.5,1.0)
IF((RMPS3.LT.1.0).OR.(RMPS3.GT.7.0))GO TO 300
```

```
470 SAT=.1+(.89*RMPS3)
480 IF((SAT.LT.1.0).OR.(SAT.GT.7.0))GO TO 300
490 100 ICOUNT=ICOUNT+1
500 WRITE(13,101)ICOUNT,J,RMPS3,SAT
510 101 FORMAT(I4,1X,I2,1X,F4.2,1X,F4.2)
520 400 CONTINUE
530 200 CONTINUE
540 STOP
550 END
```

DIFFERENCE PROGRAM

```
CALL ATTACH(12,"GTDATA;",3,0,,)
CALL ATTACH(13,"DATA;",3,0,,)
DO 200 I=1,10003
READ(13,101,END=100)GNS,RMPS3,SAT
101 FORMAT(5X,F2.0,1X,F4.2,1X,F4.2)
ZSAT=(SAT-2.785)/0.902
ZRMPS3=(RMPS3-4.492)/0.971
DIFF=ABS(ZRMPS3-ZSAT)
WRITE(12,102)I,GNS,DIFF
102 FORMAT(I4,1X,F4.2,1X,F4.2)
200 CONTINUE
100 STOP
END
```

THE GHISELLI TECHNIQUE PROGRAM

```
100##S,R(SL) :,8,16;;,16
110$:IDENT:WP1186,AFIT/LSG TACKETT 78B
120$:SELECT:SPSS/SPSS
130RUN NAME;GHISELLI TECHNIQUE
140VARIABLE LIST;GNS,DIFF
150INPUT FORMAT;FIXED(1X,F4.2,1X,F4.2)
160INPUT MEDIUM;CARD
170N OF CASES;10003
180PEARSON CORR;GNS,DIFF
190OPTIONS;3
200STATISTICS;ALL
210READ INPUT DATA
220$:SELECTA:78B81/GTDATA,R
230FINISH
240$:ENDJOB
```

ANALYSIS OF COVARIANCE PROGRAM

```
100##S,R(SL) :,8,16;;,16
110$:IDENT:WP1186,AFIT/LSG TACKETT 78B
120$:SELECT:SPSS/SPSS
130RUN NAME;ANCOVA
140VARIABLE LIST;GNS,MPS3,SAT
150INPUT FORMAT;FIXED(1X,F2.0,1X,F4.2,1X,F4.2)
160INPUT MEDIUM;CARD
170N OF CASES;10003
180IF;(MPS3 GE 5.00)DV=1
190IF;(MPS3 LT 5.00)DV=0
200COMPUTE;INTACT=DV*GNS
210REGRESSION;VARIABLES=SAT,GNS,DV,INTACT/
220;REGRESSION=SAT WITH INTACT(5),DV(1),GNS(1) RESID=0
230STATISTICS;1,2,4,5,6
240READ INPUT DATA
250$:SELECTA;78B81/DATA,R
260FINISH
270$:ENDJOB
```

MODERATED REGRESSION PROGRAM

```
100##S,R(SL) :,8,16;;,16
110$:IDENT:WP1186,AFIT/LSG TACKETT 78B
120$:SELECT:SPSS/SPSS
130RUN NAME;MODERATED REGRESSION ANALYSIS
140VARIABLE LIST;GNS,MPS3,SAT
150INPUT FORMAT;FIXED(1X,F2.0,1X,F4.2,1X,F4.2)
160INPUT MEDIUM;CARD
170N OF CASES;10003
180COMPUTE;INTACT=MPS3*GNS
190REGRESSION;VARIABLES=SAT,GNS,MPS3,INTACT/
200;REGRESSION=SAT WITH INTACT(5),MPS3(1),GNS(1) RESID=0
210STATISTICS;1,2,4,5,6
220READ INPUT DATA
230$:SELECTA:78B81/DATA,R
240FINISH
250$:ENDJOB
```

AD-A061 358 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OHIO SCHO--ETC F/G 5/9
A COMPARISON OF STATISTICAL TECHNIQUES FOR ASSESSING THE EFFECT--ETC(U)
SEP 78 H L TACKETT

UNCLASSIFIED AFIT-LSSR-34-78B NL

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SUBGROUP ANALYSIS PROGRAM

```
100##S,R(SL) :,8,16;;,16
110$:IDENT:WP1186,AFIT/LSG TACKETT 78B
120$:SELECT:SPSS/SPSS
130RUN NAME;SUBGROUP ANALYSIS
140VARIABLE LIST;GNS,MPS3,SAT
150INPUT FORMAT;FIXED(1X,F2.0,1X,F4.2,1X,F4.2)
160INPUT MEDIUM;CARD
170N OF CASES;10003
180TASK NAME;LOW SPLIT ON GNS
190*SELECT IF;(GNS LE 3)
200PEARSON CORR;SAT,MPS3
210OPTIONS;3
220STATISTICS;ALL
230READ INPUT DATA
240$:SELECTA:78B81/DATA,R
250TASK NAME;HIGH SPLIT ON GNS
260*SELECT IF;(GNS GE 6)
270PEARSON CORR;SAT,MPS3
280OPTIONS;3
290STATISTICS;ALL
300TASK NAME;MIDDLE SPLIT ON GNS
310*SELECT IF;(GNS GT 3 AND GNS LT 6)
320PEARSON CORR;SAT,MPS3
330OPTIONS;3
340STATISTICS;ALL
350FINISH
360$:ENDJOB
```

ANALYSIS OF VARIANCE PROGRAM

```
100##S,R(SL) :,8,16;;,16
110$:IDENT:WP1186,AFIT/LSG TACKETT 78B
120$:SELECT:SPSS/SPSS
130RUN NAME;TWO-WAY ANOVA
140VARIABLE LIST;GNS,MPS3,SAT
150INPUT FORMAT;FIXED(1X,F2.0,1X,F4.2,1X,F4.2)
160INPUT MEDIUM;CARD
170N OF CASES;10003
180IF;(MPS3 GE 5.00)NMPS3=3
190IF;(MPS3 GT 4.00 AND MPS3 LT 5.00)NMPS3=2
200IF;(MPS3 LE 4.00)NMPS3=1
210IF;(GNS LE 3)NGNS=1
220IF;(GNS GT 3 AND GNS LT 6)NGNS=2
230IF;(GNS GE 6)NGNS=3
240ANOVA;SAT BY NMPS3(1,3),NGNS(1,3)
250STATISTICS;1
260READ INPUT DATA
270$:SELECTA:78B81/DATA,R
280FINISH
290$:ENDJOB
```

APPENDIX D

ADDITIONAL MODERATED REGRESSION AND ANALYSIS OF COVARIANCE OUTPUT

TABLE 10

ANALYSIS OF COVARIANCE WITH A MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=1000)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
<u>MPS3 Entered First</u>			
MPS3	0.06867	0.06867	0.26204
GNS	0.19290	0.12423	0.36817
Interaction	0.20653	0.01363	0.32402
<u>Interaction Entered First</u>			
Interaction	0.10499	0.10499	0.32402
GNS	0.20215	0.09716	0.36817
MPS3	0.20653	0.00439	0.26204

TABLE 11

MODERATED REGRESSION WITH A MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=2500)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
MPS3 Entered First			
MPS3	0.12859	0.12859	0.35859
GNS	0.23018	0.10159	0.35813
Interaction	0.25030	0.02012	0.49516
Interaction Entered First			
Interaction	0.24519	0.24519	0.49516
MPS3	0.24553	0.00034	0.35859
GNS	0.25030	0.00477	0.35813

TABLE 12

ANALYSIS OF COVARIANCE WITH A MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=2500)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
<u>MPS3 Entered First</u>			
MPS3	0.09078	0.09078	0.30130
GNS	0.20144	0.11066	0.35813
Interaction	0.21061	0.00918	0.34927
<u>Interaction Entered First</u>			
Interaction	0.12199	0.12199	0.34927
MPS3	0.15507	0.03308	0.30130
GNS	0.21061	0.05554	0.35813

101

TABLE 13

MODERATED REGRESSION WITH A MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=5000)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
MPS3 Entered First			
MPS3	0.12831	0.12831	0.35821
GNS	0.22307	0.09476	0.35330
Interaction	0.25166	0.02859	0.49183
Interaction Entered First			
Interaction	0.24190	0.24190	0.49183
MPS3	0.24222	0.00032	0.35821
GNS	0.25166	0.00944	0.35330

TABLE 14

ANALYSIS OF COVARIANCE WITH A MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=5000)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
MPS3 Entered First			
MPS3	0.08050	0.08050	0.28373
GNS	0.18948	0.10898	0.35330
Interaction	0.20178	0.01226	0.33721
Interaction Entered First			
Interaction	0.11371	0.11371	0.33721
GNS	0.19824	0.08453	0.35330
MPS3	0.20174	0.00350	0.28373

TABLE 15

MODERATED REGRESSION WITH A MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=7500)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
MPS3 Entered First			
MPS3	0.12497	0.12497	0.35351
GNS	0.22149	0.09652	0.35752
Interaction	0.24590	0.02441	0.48866
Interaction Entered First			
Interaction	0.23879	0.23879	0.48866
MPS3	0.23914	0.00035	0.35351
GNS	0.24590	0.00675	0.35752

TABLE 16

ANALYSIS OF COVARIANCE WITH A MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=7500)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
<u>MPS3 Entered First</u>			
MPS3	0.07786	0.07786	0.27904
GNS	0.18972	0.11186	0.35752
Interaction	0.19848	0.00876	0.32881
<u>Interaction Entered First</u>			
Interaction	0.10811	0.10811	0.32881
GNS	0.19661	0.08850	0.35752
MPS3	0.19848	0.00187	0.27904

TABLE 17

MODERATED REGRESSION WITH A MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=10000)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
<u>MPS3 Entered First</u>			
MPS3	0.11968	0.11968	0.34594
GNS	0.21098	0.09130	0.34744
Interaction	0.23985	0.02887	0.47893
<u>Interaction Entered First</u>			
Interaction	0.22937	0.22937	0.47893
MPS3	0.23001	0.00064	0.34594
GNS	0.23985	0.00984	0.34744

TABLE 18

ANALYSIS OF COVARIANCE WITH A MODERATOR EFFECT PRESENT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=10000)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
<u>MPS3 Entered First</u>			
MPS3	0.07722	0.07722	0.27789
GNS	0.18068	0.10346	0.34744
Interaction	0.19299	0.01231	0.32816
<u>Interaction Entered First</u>			
Interaction	0.10769	0.10769	0.32816
GNS	0.18910	0.08141	0.34744
MPS3	0.19299	0.00388	0.27789

TABLE 19

MODERATED REGRESSION WITH A MODERATOR EFFECT PRESENT AND AN EQUAL NUMBER OF CASES FOR EACH GNS LEVEL (n=7504)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
MPS3 Entered First			
MPS3	0.05520	0.05520	0.23494
GNS	0.17230	0.11711	0.39232
Interaction	0.23051	0.05821	0.45238
Interaction Entered First			
Interaction	0.20465	0.20465	0.45238
GNS	0.20733	0.00268	0.39232
MPS3	0.23051	0.02319	0.23494

TABLE 20

ANALYSIS OF COVARIANCE WITH A MODERATOR EFFECT PRESENT AND AN EQUAL NUMBER OF CASES FOR EACH GNS LEVEL (n=7504)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
<u>MPS3 Entered First</u>			
MPS3	0.04668	0.04668	0.21607
GNS	0.17389	0.12720	0.39232
Interaction	0.19774	0.02385	0.32748
<u>Interaction Entered First</u>			
Interaction	0.10724	0.10724	0.32748
GNS	0.19059	0.08334	0.39232
MPS3	0.19774	0.00715	0.21607

TABLE 21

MODERATED REGRESSION WITH A MODERATOR EFFECT PRESENT AND AN EQUAL NUMBER OF CASES FOR EACH GNS LEVEL (n=10003)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
MPS3 Entered First			
MPS3	0.05352	0.05352	0.23135
GNS	0.16452	0.11100	0.38681
Interaction	0.22603	0.06151	0.44269
Interaction Entered First			
Interaction	0.19597	0.19597	0.44269
MPS3	0.19856	0.00259	0.23135
GNS	0.22603	0.02747	0.38681

TABLE 22

ANALYSIS OF COVARIANCE WITH A MODERATOR EFFECT PRESENT AND AN EQUAL NUMBER OF CASES FOR EACH GNS LEVEL (n=10003)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
<u>MPS3 Entered First</u>			
MPS3	0.04874	0.04874	0.22077
GNS	0.16860	0.11987	0.38681
Interaction	0.19749	0.02889	0.32623
<u>Interaction Entered First</u>			
Interaction	0.10642	0.10642	0.32623
GNS	0.18666	0.08023	0.38681
MPS3	0.19749	0.01083	0.22077

TABLE 23

MODERATED REGRESSION WITH A MODERATOR EFFECT PRESENT, AN EQUAL NUMBER OF CASES FOR EACH GNS LEVEL, OVERALL MPS3 DISTRIBUTION USED, AND NO VARIABILITY ABOUT THE REGRESSION LINES (n=10003)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
<u>MPS3 Entered First</u>			
MPS3	0.05427	0.05427	0.23295
GNS	0.69334	0.63907	0.79936
Interaction	0.91645	0.22311	0.90236
<u>Interaction Entered First</u>			
Interaction	0.81425	0.81425	0.90236
MPS3	0.83027	0.01602	0.23295
GNS	0.91645	0.08618	0.79936

TABLE 24

ANALYSIS OF COVARIANCE WITH A MODERATOR EFFECT PRESENT, AN EQUAL NUMBER OF CASES FOR EACH GNS LEVEL, OVERALL MPS3 DISTRIBUTION USED, AND NO VARIABILITY ABOUT THE REGRESSION LINES
(n=10003)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
MPS3 Entered First			
MPS3	0.03024	0.03024	0.17389
GNS	0.67040	0.64016	0.79936
Interaction	0.80060	0.13020	0.53080
Interaction Entered First			
Interaction	0.28175	0.28175	0.53080
GNS	0.74121	0.45946	0.79936
MPS3	0.80060	0.05939	0.17389

TABLE 25

MODERATED REGRESSION IN THE ABSENCE OF A MODERATOR EFFECT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=7500)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
__MPS3 Entered First__			
MPS3	0.20251	0.20251	0.45001
GNS	0.20269	0.00018	-0.00243
Interaction	0.20308	0.00039	0.29959
__Interaction Entered First__			
Interaction	0.08975	0.08975	0.29959
MPS3	0.20260	0.11284	0.45001
GNS	0.20308	0.00048	-0.00243

TABLE 26

ANALYSIS OF COVARIANCE IN THE ABSENCE OF A MODERATOR EFFECT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=7500)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
MPS3 Entered First			
MPS3	0.12447	0.12447	0.35281
GNS	0.12459	0.00012	-0.00243
Interaction	0.12472	0.00013	0.34182
Interaction Entered First			
Interaction	0.11684	0.11684	0.34182
MPS3	0.12448	0.00764	0.35281
GNS	0.12472	0.00024	-0.00243

TABLE 27

MODERATED REGRESSION IN THE ABSENCE OF A MODERATOR EFFECT AND GNS LEVEL GENERATIONS FOR A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=10000)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
<u>MPS3 Entered First</u>			
MPS3	0.20930	0.20930	0.45749
GNS	0.20940	0.00010	-0.00669
Interaction	-	-	0.29856
<u>Interaction Entered First</u>			
Interaction	0.08914	0.08914	0.29856
MPS3	0.20939	0.12025	0.45749
GNS	0.20940	0.00001	0.00669

TABLE 28

ANALYSIS OF COVARIANCE IN THE ABSENCE OF A MODERATOR EFFECT AND GNS LEVEL GENERATIONS FROM A CUMULATIVE PROBABILITY DISTRIBUTION BASED ON MAINTENANCE PERSONNEL DATA ANALYSIS (n=10000)

Regressor	R^2	ΔR^2	Correlation of Regressor With Satisfaction
MPS3 Entered First			
MPS3	0.13635	0.13635	0.36925
GNS	0.13648	0.00013	-0.00669
Interaction	0.13659	0.00011	0.35218
Interaction Entered First			
Interaction	0.12403	0.12403	0.35218
MPS3	0.13658	0.01255	0.36925
GNS	0.13659	0.00001	-0.00669

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