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ROBUSTNESS OF POWER IN ANALYSIS OF VARIANCE FOR VARIOUS DESIGNS

by

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A thesis submitted to the Council for National Academic Awards in partial fulfilment of the requirements for the degree of Master of Philosophy.

JULY, 1982

SHEFFIELD CITY POLYTECHNIC

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ABSTRACT

Robustness of power of the analysis of variance technique to the departures from the underlying assumptions of homoskedasticity and independence of error has been considered in various designs, including the mixed and non-orthogonal designs. Distribution of the ratio of two independent quadratic forms is modified with arbitrary scale parameter g and has been used extensively. The choice of g is also discussed.

The results, in general, indicate that the power of the test of equal means is seriously affected when the assumption of homoskedasticity is violated, but for moderate degree of heteroskedasticity, the actual type I error is not seriously affected. Also, the power of the test of homogeneity of means is highly sensitive to the departure from the fixed effects model to the corresponding random effects model.

The problem of design of experiments to optimise power of the test under the constraint of cost is discussed with reference to the one-way classification for both cases of homogeneous and heterogeneous group error variances.

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ACKNOWLEDGEMENTS

The author wishes to thank Dr.G.K.Kanji and Dr.W.G.Gilchrist for their guidance and encouragement throughout this research programme.

CONTENTS

CHAPTER 1

1. INTRODUCTION

1.1 HISTORICAL BACKGROUND

The assumptions, on which analysis of variance is based, are that the experimental errors a) have equal variances; b) are statistically independent and; c) are normally distributed.

Like many other fields of statistics, it was R A Fisher who germinated the idea of robustness in 1935. In his book, 'The Design of Experiment', he raises for the first time, the concept of robustness in terms of the sensitivity of the 't' test to the underlying assumption of normality.

Stigler (1980) traced back the history of the study of robustness. He described the method of robust estimate of location first proposed by R H Smith, a Professor in Engineering at Mason College (later, the University of Birmingham), in 1888.

Cochran (1947) gave an account on the consequences when the assumptions for the Analysis of Variance are not satisfied. The consequences on the effects of non-normality, gross errors, heterogeneity of errors, correlations amongst the errors and non-additivity were discussed in general terms.

It was Box (1953) who actually introduced the term 'Robust' to denote a statistical procedure which is insensitive to departures from assumptions on which the model is based. Such procedures are commonly used and studies of robustness have been carried out in the field of 'Analysis of Variance'.

The effects of non-normality in the distribution of error were studied by Pearson (1931), Geary (1947) and Gayen (1950) for the one-way layout. Kanji (1976b, 1977) studied the effects of non-normality on the power in analysis of variance for both one- and two-way layouts by a simulation method (for both fixed and random effects). David and Johnson (1951) considered the extent to which non-normality of the error distribution affects the F-test. It is found that the test, in general, is little affected by non-normality of error.

In the study of statistical independence, Box (1954b) studied the effects of serially correlated errors within rows in the two-way layout. His results indicate that the between-rows comparisons are greatly affected by serial correlation within rows, but that the between-columns comparisons are much less seriously affected. Kanji (1975, 1976a) considered the effects of serial correlation of errors on the power in the general linear model and in the two-way layout like Box. It is found that, in the general linear model and the between-columns comparisons in the two-way layout, the test is not seriously affected by serially correlated errors.

However, Andersen et al (1981) followed the foot-path of Box (1954b) and derived the approximations to the distributions of the usual test-statistics of no column effect and no row effect. The behaviour of the approximations was studied by simulation in the cases of the first-order autoregressive and first-order moving average models. They found that if the correlations are disregarded, it may lead to seriously mis-leading conclusions.

Numerous studies have been made on the effects of departure from the usual assumption that the error variables have equal variances. Kanji (1975) studied the effects of unequal error variances on the power in the general linear model. He found that the power value is seriously affected when normally and independently distributed error variables have unequal error variances and, wherever error variances are unequal, the power value is greater than for equal error variances. Welch (1938) considered the effect of unequal group variances on the t-test. His results indicate that when the groups are of equal size, the effect is small, but this becomes larger when the groups are of unequal size. Hsu (1938) attempted to find exact probability for this case. Gronow (1951) carried out the investigation using a different approximating method. Both of their investigations supported Welch's finding. Carter et al (1979) also attempted the same problem. Their result indicates that there is no appreciable effect on the significance level even if the ratio of the variances differs from one by as much as 0.4. When this difference exceeds 0.4, the effect starts showing but can be compensated for if one is permitted to take a larger number of observations from the population with the larger variance than from the one with smaller variance. The effect on power is similar. Murphy (1967) used a simulation method for his study of the two sample test when the variances are unequal. His investigation indicates that the permutation test and the t-test are virtually identical in practice and are fairly robust to inequality of variances as long as sample sizes are equal.

Horsnell (1953) brought David and Johnson's work a step further, and considered the effect of unequal group variances on the power of the test for a special case of the one-way layout. Box (1954a) derived an approximate method to study the effect of unequal group variances in the one-way layout. His results indicate that if the group variances are unequal and the groups are equal, then the test is not seriously affected. However, quite large discrepancies can occur when the groups are unequal for even moderate variations of variance. Kanji (1979) considered the power aspects for the same case using different method. The results he obtained show that the power of the test when the group variance are not equal is larger than when they are equal, and; that the group sizes do not greatly affect the power. In addition, the power will be affected if the group sizes are greatly unequal.

Both Box (1954b) and Kanji (1976a) continued their studies of the effect of unequal error variances in the two-way layout. The results Box obtained are similar to those for equal groups with the one-way classification, i.e., both between-columns and between-rows tests are not seriously affected by inequality of column variances. In contrast, the results of Kanji show that the power of the between-columns test is greatly affected by the unequal column variances.

Ito and Schull (1964) studied the robustness of the T_o^2 test in multivariate analysis of variance when variance and covariance matrices are not equal. Their results show that, for large samples of equal size and moderate inequality of variance and covariance matrices, the test is not seriously affected but, for unequal size, the effects are quite large. Carter et al (1979) extended their study of the effect of inequality of variances on the t-test to the multivariate situation. The results they obtained are similar to those of the univariate case.

The statistically important problem of the distribution of homogeneous positive quadratic forms was discussed in detail by Robbins (1948), Hotelling (1948) and, Robbins and Pitman (1949). The more difficult distribution of non-homogeneous quadratic forms was studied by Solomon (1961). Ruben (1962, 1963) derived the distribution function of a non-negative quadratic form, both homogeneous and non-homogeneous, in terms of an infinite linear combination of chi-square distribution functions with arbituary scale parameter. Alternative representation of the distribution function of the non-homogeneous form in terms of non-central chi-square distribution functions with arbituary scale parameter was also derived.

1.2 AIM OF STUDY

Following Kanji (1978), a distribution of the ratio of two independent quadratic forms is modified with arbituary scale parameter and has been referred to as a generalised incomplete beta distribution. It is then applied to investigate in detail the effect of unequal error variances and serially correlated errors on the power in the following cases:

i) the general linear model;

ii) the one-way layout analysis of variance for fixed and random effect models;

iii) the two-way layout analysis of variance for fixed and random effects models;

iv) the fixed effect one-way layout analysis of covariance model with one concomitant variable and;

v) the fixed effect split-plot design model.

In addition, the cost aspects in relation to power is considered for the unequal error variances situation in the one-way layout.

Although this thesis is an extension to the various work by Kanji, there are many features that differ from its predecessor. For example, different scale parameter and different transformation in the application of Ruben's theorems; different expressions for the variance-covariance matrices in the random effect models are used.

CHAPTER 2

2. POWER ASPECTS IN GENERAL LINEAR MODEL

2.1 ESTIMATION OF PARAMETER

The general linear model of full rank can be expressed as

$$\underline{Y} = \underline{X}\underline{\beta} + \underline{\varepsilon} \qquad (2.1.1)$$

where $\underline{Y}$ is a (nx1) vector of observation, $\underline{X}$ is a (nxp) matrix of known coefficients ($p \leq n$); $\underline{\beta}$ is a (px1) vector of unknown parameters and $\underline{\varepsilon}$ is a (nx1) vector of 'error' random variables.

In order to investigate the effect of a departure from the usual test assumption on the power in Analysis of Variance, we will consider the vector $\underline{\varepsilon}$ such that $\underline{\varepsilon}$ is distributed as $N(\underline{0}, \sigma^2 \underline{\delta})$ where $\underline{\delta}$ is an (nxn) unknown positive definite symmetric matrix and σ^2 is an unknown scale factor. This will allow for both heteroskedasticity (unequal diagonal elements of $\underline{\delta}$) and interdependence (non-zero off diagonal elements of $\underline{\delta}$) of the errors. Since the errors are normally distributed with expectation zero and variance-covariance matrix $\sigma^2 \underline{\delta}$, the likelihood function to be maximized becomes

$$f(\underline{\varepsilon};\underline{\beta},\sigma^2\underline{\delta}) = \frac{(2\pi)^{-n/2}}{\sigma^n |\underline{\delta}|^{1/2}} \quad EXP(\frac{1}{2\sigma^2}(\underline{N}\underline{Y} - \underline{N}\underline{X}\underline{\beta})' \quad (\underline{N}\underline{Y}-\underline{N}\underline{X}\underline{\beta})) \qquad (2.1.2)$$

where $\underline{\delta}^{-1} = \underline{N}'\underline{N}$, since any symmetric matrix can be split up into the product of triangular matrices. The maximum likelihood estimates of $\underline{\beta}$ and σ^2 are:

$$\hat{\underline{\beta}} = (\underline{X}'\underline{\delta}^{-1}\underline{X})^{-1}\underline{X}'\underline{\delta}^{-1}\underline{Y}$$

and $\hat{\sigma}^2 = \frac{1}{n}(\underset{=}{N}\underset{-}{Y} - \underset{=}{N}\underset{=}{X}\hat{\underset{-}{\beta}})'(\underset{=}{N}\underset{-}{Y} - \underset{=}{N}\underset{=}{X}\hat{\underset{-}{\beta}})$.

Since $E(\hat{\underset{-}{\beta}})=\underset{-}{\beta}$, then $\hat{\underset{-}{\beta}}$ is an unbiased estimate of $\underset{-}{\beta}$. It can also be proved that $E(\hat{\sigma}^2)= \frac{n-p}{n}\sigma^2$ and therefore

$$\tilde{\sigma}^2 = \frac{n}{n-p}E(\hat{\sigma}^2) = \frac{1}{n-p}(\underset{=}{N}\underset{-}{Y} - \underset{=}{N}\underset{=}{X}\underset{-}{\beta})'(\underset{=}{N}\underset{-}{Y} - \underset{=}{N}\underset{=}{X}\underset{-}{\beta})$$

is an unbiased estimate of σ^2.

2.2 TEST OF HYPOTHESIS

Testing the hypothesis $\underset{-}{\beta} = \underset{-}{\beta}^*$ in the model (2.1.1) is equivalent to testing simultaneously that each β_i equals a given constant β_i^* . In testing the hypothesis H_0: $\underset{-}{\beta} = \underset{-}{\beta}^*$, it is essential to devise a test function. For the evaluation of the power of the test, it is also necessary to know the distribution of the test function when the alternative hypothesis H_1: $\underset{-}{\beta} \neq \underset{-}{\beta}^*$ is true. Also we can test any sub-hypothesis $\underset{-}{\gamma} = \underset{-}{\gamma}^*$ where the elements of $\underset{-}{\gamma}^*$ are given constants (see, for example Graybill (1961), pp.135). This can be seen in later chapters.

Following Graybill (1961, pp.128-133), the likelihood ratio criterion for the classical case of independent equal error variances that has been used to test the hypothesis can be expressed as

$$L = ((\underset{-}{Y} - \underset{=}{X}\hat{\underset{-}{\beta}})'(\underset{-}{Y} - \underset{=}{X}\hat{\underset{-}{\beta}})^{n/2}((\underset{-}{Y} - \underset{=}{X}\overset{*}{\underset{-}{\beta}})'(\underset{-}{Y} - \underset{=}{X}\overset{*}{\underset{-}{\beta}}))^{-n/2}$$
$$= (1 + Q_2/Q_1)^{-n/2}$$

where $Q_2 = (\underset{-}{Y} - \underset{=}{X}\overset{*}{\underset{-}{\beta}})'\underset{=}{A}_2(\underset{-}{Y} - \underset{=}{X}\overset{*}{\underset{-}{\beta}})$ (2.2.1)

$$Q_1 = (\underline{Y} - \underline{X}\underline{\beta}^*)'\underline{A}_1(\underline{Y} - \underline{X}\underline{\beta}^*) \tag{2.2.2}$$

and $\underline{A}_2 = \underline{X}(\underline{X}'\underline{X})^{-1}\underline{X}'$

$$\underline{A}_1 = \underline{I} - \underline{X}(\underline{X}'\underline{X})^{-1}\underline{X}' = \underline{I} - \underline{A}_2$$

are both indempotent matrices.

The rank of Q_2, which is also the rank of $\underline{A}_2$, can be determined by

$$\text{trace}(\underline{A}_2) = \text{trace}(\underline{X}(\underline{X}'\underline{X})^{-1}\underline{X}') = p.$$

Therefore the rank of $\underline{A}_2$ is p and similarly, the rank of $\underline{A}_1$ is n-p. Hence, Q_1 and Q_2 are positive semidefinite quadratic forms.

To determine whether Q_1 and Q_2 are independent, we employ a lemma due to Seber (1966, pp.8) with slight modification as follows:

<u>Lemma</u> (2.2.3)

If $\underline{A}_1$ and $\underline{A}_2$ are symmetric idempotent matrices such that $\underline{A}_1\underline{A}_2 = \underline{0}$, then $\underline{Y}'\underline{A}_1\underline{Y}$ and $\underline{Y}'\underline{A}_2\underline{Y}$ are statistically independent.

<u>Proof</u>:

$$\begin{aligned} \text{COV}(\underline{A}_1\underline{Y}, \underline{A}_2\underline{Y}) &= E(\underline{A}_1\underline{\varepsilon}\underline{\varepsilon}'\underline{A}_2) \\ &= \underline{A}_1 E(\underline{\varepsilon}\underline{\varepsilon}')\underline{A}_2 \\ &= \sigma^2\underline{A}_1\underline{\delta}\underline{A}_2 = \sigma^2\underline{A}_1\underline{A}_2\underline{\delta} = \underline{0}. \end{aligned}$$

In our case, we have

$$\underline{A}_1\underline{A}_2 = (\underline{I} - \underline{A}_2)\underline{A}_2 = \underline{A}_2 - \underline{A}_2 = \underline{0}.$$

If $\tau = Q_2/Q_1$, then the numerator and denominator of τ are mutually independent with rank p and n-p respectively.

2.3 DISTRIBUTION OF THE QUADRATIC FORMS

In order to assess the effects of interdependence and heterogeneity of error variances, we will assume the hypothesis testing procedure for the classical case when the error variances are, in fact, not independent and unequal. From equation (2.2.1), we have

$$Q_2 = (\underline{Y} - \underline{X}\underline{\beta}^*)'\underline{A}_2(\underline{Y} - \underline{X}\underline{\beta}^*)$$

where $\underline{Y}$ is distributed as $N(\underline{X}\underline{\beta}, \underline{V})$ and $\underline{V} = \sigma^2\underline{\delta}$. Let $\underline{\psi} = \underline{Y} - \underline{X}\underline{\beta}$ and $\underline{\mu}^* = \underline{X}\underline{\beta} - \underline{X}\underline{\beta}^*$, then

$$Q_2 = (\underline{\psi} + \underline{\mu}^*)'\underline{A}_2(\underline{\psi} + \underline{\mu}^*) \tag{2.3.1}$$

and $\underline{\psi}$ is distributed as $N(\underline{0}, \underline{V})$.

To achieve the required quadratic form for the application of Ruben (1962) theorem 1, the linear transformations

$$\underline{\psi} = \underline{t}'\underline{K}\underline{Z} \qquad \text{and} \qquad \underline{\mu}^* = -\underline{t}'\underline{K}\underline{b}$$

transform the quadratic form of Q_2 to the canonical form given by $(\underline{Z} - \underline{b})'\underline{A}(\underline{Z} - \underline{b})$ where $\underline{Z}$ is distributed as $N(\underline{0},\underline{I})$ and $\underline{t}$ is the upper triangular matrix defined by $\underline{V} = \underline{t}'\underline{t}$, and $\underline{K}$ is the orthogonal matrix of eigen-vectors of $\underline{t}\underline{A}_2\underline{t}'$. The a_i's are the diagonal elements of the matrix $\underline{A} = \underline{K}'\underline{t}\underline{A}_2\underline{t}'\underline{K}$ and also the eigen-values of $\underline{t}\underline{A}_2\underline{t}'$, and $\underline{b}$ is a fixed n-dimentsional vector. Since Q_2 is a non-homogeneous quadratic form, Ruben's (1962) theorem 1 can be applied, viz,

$$H_{f_1;\underline{A},\underline{b}}(\alpha) = P(Q_2 \leq \alpha) = \sum_{j=0}^{\infty} c_j \chi^2_{f_1+2j}(\alpha/g_2) \qquad (2.3.2)$$

where $f_1 = p$ is the rank of $\underline{t}\underline{A}_2\underline{t}'$; and therefore of $\underline{A}_2$ since $\underline{t}$ is nonsingular; $g_2 = a_1$, assuming without loss of generality that $a_1 \leq a_2 \leq \ldots \leq a_p$, which is different from the value 1 as used by Kanji (1975); $\chi^2_{f_1+2j}(\cdot)$ is a chi-square distribution and the c_j satisfy the recursion relationship

$$c_j = (2j)^{-1} \sum_{r=0}^{j-1} h_{j-r}\, c_r \qquad j = 1,2,\ldots$$

where $c_0 = EXP(-\lambda^2) \prod_{i=1}^{f_1} A_i^{-1/2}$,

$$h_s = \sum_{i=1}^{f_1} (1 - 1/A_i)^s + s \sum_{i=1}^{f_1} (b_i^2/A_i)(1 - 1/A_i)^{s-1},$$

and

$$A_i = a_i/g_2.$$

The noncentrality parameter λ can be obtained by using vector $\underline{b}$.

And, similarly, the distribution of Q_1 can be obtained. But in this case, it is a homogeneous quadratic form and theorem 2 can be applied, viz:

$$H_{f_2;\underline{A},\underline{0}}(\alpha) = P(Q_1 \leq \alpha) = \sum_{i=0}^{\infty} d_i\, \chi^2_{f_2+2i}(\alpha/g_1) \qquad (2.3.3)$$

where $f_2 = n-p$ is the rank of $\underline{A}_1$, $\underline{M} = \underline{K}_1'\underline{t}\underline{A}_1\underline{t}'\underline{K}$ is a diagonal matrix whose diagonal elements m_j are also the eigenvalues of $\underline{t}\underline{A}_1\underline{t}'$; $\underline{K}_1$ is an orthogonal matrix of eigenvectors of $\underline{t}\underline{A}_1\underline{t}'$; $g_1 = m_1$; $\underline{b} = \underline{0}$ and the d_i satisfy the recursion relationship

$$d_i = (2i)^{-1} \sum_{r=0}^{i-1} h_{i-r} \, d_r \qquad i = 1,2,\ldots$$

where

$$d_0 = \prod_{j=1}^{f_2} M_j^{-1/2} ,$$

$$h_s = \prod_{j=1}^{f_2} (1 - 1/M_j)^s$$

and

$$M_j = m_j/g_1$$

2.4 NONCENTRALITY PARAMETER

It is always desirable to express the noncentrality parameter λ in terms of $\underline{\mu}^*$ and $\underline{V}$. From the equation

$$\underline{\mu}^* = -\underline{t}'\underline{K}\underline{b}$$

we have $\underline{b} = -\underline{K}^{-1}(\underline{t}')^{-1}\underline{\mu}^* = -\underline{K}'(\underline{t}')^{-1}\underline{\mu}^*$.

where $\underline{K}$ is the orthogonal matrix defined in section 2.3.

Again we have $\underline{V} = \underline{t}'\underline{t}$ or $(\underline{t}')^{-1} = \underline{t}\underline{V}^{-1}$

and $\underline{b} = -\underline{K}'(\underline{t}')^{-1} \underline{\mu}^* = -\underline{K}'\underline{t}\underline{V}^{-1}\underline{\mu}^*$.

Now, $\lambda^2 = \frac{1}{2}\underline{b}'\underline{b} = \frac{1}{2} \Sigma b_i^2$

and

$$\begin{aligned} \underline{b}'\underline{b} &= (-\underline{K}'\underline{t}\underline{V}^{-1}\underline{\mu}^*)'(-\underline{K}'\underline{t}\underline{V}^{-1}\underline{\mu}^*) \\ &= \underline{\mu}^{*\prime}\underline{V}^{-1}\underline{t}'\underline{K}\underline{K}'\underline{t}\underline{V}^{-1} \underline{\mu}^* \\ &= \underline{\mu}^{*\prime}\underline{V}^{-1}\underline{t}'\underline{t}\underline{V}^{-1} \underline{\mu}^* \\ &= \underline{\mu}^{*\prime}\underline{V}^{-1} \underline{\mu}^* . \end{aligned}$$

Therefore we obtain $\lambda^2 = \frac{1}{2}\underline{b}'\underline{b} = \frac{1}{2}\underline{\mu}^{*\prime}\underline{V}^{-1}\underline{\mu}^*$.

2.5 DISTRIBUTION OF THE RATIO OF QUADRATIC FORMS

Having obtained the distribution of Q_1 and Q_2 in the preceding section, the distribution of the ratio of Q_2 to Q_1, i.e. the distribution of τ, is required.

It has been shown that Q_1 and Q_2 are independently distributed as mixture of central χ^2 distributions. Therefore the ratio of Q_2/Q_1 is distributed as a mixture of ratios of central χ^2 distributions (see Appendix I). Thus,

$$P(\tau = Q_2/Q_1 \leq \alpha) = \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i F_{p+2j,n-p+2i} \left(\frac{n-p+2i}{p+2j}\alpha_c\right) \quad (2.4.1)$$

where $F_{\nu 1,\nu 2}(.)$ is an F-distribution and $\alpha_c = \alpha g_1/g_2$.

2.6 POWER OF THE TEST

As it is more convenient to compute the incomplete beta distribution than the F distribution, the series (2.4.1) is expressed in terms of incomplete beta distribution with the help of the identity

$$F_{\nu 1,\nu 2}(x) = I_{x/(1+x)}(\tfrac{1}{2}\nu 1, \tfrac{1}{2}\nu 2)$$

where $I_\phi(.)$ is the incomplete beta distribution. Then, the series (2.4.1) (see for example, Kanji (1975)) can be written as

$$P(\tau = Q_2/Q_1 \leq \alpha) = \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_\phi(\tfrac{1}{2}p+j, \tfrac{1}{2}(n-p)+i) \quad (2.6.1)$$

where $\phi = \alpha_c/(1+\alpha_c)$.

Let P_{II} be the type II error. Then,

$$P_{II} = P(\tau = Q_2/Q_1 \leq \alpha)$$

$$= \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_\phi(\tfrac{1}{2}p+j, \tfrac{1}{2}(n-p)+i) \qquad (2.6.2)$$

is a generalised incomplete beta distribution, where $\alpha = \frac{p}{n-p} F_\varepsilon$, $\alpha_c = \alpha g_1/g_2$ and ε is the level of significance. Thus, the power of the test is given by

$$B(\lambda) = 1 - P_{II}$$

$$= \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_\phi (\tfrac{1}{2}p+j), \tfrac{1}{2}(n-p)+i) \qquad (2.6.3)$$

We will consider the cases where the error variances for the observations are not equal (tables 1A) and that the observations are serially correlated (tables 1B) in the manner given in Box (1954b). We consider also that $\underset{\sim}{X}$, as referred in (2.1.1), is a design matrix.

When more than two treatments are involved, like Horsnell (1953), we will consider two cases of divergent mean, namely,

i) $U_2^* = U_3^* = \ldots = U_p^* \leq U_1^*$, that is divergent mean in the group with smallest error variance;

ii) $U_1^* = U_2^* = \ldots = U_{p-1}^* \leq U_p^*$, that is divergent mean in the group with largest error variance

Notice that, when $\lambda = 0$, $B(0)$ provides a measure of the effect of departure from the assumptions of homegeneity and independence of error variances on the test when the null hypothesis of equal group means is true.

For practical purposes only the first 26 terms will be considered in all the infinite sums in the actual calculations of power.

CHAPTER 3

3. POWER ASPECTS IN THE ONE-WAY LAYOUT

3.1 FIXED EFFECT MODEL

Consider a simple experiment, for example in a variety trial, to compare the mean damage of each variety due to a certain disease, using a complete randomised design, where the variabilities of susceptibility to that particular disease for each variety are different. In other words, we wish to compare group to group homogeneity of means while the group to group variances are heterogeneous, in the one-way classification of analysis of variance.

Suppose that there are n_i observations in group i, i = 1,2,...k. Denote by y_{ij} the j^{th} observation in group i, by $\bar{y}_{i\cdot}$ the i^{th} group mean and $\bar{y}_{\cdot\cdot}$ the grand mean. Usually we assume the model,

$$y_{ij} = \mu + t_i + e_{ij} \qquad (3.1.1)$$

where $\mu+t_i$ is the population mean for the i^{th} group; $\Sigma n_i t_i=0$ and e_{ij} are errors distributed normally and independently about zero mean with common variance σ^2. In matrix notation, model (3.1.1) becomes,

$$\underline{Y} = \underline{\mu} + \underline{T}\underline{t} + \underline{\varepsilon} \qquad (3.1.2)$$

where $\underline{Y}$, $\underline{\mu}$ and $\underline{\varepsilon}$ are respectively (Nx1) vectors of observations, expected values of $\underline{Y}$ and random errors; $\underline{T}$ and $\underline{t}$ are respectively (Nxk) design matrix for the treatments and (kx1) vector of treatment constants. A method developed in the general linear model has been adopted which provides a more flexible alternative to that suggested by Box (1954a).

We retain the assumptions of homogeneity and independence of the errors but assume variance σ_i^2 for the i^{th} group where the σ_i^2 's are not necessarily equal. The sums of squares involved are

$$Q_2 = \sum_i n_i(\bar{y}_{i.} - \bar{y}_{..})^2 = \underline{Y}'\underline{A}_2\underline{Y} \tag{3.1.3}$$

$$Q_1 = \sum_{i}\sum_{j}(\bar{y}_{ij} - \bar{y}_{i.})^2 = \underline{Y}'\underline{A}_1\underline{Y} \tag{3.1.4}$$

where $\underline{A}_2 = (\underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}' - \frac{1}{N}\underline{1}\underline{1}')$

$$\underline{A}_1 = (\underline{I} - \underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}')$$

are both symmetric idempotent matrix of quadratic forms and $\underline{I}$ is an (NxN) identity matrix.

Let $\underline{H} = \underline{A}_2\underline{Y}$ and $\underline{\tau} = \underline{T}\underline{t}$ where $\underline{\tau}$ is an (Nx1) vector with elements t_i. Then Q_2 can be expressed in terms of $\underline{H}$, viz,

$$Q_2 = \underline{H}'\underline{A}_2\underline{H} = \underline{Y}'\underline{A}_2\underline{Y}$$

where $\underline{H}$ is distributed as $N(\underline{\tau},\underline{V})$. And, on setting

$$\underline{\psi} = \underline{H} - \underline{\tau} ,$$

Q_2 becomes $Q_2 = (\underline{\psi} + \underline{\tau})'\underline{A}_2 (\underline{\psi} + \underline{\tau})$

where $\underline{\psi}$ is distributed as $N(\underline{0}, \underline{V})$.

With the help of the transformations

$$\underline{\psi} = \underline{N}'\underline{K}\underline{z} \quad \text{and} \quad \underline{\tau} = -\underline{N}'\underline{K}\underline{b}$$

Q_2 can be transformed to its canonical form as

$$Q_2 = (\underline{z} - \underline{b})'\underline{A}(\underline{z} - \underline{b})$$

where $\underline{z}$ is distributed as $N(\underline{0}, \underline{I})$; $\underline{A} = \underline{K}'\underline{N}\underline{A}_2\underline{N}'\underline{K}$ is a diagonal matrix with diagonal elements a_i which are also the eigenvalues of $\underline{N}\underline{A}_2\underline{N}'$; $\underline{K}$ is the orthogonal matrix of eigenvectors of $\underline{N}\underline{A}_2\underline{N}'$, and; $\underline{N}$ is the upper triangular matrix defined by $\underline{V} = \underline{N}'\underline{N}$. Thus the quadratic form of the between group sum of squares Q_2 can be expressed as a non-homogeneous quadratic form. The distribution of Q_2 (see section 2.3) is given by

$$P(Q_2 \leqslant \alpha) = \sum_{j=0}^{\infty} c_j \, \chi^2_{f_1+2j}(\alpha/g_2) \qquad (3.1.5)$$

where $f_1 = k-1$ is the rank $\underline{A}_2$; $g_2 = a_1$; $\chi^2_f(.)$ is a chi-square distribution, and; the c_j satisfy the recursion relationship

$$c_j = (2j)^{-1} \sum_{r=0}^{j-1} h_{j-r} \, c_r \qquad j = 1,2,\ldots$$

$$c_0 = \text{EXP}\,(-\lambda^2) \prod_{i=1}^{f_1} A_i^{-\frac{1}{2}}$$

where $h_m = \sum_{i=1}^{f_1} (1 - 1/A_i)^m + m \sum_{i=1}^{f_1} (b_i^2/A_i)(1 - 1/A_i)^{m-1}$

and $A_i = a_i/g_2$.

Similarly, the quadratic form of Q_1 can be expressed as $\underline{\psi}'\underline{A}_1\underline{\psi}$. By the transformation $\underline{\psi} = N'\underline{K}_1\underline{z}$, Q_1 is reduced to $\underline{z}'\underline{M}\underline{z}$ where $\underline{M} = \underline{K}_1'\underline{N}\underline{A}_1\underline{N}'\underline{K}_1$ is a diagonal matrix with diagonal elements m_j which are also the eigenvalues of $\underline{N}\underline{A}_1\underline{N}'$; $\underline{K}_1$ is an orthogonal matrix of eigenvectors and $\underline{N}$ is as defined earlier. The distribution of Q_1 is given by

$$P(Q_1 \leq \alpha) = \sum_{i=0}^{\infty} d_i \chi^2_{f_2+2i}(\alpha/g_1) \qquad (3.1.6)$$

where f_2 = N-k is the rank of $\underline{A}_1$; $g_1 = m_1$ and the d_i satisfy the recursion relationship

$$d_i = (2i)^{-1} \sum_{r=0}^{i-1} h_{i-r}\, d_r \qquad i = 1,2,\ldots$$

where $d_0 = \prod_{j=0}^{f_2} M_j^{-\frac{1}{2}}$

$$h_n = \sum_{j=0}^{f_2} (1 - 1/M_j)^n$$

and

$$M_j = m_j/g_1.$$

It can be proved, by lemma (2.2.3), that the two quadratic forms Q_1 and Q_2 are statistically independent.

The noncentrality parameter λ is given by

$$\lambda = (\tfrac{1}{2}\underline{b}'\underline{b})^{\frac{1}{2}} = (\tfrac{1}{2}\sum_{i=1}^{f_1} b_i^2)^{\frac{1}{2}} \qquad (3.1.7)$$

where $\underline{b} = \underline{K}'(\underline{N}')^{-1}\underline{\tau}$. Alternatively, $\lambda^2 = \frac{1}{2}\underline{\tau}'\underline{V}^{-1}\underline{\tau}$.

Proceeding as in section 2.6, the distribution of the test criterion U is given by

$$P(U=Q_2/Q_1 \leq \alpha) = \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_\phi \left(\tfrac{1}{2}f_1+j,\ \tfrac{1}{2}f_2+i\right) \qquad (3.1.8)$$

where $I_\phi(.)$ is a generalised incomplete beta distribution; $\phi=\alpha_c/(1+\alpha_c)$ and $\alpha_c=\alpha g_1/g_2$. For a chosen level of significance ε, α is given by $\alpha = F_\varepsilon\ f_1/f_2$.

Let P_{II} be the type II error. Then

$$P_{II} = P(U \leqslant \alpha)$$

and the power of the test is given by

$$B(\lambda) = 1 - P_{II}$$

or $$B(\lambda) = 1 - \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_\phi\left(\frac{k-1+2j}{2}, \frac{N-k+2i}{2}\right) \qquad (3.1.9)$$

3.2 RANDOM EFFECT MODEL

If the k populations described in the previous section were a random sample drawn from the large (possibly infinite) set of populations, the model described by (3.1.1) becomes a random effect model.

For example, in the determination of fuel consumption for a certain engine capacity, 1300 cc say, k models are randomly selected out of all possible models available in the market within the category. Let y_{ij} be the observed fuel consumption of the j^{th} car from the i^{th} model after completion of a given route. Then, the model

$$y_{ij} = \mu + t_i + e_{ij} \qquad \begin{matrix} i = 1,2,\dots,k \\ j = 1,2,\dots,n_i \end{matrix} \qquad (3.2.1)$$

describing the structure becomes a random effect model where t_i and e_{ij} are independent normal variables each with zero expectation and with variances σ_t^2 and σ_i^2 respectively. And the σ_i^2's are not necessarily equal.

The general procedure for testing a hypothesis, and for estimation, is the same for the random effect model as for the fixed effect model. Sheffé (1959) has discussed the power of the test when the error variances are equal and the layout is balanced. Here we will consider the power of the test in the random effect model when the error variances are not equal and the layout is not balanced.

The sums of squares involved are,

$$Q_1 = \sum_{i=1}^{k} \sum_{j=1}^{n_i} (y_{ij} - \bar{y}_{i.})^2 \qquad (3.2.2)$$

$$Q_3 = \sum_{i=1}^{k} n_i(\bar{y}_{i.} - \bar{y}_{..})^2. \qquad (3.2.3)$$

Under the present model, the quadratic form of Q_1,

$$Q_1 = \sum_{i=1}^{k} \sum_{j=1}^{n_i} (y_{ij} - \bar{y}_{i.})^2 = \sum_{i=1}^{k} \sum_{j=1}^{n_i} (e_{ij} - \bar{e}_{i.})^2, \qquad (3.2.4)$$

is the same as that for the fixed effect model and so does the distribution of Q_1.

Like in the fixed effect model, Q_3 can be expressed as

$$Q_3 = \underline{H}_r'\underline{A}_2\underline{H}_r$$

where $\underline{H}_r = \underline{A}_2\ \underline{Y}$ is distributed as $N(\underline{\tau}, \underline{S})$. $\underline{A}_2$ is given in (3.1.3), and $\underline{S}$ is a variance-covariance matrix with diagonal elements $(n_i\sigma_t^2 + \sigma_i^2)$. Setting $\underline{\psi}_r = \underline{H}_r - \underline{\tau}$ and following a similar procedure as in the fixed effect model, Q_3 can be reduced to its canonical form $(\underline{z} - \underline{b}_r)'\underline{A}^*(\underline{z} - \underline{b}_r)$, where $\underline{A}^* = \underline{K}_r'\underline{N}_r\underline{A}_2\underline{N}_r'\underline{K}_r$ and $\underline{N}_r$ is defined by $\underline{S} = \underline{N}_r'\underline{N}_r$. The elements of $\underline{z}$ are standard normal variates. The distribution of Q_3 can then be obtained easily and is given by

$$P(Q_3 \leq \alpha) = \sum_{j=0}^{\infty} c_j' \chi^2_{k-1+2j}(\alpha/g_3) \qquad (3.2.5)$$

where $c_j' \neq c_j$ and $g_3 \neq g_2$.

The noncentrality parameter λ is then given by

$$\lambda = (\tfrac{1}{2}\underline{b}_r'\underline{b}_r)^{\frac{1}{2}} \qquad \text{or} \qquad \lambda^2 = \tfrac{1}{2}\underline{\tau}'\underline{S}^{-1}\underline{\tau}.$$

To test the hypothesis of equal treatment effect, we proceed as in section 2.6 and the power of the test is given by

$$B(\lambda) = 1 - \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c'_j d_i I_{\phi'} \left(\frac{k-1+2j}{2}, \frac{N-k+2i}{2}\right) \qquad (3.2.6)$$

where $\phi' \neq \phi$.

Four values of σ_t^2, or VA as referred in tables 2.1A, 2.1B and 2.2A) namely 0.0, 0.5, 1.0 and 3.0 will be considered. Notice that when $\sigma_t^2 = 0.0$, the random effect model is reduced to the fixed effect model.

Apart from the heterogeneity of error variances, first-order serial correlation within treatment in the fixed effect model will also be considered, for both balanced and unbalanced layouts.

CHAPTER 4

4. POWER ASPECTS IN THE TWO-WAY LAYOUT

4.1 FIXED EFFECTS MODEL

Sometimes, when testing the k treatments in r blocks in two-way layout, circumstances arise where the variances of the k treatments differ from treatment to treatment. Similarly, when the experimental material, which is homogeneous within block, is not homogeneous between blocks changes in variance may occur from block to block.

For example, in an experiment to compare t treatments and n breeds of cow for milk production on tn cows having similar characteristics like age, weight and lactation stage, in the two-way layout. The variability for each treatment is homogeneous but may differ for different treatments and so do for breeds.

Consider a simple randomized block design with k columns, r rows, one observation per cell and no interaction. We make the usual assumptions that y_{ij}, the observed value from the i^{th} row and the j^{th} column, may be represented by the linear model

$$y_{ij} = \mu + \beta_i + \gamma_j + e_{ij} \qquad (4.1.1)$$

where μ, β_i and γ_j are respectively the grand mean, the row constants and the column constants such that $\Sigma\beta_i = \Sigma\gamma_j = 0$.

And the e_{ij} are the random errors distributed independently about zero mean with common variance σ^2.

Like Box (1954b), we retain the assumptions of independence and equal variances but assume σ_j^2 for the j^{th} column and that correlations within row may exist while the rows remain statistically independent. But unlike Box, we will use the method developed in Chapter 2 which provides greater scope and flexibility than that suggested by him, so long as normality is assumed.

Alternatively, we can denote the model (4.1.1) in matrix notation as

$$\underline{Y} = \underline{\mu} + \underline{\beta}_N + \underline{\gamma}_N + \underline{\varepsilon} \qquad (4.1.2)$$

where $\underline{\beta}_N = \underline{R}\underline{\beta}_r$, $\underline{\gamma}_N = \underline{C}\underline{\gamma}_k$ and $N = rk$; $\underline{R}$ is an $(N\times r)$ design matrix for the rows and $\underline{\beta}_r$ is the corresponding $(r\times 1)$ vector of row constants, and similarly, $\underline{C}$ and $\underline{\gamma}_k$ for the columns. $\underline{Y}$, $\underline{\mu}$ and $\underline{\varepsilon}$ are, as before, $(N\times 1)$ vectors of observations, expected values of $\underline{Y}$ and errors respectively, where $\underline{\varepsilon}$ is distributed as $N(\underline{0},\underline{V})$.

The sums of squares involved in the between-columns and the between-rows tests are

$$Q_3 = r\sum_{j=1}^{k}(\bar{y}_{.j} - \bar{y}_{..})^2 = \underline{Y}'\underline{A}_3\underline{Y} \qquad (4.1.3)$$

$$Q_2 = k \sum_{i=1}^{r} (\bar{y}_{i.} - \bar{y}_{..})^2 = \underline{Y}'\underline{A}_2\underline{Y} \tag{4.1.4}$$

$$Q_1 = \sum_{i=1}^{r} \sum_{j=1}^{k} (y_{ij} - \bar{y}_{i.} - \bar{y}_{.j} + \bar{y}_{..})^2 = \underline{Y}'\underline{A}_1\underline{Y} \tag{4.1.5}$$

where $\underline{A}_3 = (\underline{C}(\underline{C}'\underline{C})^{-1}\underline{C}' - \frac{1}{N}\underline{1}_N\underline{1}_N') = (\frac{1}{r}\underline{C}\underline{C}' - \frac{1}{N}\underline{1}_N\underline{1}_N')$

$\underline{A}_2 = (\underline{R}(\underline{R}'\underline{R})^{-1}\underline{R}' - \frac{1}{N}\underline{1}_N\underline{1}_N') = (\frac{1}{k}\underline{R}\underline{R}' - \frac{1}{N}\underline{1}_N\underline{1}_N')$

and $\underline{A}_1 = (\underline{I}_N - \underline{A}_2 - \underline{A}_3 + \frac{1}{N}\underline{1}_N\underline{1}_N')$

are all symmetric idempotent matrix of quadratic forms. $\underline{I}_N$ and $\underline{1}_N$ are respectively the (NxN) identity matrix and the (Nx1) vector of unity elements.

Consider the distribution of Q_3. Let $\underline{H}_c = \underline{A}_3\underline{Y}$. Then Q_3 can be expressed in terms of $\underline{H}_c$ as

$$Q_3 = \underline{H}_c'\underline{A}_3\underline{H}_c = \underline{Y}'\underline{A}_3\underline{Y}$$

where $\underline{H}_c$ is distributed as $N(\underline{\Upsilon}_N, \underline{V})$. On setting $\underline{\psi}_c = \underline{H}_c - \underline{\Upsilon}_N$, Q_3 becomes

$$Q_3 = (\underline{\psi}_c + \underline{\Upsilon}_N)'\underline{A}_3(\underline{\psi}_c + \underline{\Upsilon}_N)$$

where $\underline{\psi}_c$ is distributed as $N(\underline{0}, \underline{V})$. With the transformations

$$\underline{\psi}_c = \underline{t}'\underline{K}\underline{z} \quad , \quad \text{and} \quad \underline{\Upsilon}_N = -\underline{t}'\underline{K}\underline{b}$$

Q_3 can be reduced to its canonical form $(\underline{z} - \underline{b})'\underline{A}(\underline{z} - \underline{b})$ where $\underline{z}$ is distributed as $N(\underline{0},\underline{I})$; $\underline{A} = \underline{K}'\underline{t}\underline{A}_3\underline{t}'\underline{K}$ is a diagonal matrix with diagonal elements a_i which are also the eigenvalues of $\underline{t}\underline{A}_3\underline{t}'$; $\underline{K}$ is the orthogonal matrix of eignevectors of $\underline{t}\underline{A}_3\underline{t}'$. And $\underline{t}$ is the upper triangular matrix defined by $\underline{V} = \underline{t}'\underline{t}$. Thus Q_3, or the between-columns sum of squares, can be expressed as a non-homogeneous quadratic form. The distribution of Q_3 (see section 2.3) is given by

$$P(Q_3 \leq \alpha) = \sum_{j=0}^{\infty} c_j \chi^2_{f_3+2j}(\alpha/g_3) \qquad (4.1.6)$$

where $f_3 = k-1$ is the rank of $\underline{A}_3$; $g_3=a_1$; $\chi^2_f(.)$ is a chi-square distribution and the c_j satisfy the recursion relationship

$$c_j = (2j)^{-1} \sum_{n=0}^{j-1} h_{j-n}\, c_n \qquad j = 1,2,...$$

$$c_0 = \mathrm{EXP}(-\lambda_c^2) \prod_{i=1}^{f_3} A_i^{-\frac{1}{2}}$$

where $$h_m = \sum_{i=1}^{f_3} (1 - 1/A_i)^m + m \sum_{i=1}^{f_3} (b_i^2/A_i)(1 - 1/A_i)^{m-1}$$

and $A_i = a_i/g_3$. The noncentrality parameter λ_c is given by

$$\lambda_c = (\tfrac{1}{2}\underline{b}'\underline{b})^{\frac{1}{2}} = (\tfrac{1}{2}\Sigma b_i^2)^{\frac{1}{2}} \quad \text{or} \quad \lambda_c^2 = \tfrac{1}{2}\underline{\gamma}_N'\underline{V}^{-1}\underline{\gamma}_N.$$

Similarly, with the help of the transformations

$$\underline{H}_r = \underline{A}_2\underline{Y} , \quad \underline{\psi}_r = \underline{H}_r - \underline{\beta}_N = \underline{t}'\underline{K}_2\underline{z} \text{ and } \underline{\beta}_N = -\underline{t}'\underline{K}_2\underline{b}^*,$$

Q_2 can be reduced to its canonical form $(\underline{z} - \underline{b}^*)'\underline{A}^*(\underline{z} - \underline{b}^*)$ where $\underline{A}^* = \underline{K}_2'\underline{t}\underline{A}_2\underline{t}'\underline{K}_2$ is a diagonal matrix with diagonal elements a_i^* which are also the eigenvalues of $\underline{t}\underline{A}_2\underline{t}'$; $\underline{K}_2$ is the orthogonal matrix of eigenvectors of $\underline{t}\underline{A}_2\underline{t}'$; $\underline{z}$ and $\underline{t}$ are as defined earlier. Again Q_2, or the between-rows sum of squares, can also be expressed as a non-homogeneous quadratic form. The distribution of Q_2 is given by

$$P(Q_2 \leq \alpha) = \sum_{j=0}^{\infty} c_j^* \chi^2_{f_2+2j}(\alpha/g_2) \tag{4.1.7}$$

where $f_2 = r-1$ is the rank of $\underline{A}_2$; $g_2 = a_1^*$ and the c_j^* satisfy the recursion relationship

$$c_j^* = (2j)^{-1} \sum_{n=0}^{j-1} h_{j-n}^* c_n^* \qquad j = 1,2,...$$

$$c_0^* = EXP(-\lambda_r^2) \prod_{i=1}^{f_2} A_i^{*-\frac{1}{2}}$$

where $$h_m^* = \sum_{i=1}^{f_2} (1 - 1/A_i^*)^m + m \sum_{i=1}^{f_2} (b_i^{*2}/A_i^*)(1 - 1/A_i^*)^{m-1}$$

and $A_i^* = a_i^*/g_2$. The noncentrality parameter λ_r is given by

$$\lambda_r = (\tfrac{1}{2}\underline{b}^{*\prime}\underline{b}^*)^{\frac{1}{2}} = (\tfrac{1}{2}\Sigma\, b_i^{*2})^{\frac{1}{2}} \text{ or } \lambda_r^2 = \tfrac{1}{2}\underline{\beta}_N'\underline{V}^{-1}\underline{\beta}_N$$

and likewise, with the transformations

$$\underline{H}_e = \underline{A}_1\underline{Y} = \underline{t}'\underline{K}_1\underline{z}$$

Q_1 can be reduced to its canonical form $\underline{z}'\underline{M}\underline{z}$ where $\underline{M} = \underline{K}_1'\underline{t}\underline{A}_1\underline{t}'\underline{K}_1$ is a diagonal matrix with diagonal elements m_j which are also the eigenvalues of $\underline{t}\underline{A}_1\underline{t}'$; $\underline{K}_1$ is the orthogonal matrix of eigenvectors of $\underline{t}\underline{A}_1\underline{t}'$; $\underline{z}$ and $\underline{t}$ are as defined earlier. Here, the error sum of squares Q_1 can be expressed as a homogeneous quadratic form and the distribution is given by

$$P(Q_1 \leq \alpha) = \sum_{i=0}^{\infty} d_i \chi^2_{f_1+2i}(\alpha/g_1) \qquad (4.1.8)$$

where $f_1 = (k-1)(r-1)$ is the rank of $\underline{A}_1$; $g_1 = \bar{m}_1$ and the d_i satisfy the recursion relationship

$$d_i = (2i)^{-1} \sum_{n=0}^{i-1} H_{i-n}\, d_n \qquad i = 1,2,...$$

$$d_0 = \prod_{j=1}^{f_1} M_j^{-\frac{1}{2}}$$

where $H_s = \sum_{j=1}^{f_1} (1 - 1/M_j)^s$ and $M_j = m_j/g_1$.

The sums of squares Q_1, Q_2 and Q_3 are mutually independent since, by lemma (2.2.3), $\underline{A}_1\underline{A}_2 = \underline{A}_2\underline{A}_3 = \underline{A}_3\underline{A}_1 = \underline{0}$. This condition allows us to carry out both the between-columns and the between-rows tests at the same time in the usual manner even though the assumptions, apart from normality, are not met.

To test the hypothesis of no column effects, we proceed as in section 2.6. The distribution of the test criterion U_c is given by

$$P(U_c = Q_3/Q_1 \leq \alpha) = \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_{\phi_c}(\tfrac{1}{2}f_3+j,\ \tfrac{1}{2}f_1+i) \tag{4.1.9}$$

where $I_\phi(.)$ is a generalised incomplete beta distribution; $\phi_c = \alpha_c/(1+\alpha_c)$ and $\alpha_c = \alpha g_1/g_3$. For a certain chosen level of significance ε, α is given by $\alpha = F_\varepsilon f_3/f_1$. And the power of the test is $B_c(\lambda_c)$,

$$B_c(\lambda_c) = 1 - P(U_c \leq \alpha)$$

$$= 1 - \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_{\phi_c}\left(\frac{k-1+2j}{2}, \frac{(k-1)(r-1)+2i}{2}\right). \tag{4.1.10}$$

Likewise, the power of the corresponding between-rows comparisons is given by $B_r(\lambda_r)$,

$$B_r(\lambda_r) = 1 - \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j^* d_i I_{\phi_r}\left(\frac{r-1+2j}{2}, \frac{(k-1)(r-1)+2i}{2}\right) \qquad (4.1.11)$$

where $\phi_r = \alpha_r/(1+\alpha_r)$, $\alpha_r = \alpha^* g_1/g_2$ and $\alpha^* = F_\varepsilon f_2/f_1$ for given level of significance ε.

4.2 RANDOM EFFECTS MODEL

If we now consider both treatments and blocks are random samples from their respective populations, then the model (4.1.1) becomes a random effects model.

Consider the two-way layout random effects model where the error variances may not equal and errors are not necessarily uncorrelated. We will assume a model similar to that of the fixed effects one, namely,

$$y_{ij} = \mu + \beta_i + \gamma_j + e_{ij} . \qquad (4.2.1)$$

Unlike in the fixed effects model, we assume that β_i, γ_j and e_{ij} are all independent random variables. We further assume that the β_i and the γ_j are normally distributed with zero expectations and variances σ_β^2 and σ_γ^2 respectively.

Employing the same notations as in the fixed effects model, we have

$$\underline{Y} = \underline{\mu} + \underline{\beta}_N + \underline{\gamma}_N + \underline{\varepsilon} . \qquad (4.2.2)$$

The conditions, $\Sigma\beta_i = \Sigma\gamma_j = 0$, concerning the β_i and the γ_j are no longer valid in the random effects model since they are no longer constants but independent random variables.

Owing to the fact that the e_{ij} are independent from both the β_i and the γ_j, the error sum of squares Q_1 is the same in the random effects model as in the fixed effects case. Hence the distribution of the error sum of squares in the random effects model is the same as that given in (4.1.8).

Consider the distribution of the between-columns sum of squares Q_3 in the random effects model. Again, let $\underline{H}_c = \underline{A}_3\underline{Y}$. Then Q_3 can be expressed in terms of $\underline{H}_c$ as

$$Q_3 = \underline{H}_c'\underline{A}_3\underline{H}_c = \underline{Y}'\underline{A}_3\underline{Y}$$

where $\underline{H}_c$ is now distributed as $N(\underline{\gamma}_N, \underline{S})$ and $\underline{S} = (r\sigma_\gamma^2 \underline{I}_N + \underline{V})$.

And $\underline{V}$ is the variance-covariance matrix for the $\underline{\varepsilon}$ which is the same as in the fixed effects model. Setting $\underline{\psi}_c = \underline{H}_c - \underline{\gamma}_N$, Q_3 becomes $(\underline{\psi}_c + \underline{\gamma}_N)'\underline{A}_3(\underline{\psi}_c + \underline{\gamma}_N)$. With the transformations

$$\underline{\psi}_c = \underline{t}'\underline{K}\underline{z} \qquad \text{and} \qquad \underline{\gamma}_N = -\underline{t}'\underline{K}\underline{b}$$

Q_3 can be reduced to its canonical form $(\underline{z} - \underline{b})'\underline{A}(\underline{z} - \underline{b})$ where $\underline{z}$ is the standardised normal variate; $\underline{A} = \underline{K}'\underline{t}\underline{A}_3\underline{t}'\underline{K}$ is a diagonal matrix whose diagonal elements a_i are also the eigenvalues of $\underline{t}\underline{A}_3\underline{t}'$; $\underline{K}$ is the orthogonal matrix of eigenvectors of $\underline{t}\underline{A}_3\underline{t}'$. And $\underline{t}$ is now defined by $\underline{S} = \underline{t}'\underline{t}$. The distribution of the quadratic form Q_3 is then given by

$$P(Q_3 \leq \alpha) = \sum_{j=0}^{\infty} c_j' \chi^2_{k-1+2j}(\alpha/g_3') \qquad (4.2.3)$$

where c_j' and g_3' are different from c_j and g_3 in the fixed effects model since the variance-covariance matrix $\underline{V}$ has changed to $\underline{S}$.

To test the hypothesis of equal treatment effects, we proceed as in section 2.6 and the power of the test is then given by $B_c(\lambda_c)$,

$$B_c(\lambda_c) = 1 - P(U_c = Q_3/Q_1 \leq \alpha)$$

$$= 1 - \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j' d_i I_{\phi_c'} \left(\frac{k-1+2j}{2}, \frac{(k-1)(r-1)+2i}{2}\right)$$

where $\phi_c' \neq \phi_c$.

The distribution of Q_2 and, hence, the power of the test for the hypothesis of equal row effects in the random effects model can be obtained in a similar way.

Like Box (1954b) and Kanji (1976A, 1978), we will consider the effects of unequal column variances and serial correlation within row on the power of the between-column test in the random effects model. In addition, the effects of serial correlation within row on the power of the corresponding between-row test will also be considered.

Only the effects of unequal column variances on the power for the between-column test will be considered in the random effects model for the three values of σ_{γ}^{2} (VA as referred in the table 3.2A), namely 0.5, 1.0 and 3.0.

Notice that when $\sigma_{\gamma}^{2} = 0.0$, or VA = 0.0, the random effects model is reduced to the fixed effects model. And we will refer the fixed effects model by referring VA = 0.0 in random effects model (tables 3.1A, 3.1B and 3.1C).

CHAPTER 5

5. POWER ASPECTS IN ANALYSIS OF COVARIANCE

It sometimes happens that during the carrying out of a carefully designed experiment there is an uncontrollable variable which varies between the runs of the experiment. As well as the individual results, the value of this uncontrollable or concomitant variable is also measured at the time of each run. Before a conventional analysis of variance can be performed, the effect of the concomitant variable, or the covariate, must be removed by a method analogous to the regression analysis. This technique is known as the analysis of covariance.

Consider the simple case of the analysis of covariance with one concomitant variable in, for the general case of, the unbalanaced one-way layout represented by the model

$$y_{ij} = \mu_y + t_i + \gamma(z_{ij} - \mu_z) + e_{ij} \qquad i = 1,2,\ldots,k \quad j = 1,2,\ldots,n_i \tag{5.1}$$

or in matrix notation,

$$\underline{Y} = \underline{\mu}_y + \underline{\tau}_N + (\underline{Z} - \underline{\mu}_z)\underline{\gamma} + \underline{\varepsilon} \tag{5.2}$$

where $\underline{Y}$ and $\underline{Z}$ are (Nx1) vectors of observations and covariate respectively with respective expectations $\underline{\mu}_y$ and $\underline{\mu}_z$; $\underline{\tau}_N = \underline{T}\underline{\tau}_k$ with $\underline{T}$ and $\underline{\tau}_k$ being the (Nxk) design matrix for the treatments and the (kx1) vector of adjusted treatment constants respectively, such that $\Sigma n_i t_i = 0$ or $\underline{1}_N' \underline{\tau}_N = \underline{0}$ and $\underline{1}_N$ is an (Nx1) vector of unity elements; $\underline{\varepsilon}$ is an (Nx1) vector of random errors; $\underline{\gamma}$ is a (1x1) vector of the common regression coefficient of the covariate and $N = \Sigma n_i$.

The usual assumptions associated with the analysis of covariance are that the errors are independently and normally distributed about mean zero with common variance σ^2, and that the γ_i, the regression slope for the group i, are homogeneous. Here we will consider the effects on power when these assumptions are violated in the sense that the error variances are not equal but with error variance σ_i^2 for group i, and that the γ_i are not homogeneous owing to the unequal group variabilities of the covariate.

The least squares estimate of γ is given by

$$\hat{\gamma} = \sum_i\sum_j (z_{ij} - \bar{z}_{..})(y_{ij} - \bar{y}_{..}) / \sum_i\sum_j (z_{ij} - \bar{z}_{..})^2$$

or $$\hat{\underline{\gamma}} = (\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{A}_T\underline{Y}$$

where $\underline{A}_T = (\underline{I}_N - \frac{1}{N}\underline{1}_N\underline{1}'_N)$ is a symmetric idempotent matrix, and $\bar{y}_{..}$ and $\bar{z}_{..}$ are respectively the grand means of the y's and that of the z's.

The sums of squares involved, see Sheffé (1959, pp.199 - 204), are

$$Q_1 = \sum_{ij}\sum(y_{ij} - \bar{y}_{..})^2 - \frac{[\sum_{ij}\sum(y_{ij} - \bar{y}_{..})(z_{ij} - \bar{z}_{..})]^2}{\sum_{ij}\sum (z_{ij} - \bar{z}_{..})^2}$$

$$= \underline{Y}'\underline{A}_T\underline{Y} - \underline{Y}'\underline{A}_T\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{A}_T\underline{Y},$$

$$Q_2 = \sum_{ij}\sum(y_{ij} - y_{i.})^2 - \frac{[\sum_{ij}\sum (y_{ij} - \bar{y}_{i.})(z_{ij} - \bar{z}_{i.})]^2}{\sum_{ij}\sum (z_{ij} - \bar{z}_{i.})^2}$$

$$= \underline{Y}'\underline{A}_E\underline{Y} - \underline{Y}'\underline{A}_E\underline{Z}(\underline{Z}'\underline{A}_E\underline{Z})^{-1}\underline{Z}'\underline{A}_E\underline{Y}$$

and

$$Q_3 = Q_1 - Q_2$$

where Q_1, Q_2 and Q_3 are respectively the adjusted total sum of squares, the adjusted error sum of squares and the adjusted treatment sum of squares; $\bar{y}_{i.}$ and $\bar{z}_{i.}$ are the group means of the y's and that of the z's respectively, and;

$$\underline{A}_E = (\underline{I}_N - \underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}')$$

is a symmetric idempotent matrix. Let

$$Q_1 = \underline{Y}'\underline{A}_1\underline{Y} \quad \text{and} \quad Q_2 = \underline{Y}'\underline{A}_2\underline{Y}$$

where $$\underline{A}_1 = (\underline{A}_T - \underline{A}_T\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{A}_T) \tag{5.3}$$

$$\underline{A}_2 = (\underline{A}_E - \underline{A}_E\underline{Z}(\underline{Z}'\underline{A}_E\underline{Z})^{-1}\underline{Z}'\underline{A}_E) \tag{5.4}$$

then $$Q_3 = \underline{Y}'\underline{A}_3\underline{Y}$$

where $$\underline{A}_3 = (\underline{A}_1 - \underline{A}_2).$$

It can be seen that $\underline{A}_1$ and $\underline{A}_2$ are both symmetric idempotent matrices. In fact, it can be proved that the matrix $\underline{A}_3$ (see Appendix II) is also symmetric and idempotent.

Let $\underline{H} = \underline{A}_3\underline{Y}$. Then Q_3 can be expressed in terms of $\underline{H}$ as

$$Q_3 = \underline{H}'\underline{A}_3\underline{H} = \underline{Y}'\underline{A}_3\underline{Y}$$

where $\underline{H}$ is distributed as $N(\underline{\tau}_N, \underline{V})$. Consider the expectation of $\underline{H}$.

Notice that $E(\underline{H})$ is invariant, under multiplication, to the term $\underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}'$, that is

$$\underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}'E(\underline{H}) = \underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}'\underline{\tau}_N = \underline{\tau}_N = E(\underline{H})$$

or

$$E(\underline{H}) = \underline{\tau}_N = \underline{A}_3 E(\underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}'\underline{Y}) = (\underline{A}_1 - \underline{A}_2)(\underline{\mu}_y + \underline{\tau}_o) \qquad (5.5)$$
$$= \underline{\tau}_o - \underline{A}_t \underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{\tau}_o$$

since $\underline{A}_T(\underline{\mu}_y + \underline{\tau}_o) = \underline{\tau}_o$ and $\underline{A}_E(\underline{\mu}_y + \underline{\tau}_o) = \underline{0}$,

where $\underline{Y}_i = \underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}'\underline{Y}$, $E(\underline{Y}_i) = (\underline{\mu}_y + \underline{\tau}_o)$ and $\underline{\tau}_o$ is the observed or the unadjusted treatment constants,

and $\underline{A}_t = \underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}'\underline{A}_T = (\underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}' - \frac{1}{N}\underline{1}_N\underline{1}_N')$

is also a symmetric idempotent matrix. Now, on setting $\underline{\psi} = \underline{H} - \underline{\tau}_N$, the quadratic form of Q_3 becomes

$$Q_3 = (\underline{\psi} + \underline{\tau}_N)'\underline{A}_3(\underline{\psi} + \underline{\tau}_N)$$

where $\underline{\psi}$ is distributed as $N(\underline{0},\underline{V})$. With the transformations

$$\underline{\psi} = \underline{N}'\underline{K}\underline{x} \qquad \text{and} \qquad \underline{\tau}_N = -\underline{N}'\underline{K}\underline{b}$$

Q_3 can be reduced to its canonical form $(\underline{x} - \underline{b})'\underline{A}(\underline{x} - \underline{b})$ where $\underline{A} = \underline{K}'\underline{N}\underline{A}_3\underline{N}'\underline{K}$ is a diagonal matrix whose diagonal elements a_i are also the eigenvalues of $\underline{N}\underline{A}_3\underline{N}'$; $\underline{K}$ is the orthogonal matrix of eigenvectors of $\underline{N}\underline{A}_3\underline{N}'$ and; $\underline{N}$ is the upper triangular matrix defined by $\underline{V} = \underline{N}'\underline{N}$. Thus the adjusted treatment sum of squares Q_3 can be expressed as a non-homogeneous quadratic form and the distribution (see section 2.3) is given by

$$P(Q_3 \leqslant \alpha) = \sum_{j=0}^{\infty} c_j \chi^2_{f_1+2j}(\alpha/g_3) \qquad (5.6)$$

where $f_1 = k-1$ is the rank of $\underline{A}_3$; $g_3 = a_1$; $\chi^2_f(.)$ is a chi-square distribution and the c_j satisfy the recursion relationship

$$c_j = (2j)^{-1} \sum_{r=0}^{j-1} h_{j-r} \, c_r \qquad j = 1,2,\ldots$$

$$c_0 = \text{EXP}(-\lambda^2) \prod_{i=1}^{f_1} A_i^{-\frac{1}{2}}$$

where $$h_m = \sum_{i=1}^{f_1}(1 - 1/a_i)^m + m\sum_{i=1}^{f_1}(b_i^2/A_i)(1 - 1/A_i)^{m-1}$$

and $A_i = a_i/g_3$. The noncentrality parameter λ is given by

$$\lambda = (\tfrac{1}{2}\underline{b}'\underline{b})^{\frac{1}{2}} = (\tfrac{1}{2}\Sigma b_i^2)^{\frac{1}{2}}$$

where $\underline{b} = \underline{K}'(\underline{N}')^{-1} \underline{\tau}_N$. Alternatively, $\lambda^2 = \frac{1}{2}\underline{b}'\underline{b} = \frac{1}{2}\underline{\tau}_N'\underline{V}^{-1}\underline{\tau}_N$.

If we express λ in terms of the observed treatment constants $\underline{\tau}_0$, then, using (5.5) we have

$$\lambda^2 = \tfrac{1}{2}(\underline{\tau}_0 - \underline{A}_t Z(Z'A_T Z)^{-1}\underline{Z}'\underline{\tau}_0)'\underline{V}^{-1}(\underline{\tau}_0 - \underline{A}_t\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{\tau}_0)$$

$$= \tfrac{1}{2}\underline{\tau}_o'\underline{V}^{-1}\underline{\tau}_o - \tfrac{1}{2}\underline{\tau}_o'\underline{V}^{-1}\underline{A}_t\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{\tau}_o$$

$$= \tfrac{1}{2}\underline{\tau}_o'\underline{V}^{-1}\underline{\tau}_o - \tfrac{1}{2}\underline{t}_o'\underline{V}^{-1}\underline{A}_t\underline{Z}\underline{Z}'\underline{Z}_t\underline{\tau}_o(\underline{Z}'\underline{A}_T\underline{Z})^{-1} \qquad (5.7)$$

$$\text{or } \lambda^2 = \sum_i \left(\frac{n_i t_{oi}^2}{2\sigma_i^2}\right) - \frac{\sum_i (n_i t_{oi}\bar{z}_{i.}) \; \sum_i (n_i t_{oi}\bar{z}_{i.})/\sigma_i^2}{2 \; \sum\sum_{ij} (z_{ij} - \bar{z}_{..})^2} \qquad (5.8)$$

where $\underline{V}$ is diagonal and t_{oi} are the elements of $\underline{\tau}_o$. Notice that when the error variances are equal, the noncentrality parameter given by (5.8) above is the same as that given by Graybill (1961, pp.392).

Similarly, the adjusted error sum of squares Q_2 can be expressed in terms of $\underline{H}_e$ as $\underline{H}_e'\underline{A}_2\underline{H}_e$ where $\underline{H}_e = \underline{A}_2\underline{Y}$ is distributed as $N(\underline{0},\underline{V})$. By the transformation $\underline{H}_e = \underline{N}'\underline{K}_e\underline{x}$, Q_2 is reduced to its canonical form $\underline{x}'\underline{M}\underline{x}$ where $\underline{M} = \underline{K}_e'\underline{N}\underline{A}_2\underline{N}'\underline{K}_e$ is a diagonal matrix whose diagonal elements m_j are also the eigenvalues of $\underline{N}\underline{A}_2\underline{N}'$; $\underline{K}_e$ is the orthogonal matrix of eigenvectors of $\underline{N}\underline{A}_2\underline{N}'$; $\underline{x}$ and $\underline{N}$ are as defined earlier. The distribution of Q_2 is given by

$$P(Q_2 \leq \alpha) = \sum_{i=0}^{\infty} d_i \, \chi^2_{f_2+2i}(\alpha/g_2) \qquad (5.9)$$

where $f_2 = N-k-1$ is the rank of $\underline{A}_2$; $g_2 = m_1$ and the d_i satisfy the recursion relationship

$$d_i = (2i)^{-1} \sum_{r=0}^{i-1} h_{i-r}' \, d_r \qquad i = 1,2,\ldots$$

$$d_0 = \prod_{j=1}^{f_2} M_j^{-\frac{1}{2}}$$

where $h'_s = \sum_{j=1}^{f_2} (1 - 1/M_j)^s$ and $M_j = m_j/g_2$.

It can be proved, by lemma (2.2.3), that the two quadratic forms Q_2 and Q_3 are statistically independent (using the fact that $\underline{A}_3$ is idempotent).

Proceeding as in section 2.6, the distribution of the test criterion U is given by

$$P(U = Q_3/Q_2 \leq \alpha) = \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_\phi (\tfrac{1}{2}f_1 + j, \tfrac{1}{2}f_3 + i)$$

where $I_\phi(.)$ is a generalised incomplete beta distribution; $\phi = \alpha_c/(1+\alpha_c)$, $\alpha_c = \alpha g_2/g_3$, $\alpha = \frac{k-1}{N-k-1} F_\varepsilon$ and ε is the chosen level of significance.

Let P_{II} be the type II error. Then, $P_{II} = P(U \leq \alpha)$ and the power of the test of equal adjusted treatment effects is given by

$$B(\lambda) = 1 - P_{II}$$

$$= 1 - \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_\phi \left(\frac{k-1+2j}{2}, \frac{N-k-1+2i}{2}\right) \qquad (5.10)$$

We will consider the cases where the design is balanced and the group means of the covariate are equal so that $\underline{\tau}_N = \underline{\tau}_o$. Like the divergent mean, we will consider three cases for the covariate, namely,

i) $S_1 = S_2 = \ldots = S_k$, that is the group variabilities of the covariate are homogeneous;

ii) $S_2 = S_3 = \ldots = S_k < S_1$, that is the group variability of the covariate is high in the group with small error variance, and;

iii) $S_1 = S_2 = \ldots = S_{k-1} < S_k$, that is the group variability of the covariate is high in the group with large error variance,

where $S_i = \sum_j (z_{ij} - \bar{z}_{i.})^2/(n_i - 1)$.

Apart from heterogeniety of error variances (tables 4A), like in the one-way layouts, first-order serial correlation within treatment (tables 4B) will also be considered.

6. POWER ASPECTS IN SPLIT-PLOT DESIGN

In many experiments where factorial arrangement is desired, it may not be possible to completely randomise the order of experimentation. There are still many practical situations in which randomisation within blocks is not at all feasible. Under certain conditions, these restrictions will lead to a split-plot design.

For instance, the case described by Cochran and Cox (1957, pp.293-294) in which both factors, types of furnace for the preparation of alloy and types of mould into which alloy might be poured, are to be interested. The natural procedure is to take the material prepared in any furnace, and pour some of it into each mould. That is, material prepared in one furnace at any one time provides a complete replicate for the comparisons among moulds, which is a typical feature of a split-plot design.

Consider a simple split-plot design (see, for example, Kempthorne (1973), pp.370-378) with t whole-plots or main-plots, s sub-plots and r replicates represented by the model

$$y_{ijk} = \mu + \gamma_i + \tau_j + \eta_{ij} + \xi_j + \zeta_{jk} + e_{ijk} \qquad (6.1)$$

where y_{ijk} is the observed value from the k^{th} sub-plot of the j^{th} whole-plot in the i^{th} replicate. In matrix notation we have

$$\underline{Y} = \underline{\mu} + \underline{\gamma} + \underline{\tau} + \underline{\eta} + \underline{\xi} + \underline{\zeta} + \underline{\varepsilon} \tag{6.2}$$

where $\underline{\gamma} = \underline{R}\underline{\gamma}_r$, $\underline{\tau} = \underline{W}\underline{\tau}_t$, $\underline{\xi} = \underline{S}\underline{\xi}_s$ and $\underline{\zeta} = \underline{U}\underline{\zeta}_n$ with $\underline{R}$, $\underline{W}$, $\underline{S}$ and $\underline{U}$ being design matrices for the replicates, whole-plot treatments, sub-plot treatments and the replication whole-plot interaction of dimensionalities (Nxr),(Nxt), (Nxs) and (Nxn) respectively, and $\underline{\gamma}_r$, $\underline{\tau}_t$, $\underline{\xi}_s$ and $\underline{\zeta}_n$ being the replication, the whole-plot treatment, the sub-plot treatment and the replication whole-plot interaction constants of dimensionalities (rx1), (tx1), (sx1) and (nx1) respectively such that $\underline{1}'\underline{\gamma} = \underline{1}'\underline{\xi} = \underline{1}'\underline{\zeta} = \underline{1}'\underline{\tau} = \underline{0}$;

$\underline{Y}$ is an (Nx1) vector of observations with expectation $\underline{\mu}$; $\underline{1}$ is an (Nx1) vector of unity elements; $\underline{\eta}$ and $\underline{\varepsilon}$ are (Nx1) vectors of errors distributed normally and independently of one another, both with expectation $\underline{0}$ and variance-covariance matrices $\underline{V}_w$ and $\underline{V}_s$ respectively, and; N = rts and n = rt.

The usual assumptions concerning the errors in the split-plot design are that the errors are normally distributed and that the error variances are homogeneous, i.e. $\underline{V}_w = \sigma_w^2\underline{I}$ and $\underline{V}_s = \sigma_s^2\underline{I}$ where $\underline{I}$ is an (NxN) identity matrix. Like those in previous chapters, we will consider that the error variances are not equal and that the sub-plot errors ε's are not necessarily uncorrelated while the whole-plot errors η's remain statistically independent, in the fixed effects model.

6.1 FOR WHOLE-PLOT TREATMENT COMPARISONS

The sums of squares involved in the whole-plot treatment comparisons are

$$Q_1 = rs \sum_j (\bar{y}_{.j.} - \bar{y}_{...})^2 = \underline{Y}'\underline{A}_1\underline{Y} \tag{6.1.1}$$

$$Q_2 = s \sum_{ij}\sum (\bar{y}_{ij.} - \bar{y}_{i..} - \bar{y}_{.j.} + \bar{y}_{...})^2 = \underline{Y}'\underline{A}_2\underline{Y} \tag{6.1.2}$$

where $\underline{A}_1 = (\frac{1}{rs}\underline{W}\underline{W}' - \frac{1}{N}\underline{1}\underline{1}')$

$$\underline{A}_2 = (\frac{1}{s}\underline{U}\underline{U}' - \frac{1}{ts}\underline{R}\underline{R}' - \frac{1}{rs}\underline{W}\underline{W}' + \frac{1}{N}\underline{1}\underline{1}')$$

are both summetric indempotent matrix of quadratic forms.

Consider the distribution of Q_1. Let $\underline{H} = \underline{A}_1\underline{Y}$. Then Q_1 can be expressed in terms of $\underline{H}$ as

$$Q_1 = \underline{H}'\underline{A}_1\underline{H} = \underline{Y}'\underline{A}_1\underline{Y}$$

where $\underline{H}$ is distributed as $N(\underline{\tau}, \underline{\Sigma})$ and $\underline{\Sigma} = (\underline{V}_s + s\underline{V}_w)$. On setting $\underline{\psi}_w = \underline{H} - \underline{\tau}$, Q_1 becomes

$$Q_1 = (\underline{\psi}_w + \underline{\tau})'\underline{A}_1 (\underline{\psi}_w + \underline{\tau})$$

where $\underline{\psi}_w$ is distributed as $N(\underline{0},\underline{\Sigma})$. By the transformations

$$\underline{\Psi}_w = \underline{N}'\underline{K}_1\underline{z} \qquad \text{and} \qquad \underline{\tau} = -\underline{N}'\underline{K}_1\underline{b}$$

Q_1 can be reduced to its canonical form $(\underline{z} - \underline{b})'\underline{A}(\underline{z} - \underline{b})$ where $\underline{z}$ is distributed as $N(\underline{0},\underline{I})$; $\underline{A} = \underline{K}_1'\underline{N}\underline{A}_1\underline{N}'\underline{K}_1$ is a diagonal matrix whose elements a_i are also the eigenvalues of $\underline{N}\underline{A}_1\underline{N}'$; $\underline{K}_1$ is the orthogonal matrix of eigenvectors of $\underline{N}\underline{A}_1\underline{N}'$ and $\underline{N}$ is the upper triangular matrix defined by $\underline{\Sigma} = \underline{N}'\underline{N}$. Thus the whole-plot treatment sum of squares Q_1 can be expressed as a non-homogeneous quadratic form. The distribution of Q_1 (see section 2.3) is given by

$$P(Q_1 \leq \alpha) = \sum_{j=0}^{\infty} c_j \chi^2_{f_1+2j}(\alpha/g_1) \qquad (6.1.3)$$

where $f_1 = t-1$ is the rank of $\underline{A}_1$; $g_1 = a_1$; $\chi^2_f(.)$ is a chi-square distribution and the c_j satisfy the recursion relationship

$$c_j = (2j)^{-1} \sum_{k=0}^{j-1} h_{j-k}\, c_k \qquad j = 1,2,\ldots$$

$$c_0 = \mathrm{EXP}\,(-\lambda_w^2) \prod_{i=1}^{f_1} A_i^{-\frac{1}{2}}$$

$$\text{where} \quad h_m = \sum_{i=1}^{f_1}(1 - 1/A_i)^m + m \sum_{i=1}^{f_1}(b_i^2/A_i)(1 - 1/A_i)^{m-1}$$

and $A_i = a_i/g_1$. The noncentrality parameter λ_w is given by

$$\lambda_w = (\tfrac{1}{2}\underline{b}'\underline{b})^{\frac{1}{2}} = (\tfrac{1}{2}\Sigma b_i^2)^{\frac{1}{2}} \quad \text{or} \quad \lambda_w^2 = \tfrac{1}{2}\underline{\tau}'\underline{\Sigma}^{-1}\underline{\tau}.$$

Similarly, with the help of the transformations

$$\underline{H}_e = \underline{A}_2\underline{Y} = \underline{N}'\underline{K}_2\underline{z}$$

Q_2 can be reduced to its canonical form $\underline{z}'\underline{M}\underline{z}$ where $\underline{M} = \underline{K}_2'\underline{N}\underline{A}_2\underline{N}'\underline{K}_2$ is a diagonal matrix whose diagonal elements m_j are also the eigenvalues of $\underline{N}\underline{A}_2\underline{N}'$; $\underline{K}_2$ is the orthogonal matrix of eigenvectors of $\underline{N}\underline{A}_2\underline{N}'$; $\underline{z}$ and $\underline{N}$ are as defined earlier. Here, the whole-plot error sum of squares Q_2 can be expressed as a homogeneous quadratic form and its distribution is given by

$$P(Q_2 \leq \alpha) = \sum_{i=0}^{\infty} d_i \chi^2_{f_2+2i}(\alpha/g_2) \qquad (6.1.4)$$

where $f_2 = (r-1)(t-1)$ is the rank of $\underline{A}_2$; $g_2 = m_1$ and the d_i satisfy the recursion relationship

$$d_i = (2i)^{-1} \sum_{k=0}^{i-1} H_{i-k}\, d_k \qquad i = 1,2,\ldots$$

$$d_0 = \prod_{j=1}^{f_2} M_j^{-\frac{1}{2}}$$

where $H_m = \sum_{j=1}^{f_2} (1 - 1/M_j)^m$ and $M_j = m_j/g_2$.

The sums of squares Q_1 and Q_2 are independent since, by virtue of lemma (2.2.3), they are independent when $\underline{\Sigma} = \sigma^2 \underline{I}$.

To test the hypothesis of no whole-plot treatment effects, we proceed as in section 2.6. The distribution of the test criterion U_w is given by

$$P(U_w = Q_1/Q_2 \leq \alpha) = \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_{\phi_w}(\tfrac{1}{2}f_1 + j, \tfrac{1}{2}f_2 + i) \tag{6.1.5}$$

where $I_\phi(.)$ is a generalised incomplete beta distribution; $\phi_w = \alpha_w/(1+\alpha_w)$ and $\alpha_w = \alpha g_2/g_1$. For a certain chosen level of significance ε, α is given by $\alpha = F_\varepsilon f_1/f_2$. And the power of the test is $B_w(\lambda_w)$,

$$B_w(\lambda_w) = 1 - P(U_w \leq \alpha)$$

$$= 1 - \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i I_{\phi_w}\left(\frac{t-1+2j}{2}, \frac{(t-1)(r-1)+2i}{2}\right). \tag{6.1.6}$$

6.2 FOR SUB-PLOT TREATMENT COMPARISONS

The sums of squares involved in the sub-plot treatment comparisons are

$$Q_3 = rt \sum_{k}(\bar{y}_{..k} - \bar{y}_{...})^2 = \underline{Y}'\underline{A}_3\underline{Y} \qquad (6.2.1)$$

$$Q_4 = \sum\sum\sum_{ijk}(y_{ijk} - \bar{y}_{...})^2 - Q_1 - Q_2 - Q_3 - SS_R - SS_{SxT}$$

$$= \sum\sum\sum_{ijk}(y_{ijk} - \bar{y}_{ij.} - \bar{y}_{.jk} + \bar{y}_{.j.})^2 = \underline{Y}'\underline{A}_4\underline{Y} \qquad (6.2.2)$$

where $\underline{A}_3 = (\frac{1}{rt}\underline{S}\underline{S}' - \frac{1}{N}\underline{1}\underline{1}')$,

and $\underline{A}_4 = (\underline{I} - \frac{1}{s}\underline{U}\underline{U}' - \frac{1}{r}\underline{X}\underline{X}' + \frac{1}{rs}\underline{W}\underline{W}')$;

SS_R and SS_{SxT} are the replication and the whole-plot sub-plot interaction sums of squares respectively; $\underline{X}$ is an (Nxv) design matrix for the whole-plot sub-plot interaction and v = ts.

Following a similar procedure as in section 6.1, Q_3 can be reduced to the canonical form $(\underline{z} - \underline{b}^*)'\underline{A}^*(\underline{z} - \underline{b}^*)$ by the transformations

$$\underline{H}^* = \underline{A}_3\underline{Y} , \quad \underline{\psi}_s = \underline{H}^* - \underline{\xi} = \underline{L}'\underline{K}_3\underline{z} \text{ and } \underline{\xi} = -\underline{L}'\underline{K}_3\underline{b}^*$$

where $\underline{z}$ is distributed as $N(\underline{0},\underline{I})$; $\underline{A}^* = \underline{K}_3'\underline{L}\underline{A}_3\underline{L}'\underline{K}_3$ is a diagonal matrix whose diagonal elements a_i^* are also the eigenvalues of $\underline{L}\underline{A}_3\underline{L}'$; $\underline{K}_3$ is the orthogonal matrix of eigenvectors of $\underline{L}\underline{A}_3\underline{L}'$ and $\underline{L}$ is the upper triangular matrix defined by $\underline{V}_s = \underline{L}'\underline{L}$. Thus the sub-plot treatment sum of squares Q_3 can be expressed as a non-homogeneous quadratic form and the distribution is given by

$$P(Q_3 \leq \alpha) = \sum_{j=0}^{\infty} c_j^* \chi^2_{f_3+2j}(\alpha/g_3) \qquad (6.2.3)$$

where $f_3 = s-1$ is the rank of $\underline{A}_3$; $g_3 = a_1^*$ and the c_j^* satisfy the recursion relationship

$$c_j^* = (2j)^{-1} \sum_{k=0}^{j-1} h_{j-k}^* \; c_k^* \qquad j = 1,2,\ldots$$

$$c_0^* = \mathrm{EXP}(-\lambda_s^2) \prod_{i=1}^{f_3} (A_i^*)^{-\frac{1}{2}}$$

where $h_m^* = \sum_{i=1}^{f_3}(1 - 1/A_i^*)^m + m \sum_{i=1}^{f_3}(b_i^{*2}/A_i^*)(1 - 1/A_i^*)^{m-1}$

and $A_i^* = a_i^*/g_3$. The noncentrality parameter λ_s is given by

$$\lambda_s = (\tfrac{1}{2}\underline{b}^{*\prime}\underline{b}^*)^{\frac{1}{2}} = (\tfrac{1}{2}\Sigma b_i^{*2})^{\frac{1}{2}} \text{ or } \lambda_s^2 = \tfrac{1}{2}\underline{\xi}'\underline{V}_s^{-1}\underline{\xi}.$$

And, likewise, with the help of the transformations

$$\underline{H}_e^* = \underline{A}_4\underline{Y} = \underline{L}'\underline{K}_4\underline{z}$$

Q_4 can be reduced to its canonical form $\underline{z}'\underline{M}^*\underline{z}$ where $\underline{M}^* = \underline{K}_4'\underline{L}\underline{A}_4\underline{L}'\underline{K}_4$ is a diagonal matrix whose diagonal elements m_j^* are also the eigenvalues of $\underline{L}\underline{A}_4\underline{L}'$; $\underline{K}_4$ is the orthogonal matrix of eigenvectors of $\underline{L}\underline{A}_4\underline{L}'$; $\underline{z}$ and $\underline{L}$ are as defined earlier. The sub-plot error sum of squares Q_4 can now be expressed as a homogeneous quadratic form and its distribution is given by

$$P(Q_4 \leq \alpha) = \sum_{i=0}^{\infty} d_i^* \chi^2_{f_4+2i}(\alpha/g_4) \qquad (6.2.4)$$

where $f_4 = (r-1)t(s-1)$ is the rank of $\underline{A}_4$; $g_4 = a_1^*$ and the d_i^* satisfy the recursion relationship

$$d_i^* = (2i)^{-1} \sum_{k=0}^{i-1} H_{i-k}^* \, d_k \qquad i = 1,2,\ldots$$

$$d_0 = \prod_{j=1}^{f_4} (M_j^*)^{-\frac{1}{2}}$$

where $H_m^* = \sum_{j=1}^{f_4} (1 - 1/M_j^*)^m$ and $M_j^* = m_j^*/g_4$.

The sums of squares Q_3 and Q_4 are also independent since, by virtue of lemma (2.2.3), they are independent when $\underline{V}_s = \sigma_s^2\underline{I}$.

To test the hypothesis of no sub-plot treatment effects, we proceed as in section 2.6. The distribution of the test criterion U_s is given by

$$P(U_s = Q_3/Q_4 \leq \alpha) = \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j^* d_i^* I_{\phi_s}(\tfrac{1}{2}f_3+j,\ \tfrac{1}{2}f_4+i) \tag{6.2.5}$$

where $\phi_s = \alpha_s/(1+\alpha_s)$ and $\alpha_s = \alpha g_4/g_3$. For a certain chosen level of significance ε, α is given by $\alpha = F_\varepsilon f_3/f_4$. And the power of the test is $B_s(\lambda_s)$,

$$B_s(\lambda_s) = 1 - P(U_s \leq \alpha)$$

$$= 1 - \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j^* d_i^* I_{\phi_s}\left(\frac{s-1+2j}{2},\ \frac{(r-1)t(s-1)+2i}{2}\right). \tag{6.2.6}$$

We will consider the effects of heterogeneity of the whole-plot error variances and first-order serial correlation of the sub-plots on power for the whole-plot treatment comparisons. Effects of the heterogeneity of the sub-plot error variances and the first-order serial correlation of the sub-plots on power for the sub-plot treatment comparisons will also be considered.

7. COST IN RELATION TO POWER IN THE DESIGN OF EXPERIMENTS

In many experimental situations, especially in the field of agriculture, where results may take years to yield or when cost is one of the major factors concerned, it is essential to design an experiment not only to test a certain null hypothesis for given situation but also to be able to reject that hypothesis when it is false, with maximum probability.

Overall and Dalal (1970) considered power as a criterion in choosing the best experiment, out of all possible experiments for given cost, in the two-way mixed-model. Here we will consider a procedure using power as a criterion to choose, amongst all experiments within a certain cost limit, the one which maximises power relative to cost in situations where the error variances are not homogeneous but the errors remain normally and independently distributed, in the one-way layout fixed effect model.

Let C_{max} be the effective cost ceiling for the experiment and $\underline{C}$ be a (tx1) vector whose elements C_i are the unit cost per observation in the i^{th} treatment. Employing the same notations as in section 3.1, the cost of the experiment represented by the model

$$\underline{Y} = \underline{\mu} + \underline{T}\underline{\tau} + \underline{\varepsilon}.$$

is given by C,

$$C = \underline{n}'\underline{C} \ , \qquad (7.1)$$

subject to the condition

$$C \leq C_{max} \ , \qquad (7.2)$$

where $\underline{n} = \underline{T}'\underline{1}$ is a (tx1) vector of group sizes.

For a nominal level of significance α, the power of the test of equal treatment effects (see section 3.1 for details), is given by $B(\lambda)$. In particular, when $\lambda = 0$, $B(0)$ gives the actual probability of committing a type I error, which may be different from α in the presence of heterogeneity of error variances.

Let us define the power index, PI,

$$PI = \frac{B(\lambda) - B(0)}{B(0)} \qquad 0 \leqslant PI < \infty \ , \qquad (7.3)$$

as a measure of the relative gain in power and the cost index, CI,

$$CI = \frac{PI}{C/N} \qquad (7.4)$$

as an indication of the value of a particular design $\underline{T}$ of size N, $N = \Sigma n_i$, where C/N is the average cost per observation. The object is to find, for all possible design $\underline{T}$ and all values of N subject to (7.2), a particular design $\underline{T}$, $\underline{T}_{max}$ say, which maximises CI, provided that the actual level of significance is not seriously affected.

Two illustrative examples can be found in tables 6.1 and 6.2 for homogeneity and heterogeneity of error variances respectively. The minimum group size is 3.

CHAPTER 8

8. RESULTS AND CONCLUSIONS

In this concluding chapter, only results corresponding to the 5% nominal level of significance are quoted, since results corresponding to the 1% level are similar to those for the 5% ones.

Table 7.1 indicates the accuracy of the results for equal error variances obtained by the present method compared with those obtained using Tang's (1938) method.

Table 7.2 shows the effects of heterogeneity of error variances under different choices of g, the arbituary scale parameter in the Ruben's (1962) theorems, on power. It can be seen that the choice of g, except for $g = a_n$, has little effects on the ratio of two independent χ^2 variates. In addition, our choice of $g = a_1$ guarantees the expressions (2.3.2) and (2.3.3) to be mixture representations.

One feature which is common in all analyses is that the power of the test is greater when the divergent mean falls in the group with large variance than when it falls in the group with small variance. This contradicts with Horsnell's (1953) finding.

8.1 POWER OF THE TEST IN GENERAL LINEAR MODEL

Effects of heterogeneity of error variances on power in the general linear model are shown in Table 1A and figures 1.1 to 1.2. It is seen that the power value is seriously affected when normally and independently distributed error variables have unequal error variances. But for moderate heterogeneity of error variances, the actual type I error, B(0), is not seriously affected. Furthermore, wherever error variances are unequal, the power value is greater than for equal error variances.

Effects of first-order serial correlation on power are shown in table 1A and figure 1.4. It is seen that the power value is greatly affected when the normally distributed error variables are serially correlated. But for moderate serial correlations, the actual type I error is not seriously affected.

8.2 POWER OF THE TEST IN THE ONE-WAY LAYOUT

Effects of unequal group error variances on power in the one-way layout fixed effect model are shown in table 2.1A and figures 2.1.1 to 2.1.6. It is seen that, in general, the power value is seriously affected by the heterogeneity of group error variances.

Figures 2.1.7 and 2.1.8 indicate that the power value is also seriously affected by the group sizes. Wherever large samples are taken from the group with large variance, the power value is lower than for equal groups and the actual type I error is not seriously affected.

Effects of first-order within-treatment serial correlation on power are shown in table 2.1B and figures 2.1.10 to 2.1.12. It is seen that the power value is seriously affected when the error variables are serially correlated within treatments. Under these circumstances, one large group is preferred to equal groups.

Effects of heterogeneity of group error variances on power in the random effect model are shown in table 2.2A and figures 2.2.1 to 2.2.6. It can be seen that the power value becomes less affected by the heterogeneity of group error variances, as the value of σ_t^2, or VA, increases but the difference between actual and nominal level of significance increases as well.

Figures 2.2.7 shows the extent to which power of the test of equal group means is affected by the value of σ_t^2 in the random effect model when all assumptions hold. It can be seen that the power value is seriously affected by σ_t^2 even at low values.

The results of Carter et al for the univariate case can be obtained as a special case in the fixed effect model.

8.3 POWER OF THE TEST IN THE TWO-WAY LAYOUT

Effects of unequal column error variances on power in the two-way layout fixed effects model are shown in table 3.1A and figure 3.1.1. It can be seen that the power value is seriously affected by heterogeneity of column error variances, but the actual type I error is not seriously affected. Whenever column error variances are unequal, the power value is greater than for equal column error variances.

Effects of first-order within-row serial correlation on power for the between-columns comparisons in the fixed effects model are shown in table 3.1B and figure 3.1.3. It can be seen that the power value is little affected when the errors within rows are serially correlated. In contrast, table 3.1C and figure 3.1.4 indicate that the power value for the corresponding between-rows comparisons is highly seriously affected by the within-row serial correlation.

Effects of unequal column error variances on power for the between-columns comparisons in the random effects model are shown in table 3.2A and figures 3.2.1 to 3.2.3. It can be seen that the power value becomes more seriously affected by heterogeneity of column error variances in the random effects model. The actual type I error is the worst affected.

Figure 3.2.4 shows the extent to which power of the test of equal column means is affected by the value of σ^2_γ, or VA, in the random effects model when all assumptions hold. It can be seen that the power value is seriously affected by σ^2_γ even at low values.

8.4 POWER OF THE TEST IN ANALYSIS OF COVARIANCE

Effects of unequal group error variances on power in the balanced one-way layout analysis of covariance with one concomitant variable are shown in table 4A and figures 4.1 to 4.3. Also, effects of within-treatment serial correlation on power are shown in table 4B and figure 4.6. It can be seen that, in general, the effects on power due to heterogeneity of group error variances and that due to within-treatment serial correlation are very much the same as those in the corresponding one-way layout analysis of variance for equal groups.

Effects of unequal group variabilities of the covariate on power are shown in figure 4.4. It is seen that the power value is little affected by heterogeneity of group variability of the covariate. And, when the group error variances are equal, the power value is not affected at all.

8.5 POWER OF THE TEST IN SPLIT-PLOT DESIGN

Effects of unequal whole-plot error variances on power of the test of equal whole-plot treatment means are shown in table 5.1A and figures 5.1.1 to 5.1.2. It is seen that the power value is seriously affected by the heterogeneity of whole-plot error variances, but the actual type I error is little affected. Wherever the whole-plot error variances are unequal, the power value is greater than for equal whole-plot error variances. It can also be noted that the power of the test of equal whole-plot treatment means is reduced slightly as the sub-plot error variances increase, in the presence of heterogeneity of whole-plot error variances.

Effects of first-order within-wholeplot serial correlation on power of the test of equal whole-plot treatment means are shown in table 5.1B. It is seen that the power value is little affected when the errors are serially correlated within sub-plots in the whole-plot treatment comparisons.

Effects of unequal sub-plot error variances on power of the test of equal sub-plot treatment means are shown in table 5.2A and figure 5.2.1. It can be seen that the power value is seriously affected by the heterogeneity of sub-plot error variances, but the actual type I error is little affected.

Effects of first-order within-wholeplot serial correlation on power of the test of equal sub-plot treatment means are shown in table 5.2B and figure 5.2.3. It can be seen that the power value is not seriously affected when the errors are serially correlated within whole-plots in the sub-plot treatment comparisons.

8.6 COST IN RELATION TO POWER IN THE DESIGN OF EXPERIMENTS

Illustrative examples of the use of power as a criterion in the design of experiments in the one-way layouts for a fixed cost ceiling of 19.0 cost units are given in table 6.1 for homogeneous group error variances, and in table 6.2 for heterogeneous group error variances.

For homogeneous group error variances, the power index PI is maximised when $\underline{n}' = (3\ 4\ 8)$ and when $\underline{n}' = (3\ 5\ 7)$, both giving a value of PI = 18.939. If the cost vector $\underline{C}$ is taken into account, $\underline{C}' = (2.0\ 1.2\ 1.0)$, the cost index CI is maximised when $\underline{n}' = (3\ 3\ 9)$.

For heterogeneous group error variances ($V = 1:2:3$), PI and CI are both maximised when $\underline{n}' = (3\ 3\ 9)$, giving an actual type I error of $B(0) = 0.03120$. Still, the choices remain open but the choice of $\underline{n}' = (3\ 3\ 9)$ gives the best return per unit cost in terms of power, or the relative gain in power.

CHAPTER 9

9. DISCUSSION

The method suggested by Tang (1938) for the calculation of the type II error P_{II} when all assumptions hold, is valid only for even degrees of freedom. When f_2, the error degrees of freedom, is odd and f_2 is greater than 5, Tang remarks that P_{II} can be obtained with sufficient accuracy from the tabled values for even f_2 by interpolation. However, no remark concerning the calculation of P_{II} is given when f_1 is odd. Alternative method for the calculation of P_{II} is given by (2.6.2), or (2.6.3) for the power values, which is valid for both even as well as odd degrees of freedom. In this case, the calculation is much simpler since the coefficients in (2.6.2) are Poisson probabilities given by (3.4 3) of Ruben (1962, pp.555). Kanji's (1978) method can also be used in this particular case.

The significance of the arbitrary scale parameter g in the fundamental expansion of the distribution of quadratic forms is discussed in detail by Ruben (1962, pp.562-569). He remarks that $g = a_1$ overestimate while $g = a_n$ underestimate the probability content of the n-dimensional ellipsoid $H_{n;\underline{A},\underline{b}}(\alpha)$, or P_{II} in our context, when approximated by the probability content of an n-dimensional sphere of radii $(\alpha/g)^{\frac{1}{2}}$. He remarks further that when $g = a_g$, the geometric mean of the a_i, the volume-content of the sphere is equivalent to that of the ellipsoid. However, in the expansion of the distribution of the ratio of two independent quadratic forms, table 7.2 shows that when $g = a_1$, $g = a_g$ or $g = a_h$, the harmonic mean of the a_i, the power value thus yielded are the same, but $g = a_n$ yields higher power value, or lower P_{II} value, when the heterogeneity of error variances is beyond that of V = 1 : 1.2 : 1.4. And, furthermore, the choice of $g = a_1$ guarantees mixture representations.

In the analysis of covariance model, we have made no postulate about the nature of the covariate $\underline{Z}$, whether $\underline{Z}$ are fixed values or random variables. Huitema (1980, pp. 110 - 115) has given full discussion in this respect. Due to the nature of the technique used, it is not possible to investigate the effects of departure from the assumption of homogeneity of regression slopes. Three cases that we have considered are merely to specify different fixed quantities for the covariate of each group and the word 'variability' has been used descriptively. Further, the order of these covariate values of each group has no effect on test of homogeneity of treatment means.

Due to various practical problems, all analyses are confined to a total size of 18. This may present ambiguity in the interpretation of the result of no-effect of sub-plot serial correlation on the whole-plot treatment comparisons in the analysis of split-plot design since only 2 subplots have been used. Further analyses have been carried out with 3 subplots. The result shows that sub-plot serial correlation has, indeed, little effect on the whole-plot treatment comparisons.

The results in table 6.1 and 6.2 are obtained using the fact that the eigenvalues of the distribution of error sum of squares are the error variances themselves (see Box (1954a)). The result given by $\underline{n}'=$ (3 3 9) in table 6.1 and 6.2 are the same as those given in table 2.1A. In future, whenever the eigenvalues of the distribution of error sum of squares are known, they can be used directly in the calculation of the d_i coefficients.

The author suggests the following areas for further research:

1) Effects on power when the assumption of additivity of the model is violated.

2) Effects on power when the assumption of homogeneity of regression slopes is violated in the mixed model.

3) Robustness of power in other non-orthogonal designs.

4) Robustness of power in the multivariate analysis of variance and covariance.

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APPENDIX I

DISTRIBUTION OF THE RATIO OF TWO QUADRATIC FORMS WITH ARBITUARY CONSTANTS.

From equation (2.3.2) we have

$$P(Q_2 \leq \alpha) = \sum_{j=0}^{\infty} c_j \, \chi^2_{f_1+2j}(\alpha/g_2)$$

or
$$P(Q_2/g_2 \leq \alpha) = \sum_{j=0}^{\infty} c_j \, \chi^2_{f_1+2j}(\alpha) \qquad (1)$$

where g_2 is an arbitrary constant. The condition that $g_2 < 2a_1$ guarantees the convergence of the c_j where we assume $a_1 \leq a_2 \leq \dots \leq a_n$ without loss of generality. And similarly, from equation (2.3.3), we have

$$P(Q_1/g_1 \leq \alpha) = \sum_{i=0}^{\infty} d_i \, \chi^2_{f_2+2i}(\alpha) \qquad (2)$$

Let $q_1 = Q_1/g_1$ and $q_2 = Q_2/g_2$, then the ratio of q_2 to q_1 is distributed as

$$P(q_2/q_1 \leq \alpha) = P\left(\frac{Q_2/g_2}{Q_1/g_1} \leq \alpha\right)$$

$$= P(Q_2/Q_1 \leq \alpha g_2/g_1)$$

$$= P(Q_2 \leq \alpha_d Q_1) \quad \text{where } \alpha_d = \alpha g_2/g_1$$

$$= \int_0^{\infty} P(Q_2 \leq \alpha_d Q_1) \, f(Q_1) \, dQ_1 \qquad (3)$$

where $f(Q_1)$ is the probability density function of Q_1.
Hence

$$P(q_2/q_1 \leq \alpha) = \int_0^\infty \sum_{j=0}^\infty c_j \chi^2_{f_1+2j}(\alpha_d Q_1 | Q_1) \sum_{i=0}^\infty d_i \frac{e^{-\frac{1}{2}Q_1} Q_1^{\frac{1}{2}(f_2)+i}}{2^{\frac{f_2}{2}+2i}\Gamma(\frac{1}{2}f_2+i)} dQ_1.$$

Since the two series are uniformly convergent on every finite interval of α, we have,

$$P(Q_2/Q_1 \leq \alpha_d) = \sum_{j=0}^\infty \sum_{i=0}^\infty c_j d_i \int_0^\infty \frac{\chi^2_{f_1+2j}(\alpha_d Q_1 | Q_1)}{2^{\frac{f_2}{2}+2i}\Gamma(\frac{1}{2}f_2+i)} e^{-\frac{1}{2}Q_1} Q_1^{\frac{1}{2}f_2+i} dQ_1$$

$$= \sum_{j=0}^\infty \sum_{i=0}^\infty c_j d_i \int_0^\infty h_{f_1+2j,\ f_2+2i}(U = Q_2/Q_1) \quad (4)$$

where $h_{\nu 1, \nu 2}(U)$ denotes the probability distribution function of the ratio of two independent chi-square variates (central) with $\nu 1$ and $\nu 2$ degrees of freedom in the numerator and denominator respectively.

Consider $P(U = u_1/u_2 \leq \alpha)$, where u_1 and u_2 are two independent χ^2 (central) variates with $\nu 1$ and $\nu 2$ degrees of freedom respectively. Then,

$$P(U \leq \alpha) = \int_0^\alpha h\nu_1,\nu_2\ (U)\ dU$$

as just defined. But,

$$P(U \leq \alpha) = P\left(\frac{u_1/\nu_1}{u_2/\nu_2} \leq \frac{\nu_2}{\nu_1}\alpha\right) = F_{\nu_1,\nu_2}\left(\frac{\nu_2}{\nu_1}\alpha\right)$$

where $F_{\nu1,\nu2}(.)$ denotes the cumulative distribution of Fisher's variance ratio (central F).

Hence, returning to equation (4), we have,

$$P(U = Q_2/Q_1 \leq \alpha_d) = \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i F_{f_1+2j,\, f_2+2i}\left(\frac{f_2+2i}{f_1+2j}\alpha\right)$$

or $$P(Q_2/Q_1 \leq \alpha) = \sum_{j=0}^{\infty} \sum_{i=0}^{\infty} c_j d_i F_{f_1+2j,\, f_2+2i}\left(\frac{f_2+2i}{f_1+2j}\alpha_c\right)$$

where $\alpha_c = \alpha g_1/g_2$.

APPENDIX II

IDEMPOTENCE OF THE MATRIX ($\underline{A}_3$) IN ANOCOV

If the matrix $\underline{A}_3$ is idempotent, we have

$$\underline{A}_3\underline{A}_3 = \underline{A}_3.$$

Proof:

$$\text{L.H.S.} = \underline{A}_3\underline{A}_3 = (\underline{A}_1 - \underline{A}_2)(\underline{A}_1 - \underline{A}_2)$$

$$= \underline{A}_1 + \underline{A}_2 - 2\underline{A}_1\underline{A}_2,$$

since $\underline{A}_1$ and $\underline{A}_2$ are both idempotent. Consider the product $\underline{A}_1\underline{A}_2$.

$$\underline{A}_1\underline{A}_2 = (\underline{A}_T - \underline{A}_T\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{A}_T)(\underline{A}_E - \underline{A}_E\underline{Z}(\underline{Z}'\underline{A}_E\underline{Z})^{-1}\underline{Z}'\underline{A}_E)$$

$$= \underline{A}_T\underline{A}_E - \underline{A}_T\underline{A}_E\underline{Z}(\underline{Z}'\underline{A}_E\underline{Z})^{-1}\underline{Z}'\underline{A}_E - \underline{A}_T\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{A}_T\underline{A}_E$$

$$+ \underline{A}_T\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{A}_T\underline{A}_E\underline{Z}(\underline{Z}'\underline{A}_E\underline{Z})^{-1}\underline{Z}'\underline{A}_E.$$

Now consider the product $\underline{A}_T\underline{A}_E$.

$$\underline{A}_T\underline{A}_E = (\underline{I}_N - \frac{1}{N}\underline{1}_N\underline{1}_N')(\underline{I}_N - \underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}')$$

$$= \underline{I}_N - \frac{1}{N}\underline{1}_N\underline{1}_N' - \underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}' + \frac{1}{N}\underline{1}_N\underline{1}_N'\underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}'$$

$$= \underline{I}_N - \frac{1}{N}\underline{1}_N\underline{1}_N' - \underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}' + \frac{1}{N}\underline{1}_N\underline{1}_k'\underline{T}'$$

$$= \underline{I}_N - \underline{T}(\underline{T}'\underline{T})^{-1}\underline{T}' = \underline{A}_E.$$

Therefore,

$$\underline{A}_1\underline{A}_2 = \underline{A}_E - \underline{A}_E\underline{Z}(\underline{Z}'\underline{A}_E\underline{Z})^{-1}\underline{Z}'\underline{A}_E - \underline{A}_T\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{A}_E$$

$$+ \underline{A}_T\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{A}_E\underline{Z}(\underline{Z}'\underline{A}_E\underline{Z})^{-1}\underline{Z}'\underline{A}_E$$

$$= \underline{A}_2 - \underline{A}_T\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{A}_E + \underline{A}_T\underline{Z}(\underline{Z}'\underline{A}_T\underline{Z})^{-1}\underline{Z}'\underline{A}_E = \underline{A}_2.$$

Hence,

$$\text{L.H.S.} = \underline{A}_3\underline{A}_3 = \underline{A}_1 + \underline{A}_2 - 2\underline{A}_1\underline{A}_2$$

$$= \underline{A}_1 + \underline{A}_2 - 2\underline{A}_2 = \underline{A}_3 = \text{R.H.S.}$$

and the idempotence of $\underline{A}_3$ is proved.

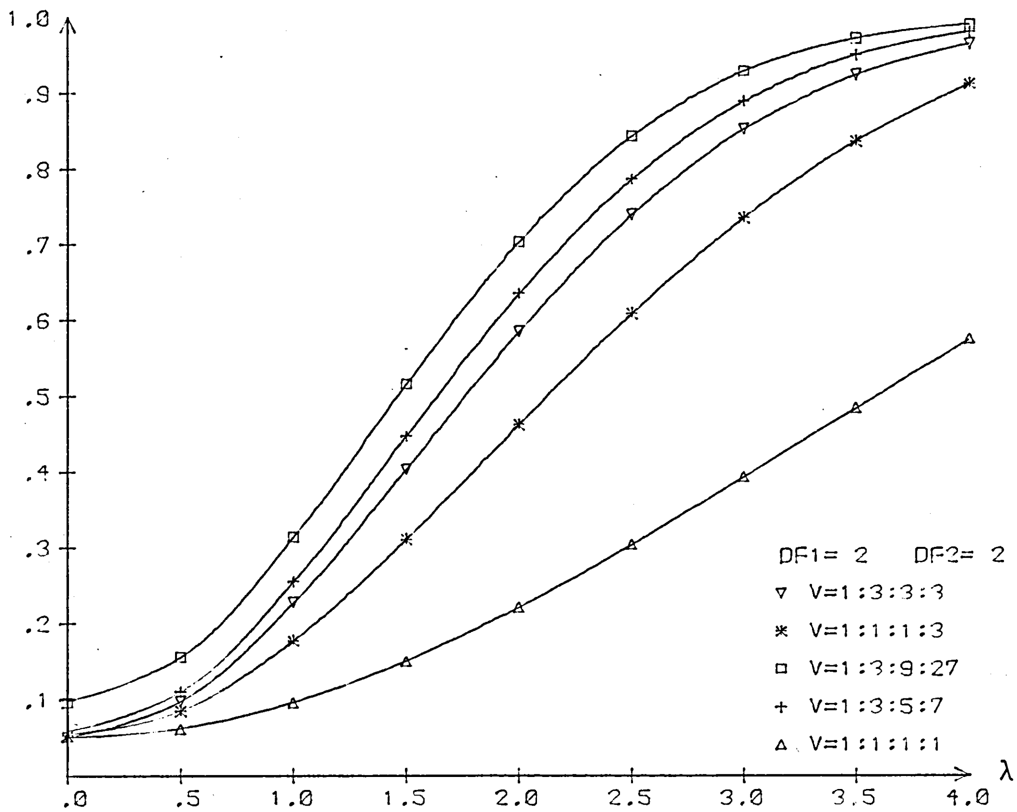

FIG. 1.1 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

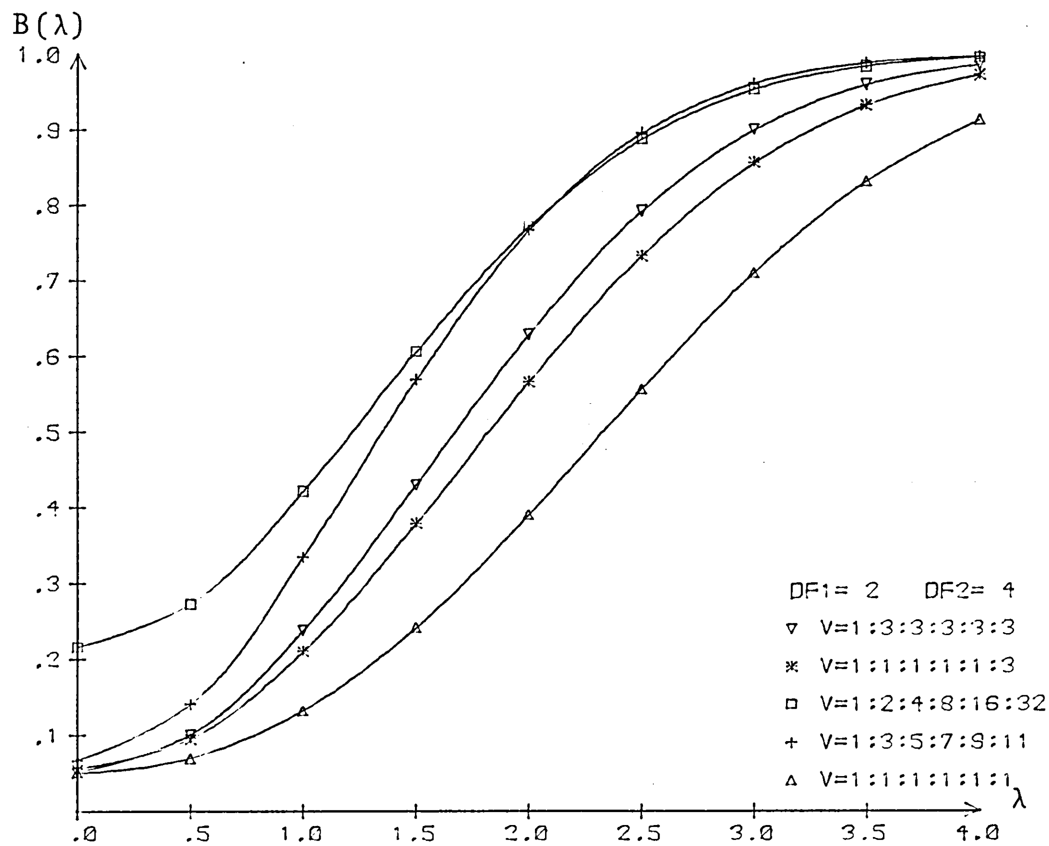

FIG. 1.2 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

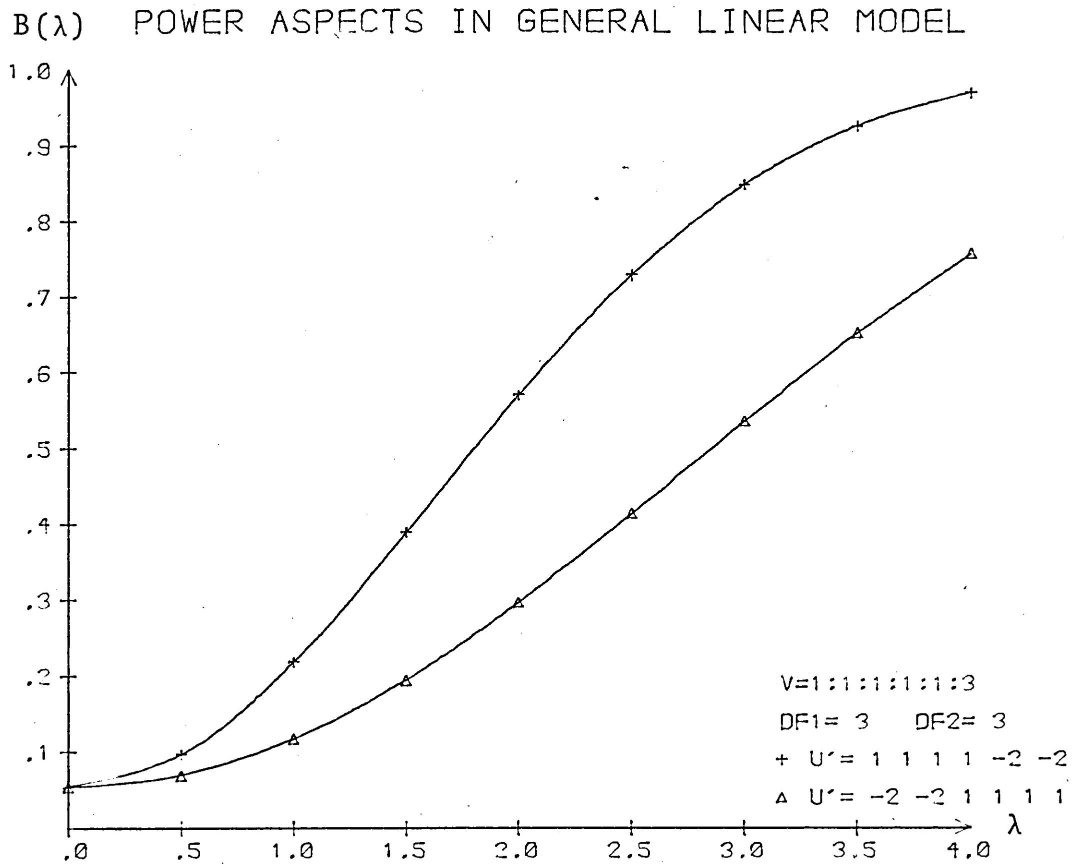

FIG. 1.3 EFFECTS OF GROUP CONTAINING DIVERGENT MEAN ON POWER.

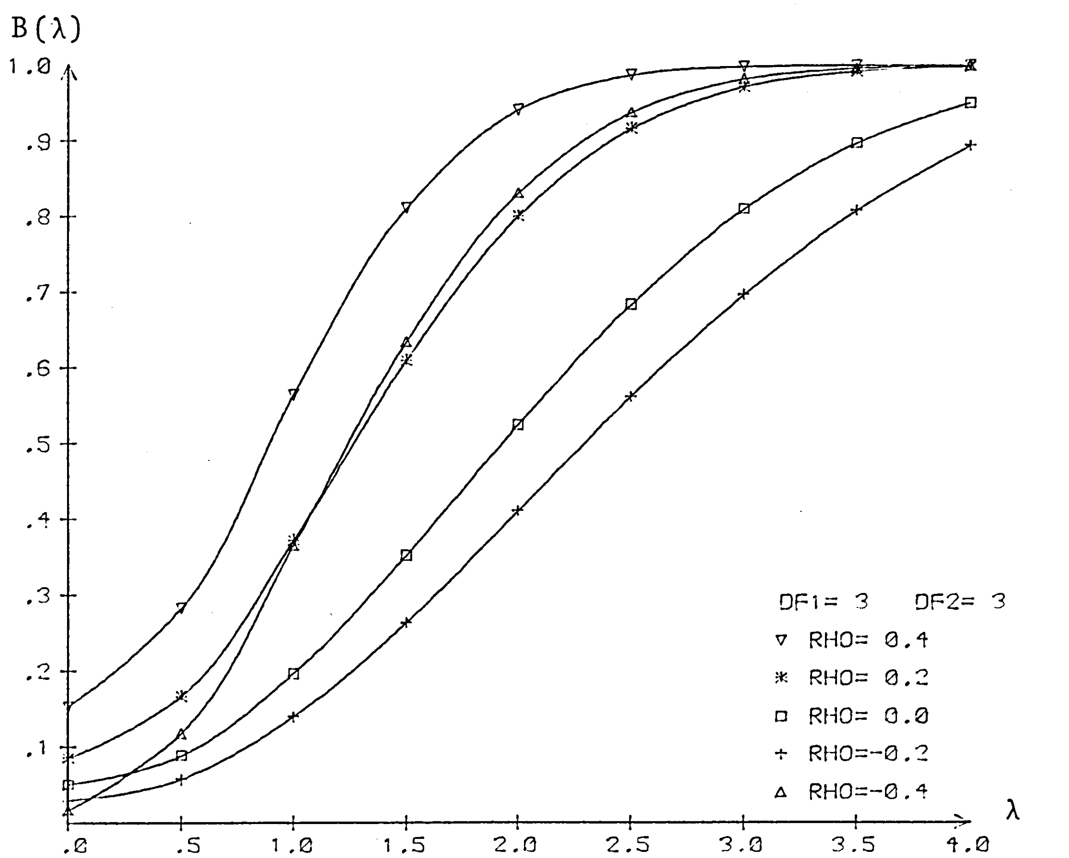

FIG. 1.4 EFFECTS OF SERIAL CORRELATION ON POWER.

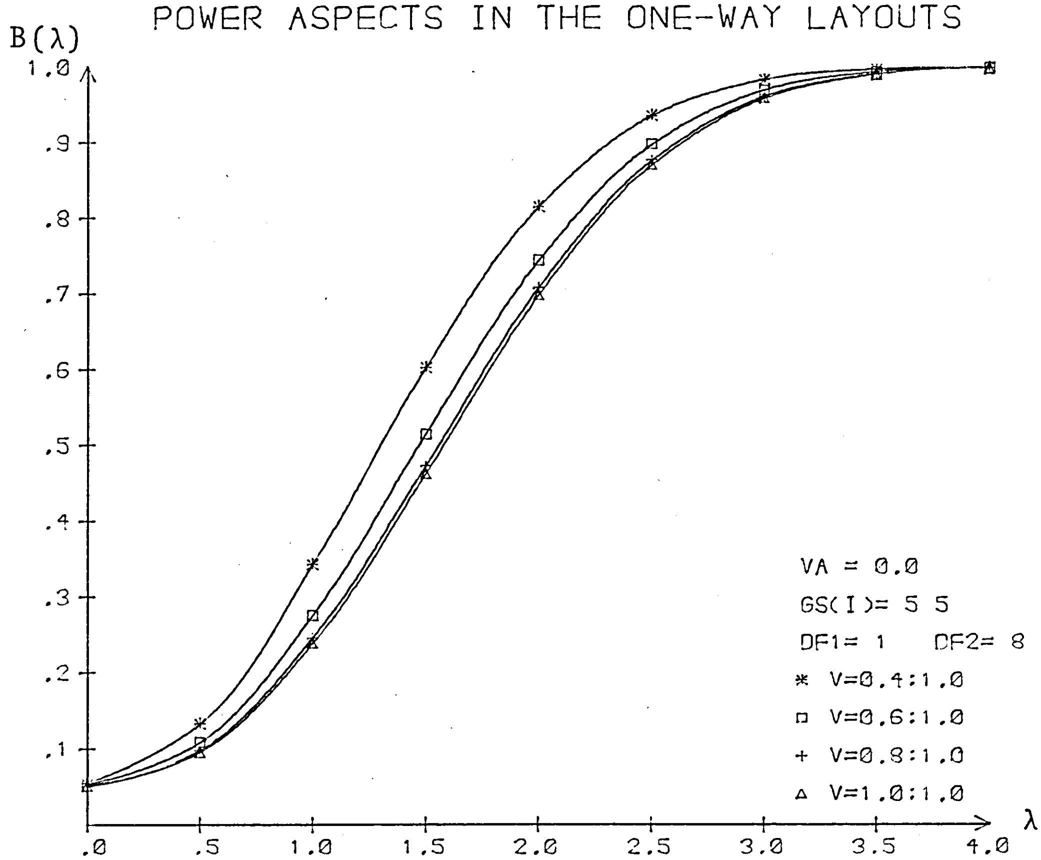

FIG. 2.1.1 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

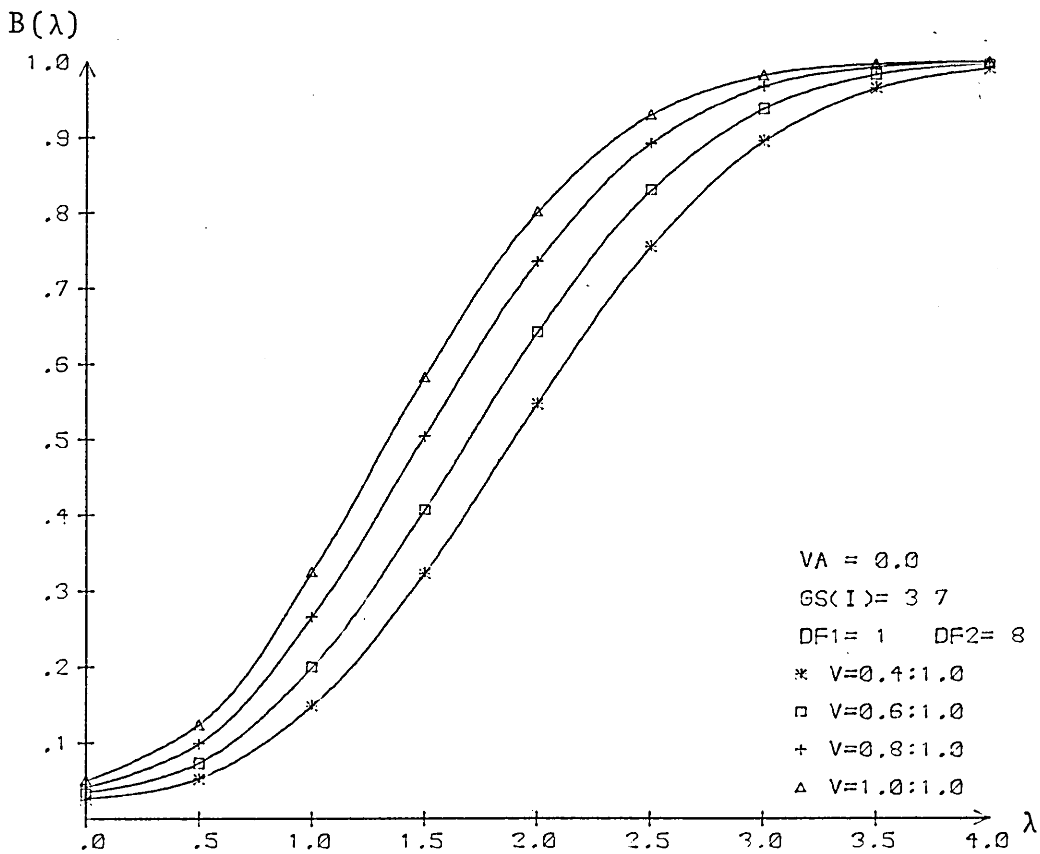

FIG. 2.1.2 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

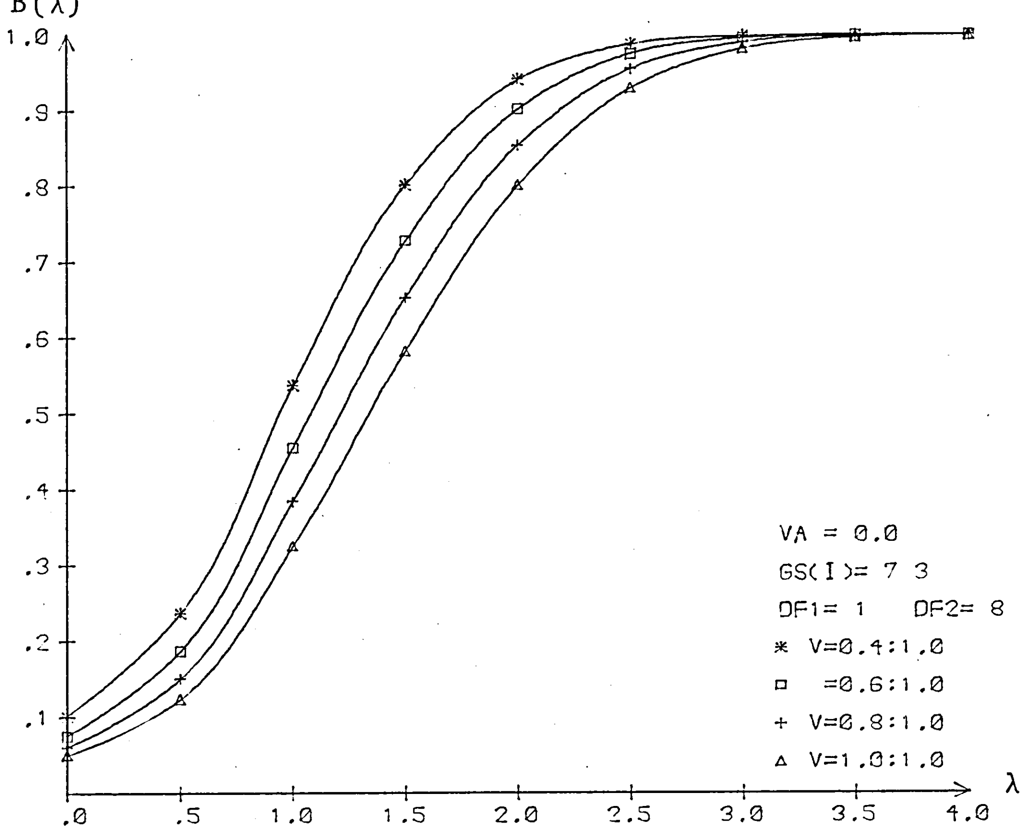

FIG. 2.1.3 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

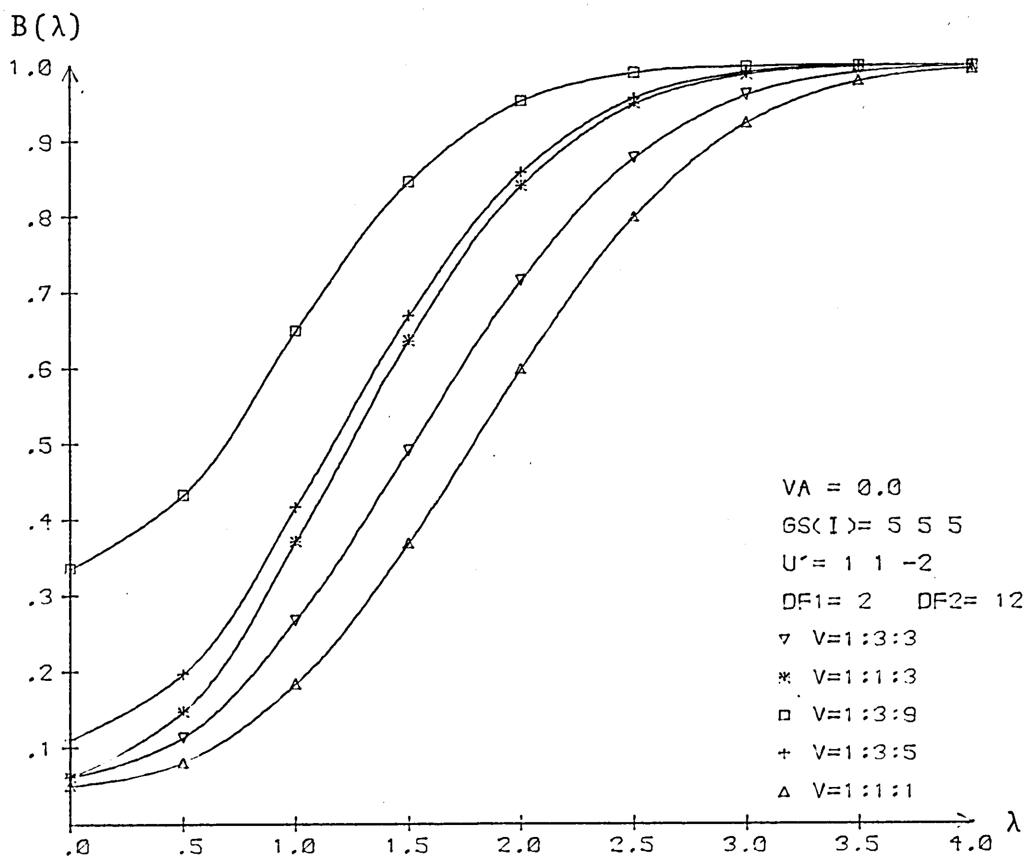

FIG. 2.1.4 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

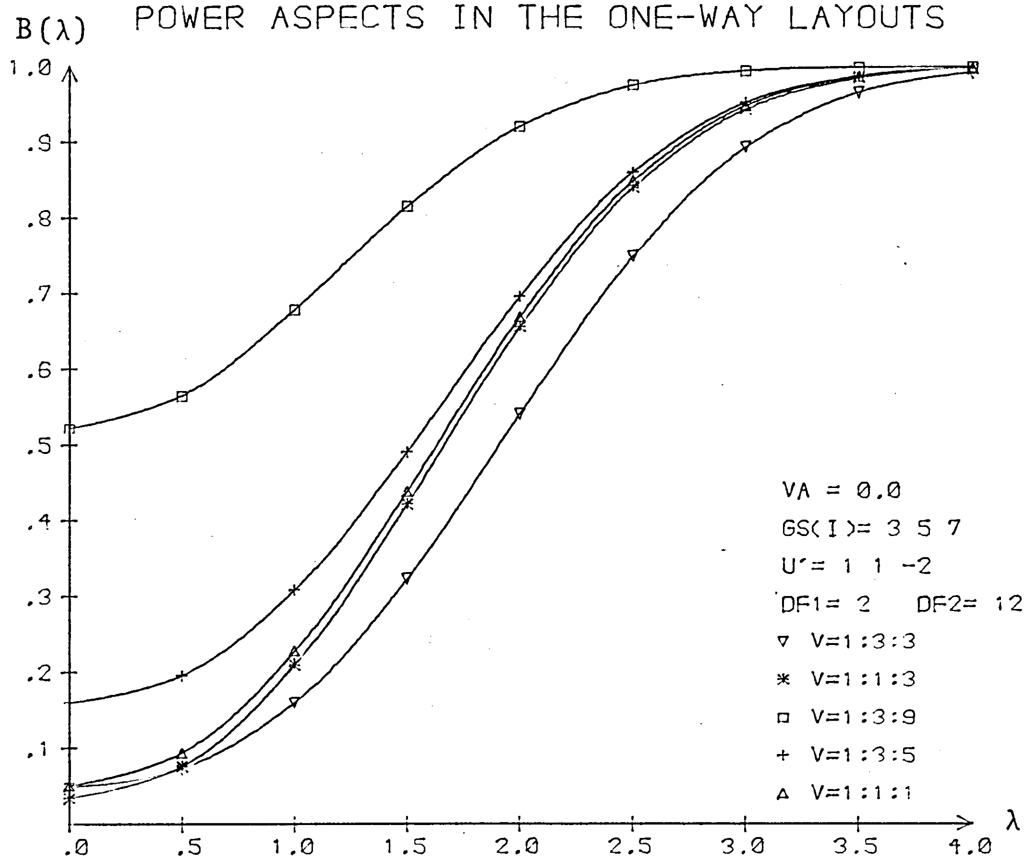

FIG. 2.1.5 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

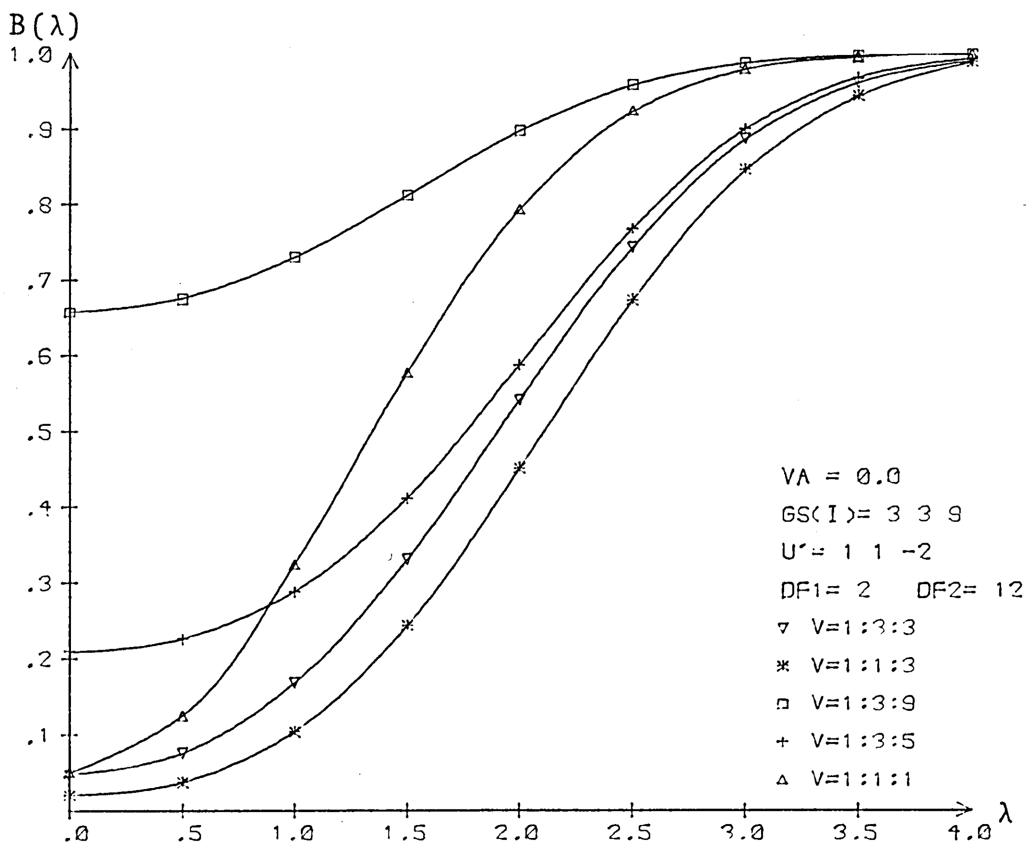

FIG. 2.1.6 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

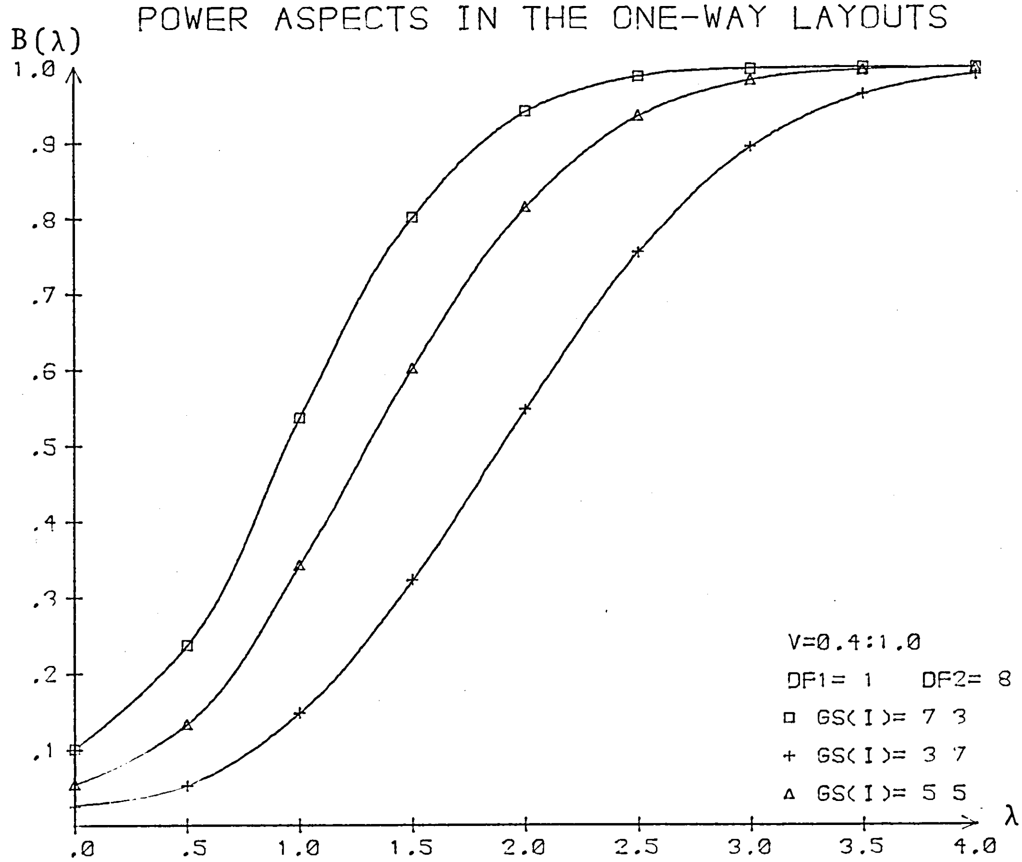

FIG. 2.1.7 EFFECTS OF GROUP SIZES ON POWER.

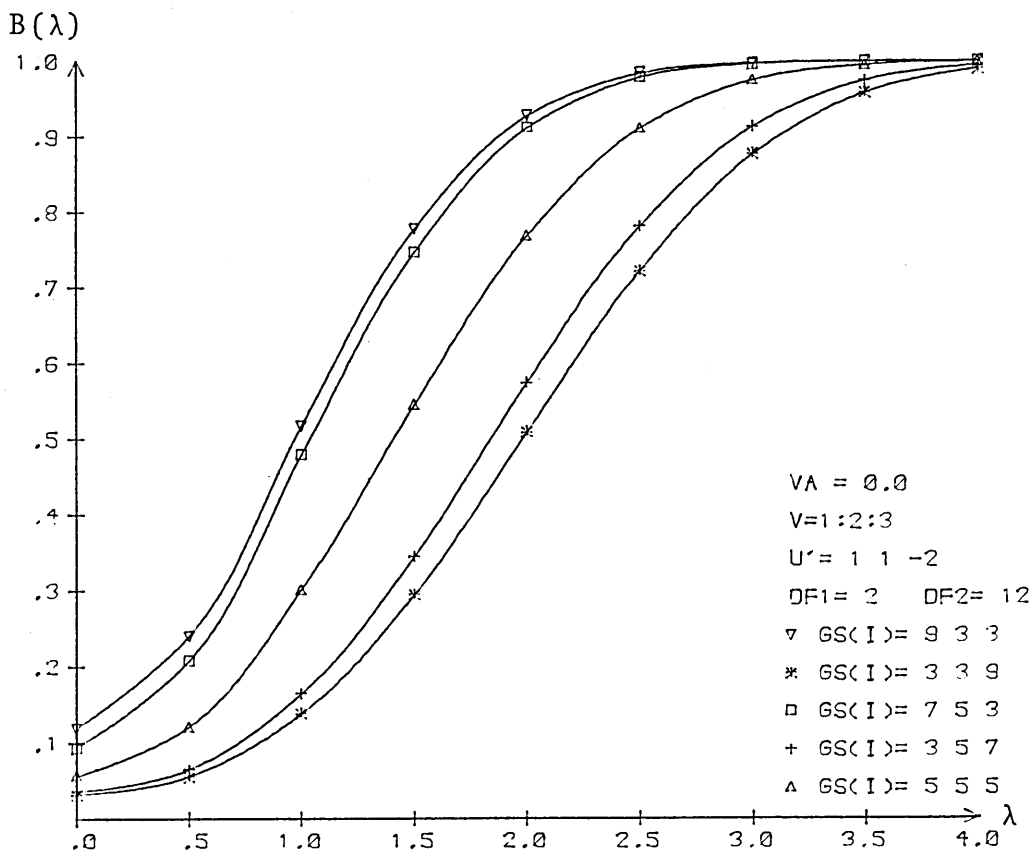

FIG. 2.1.8 EFFECTS OF GROUP SIZES ON POWER.

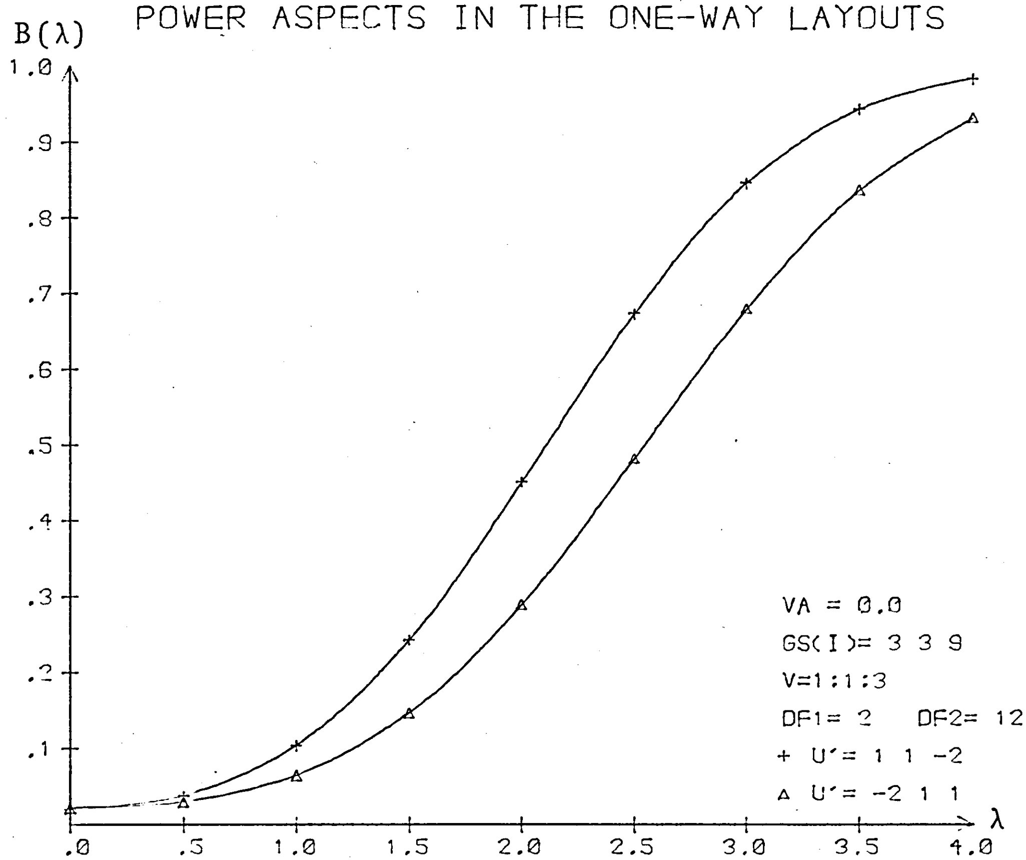

FIG. 2.1.9 EFFECTS OF GROUP CONTAINING DIVERGENT MEAN ON POWER.

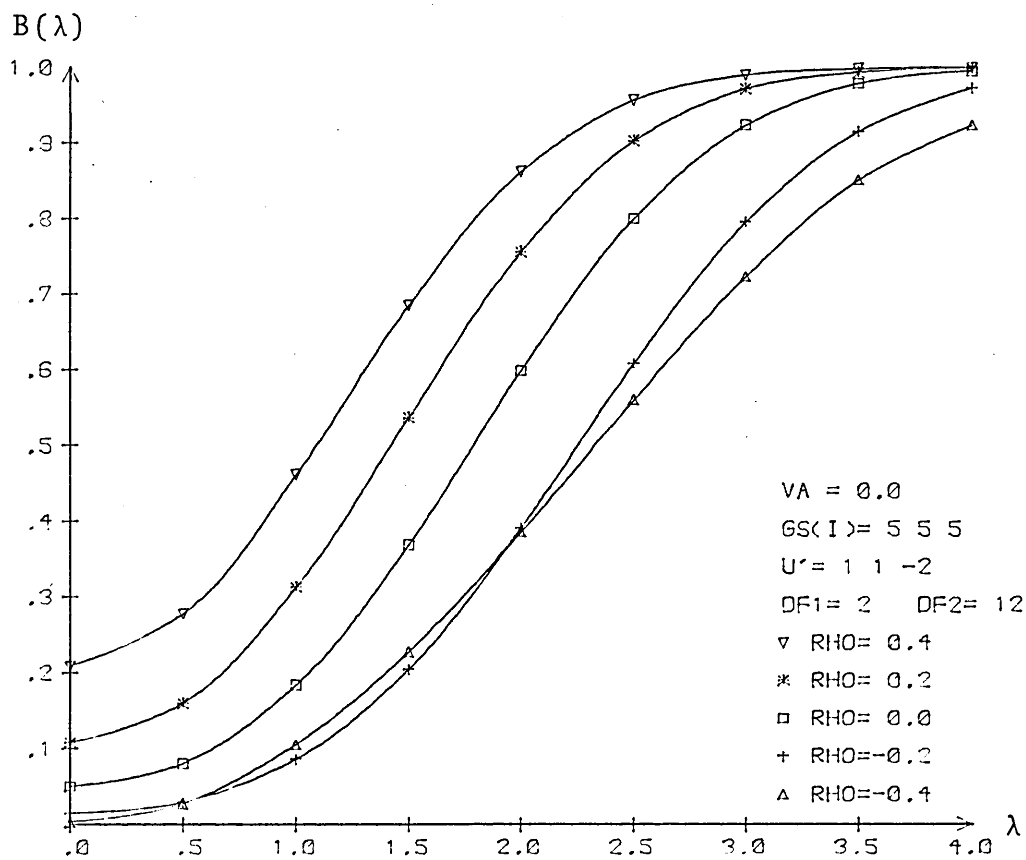

FIG. 2.1.10 EFFECTS OF WITHIN TREATMENT SERIAL CORRELATION ON POWER.

B(λ) POWER ASPECTS IN THE ONE-WAY LAYOUTS

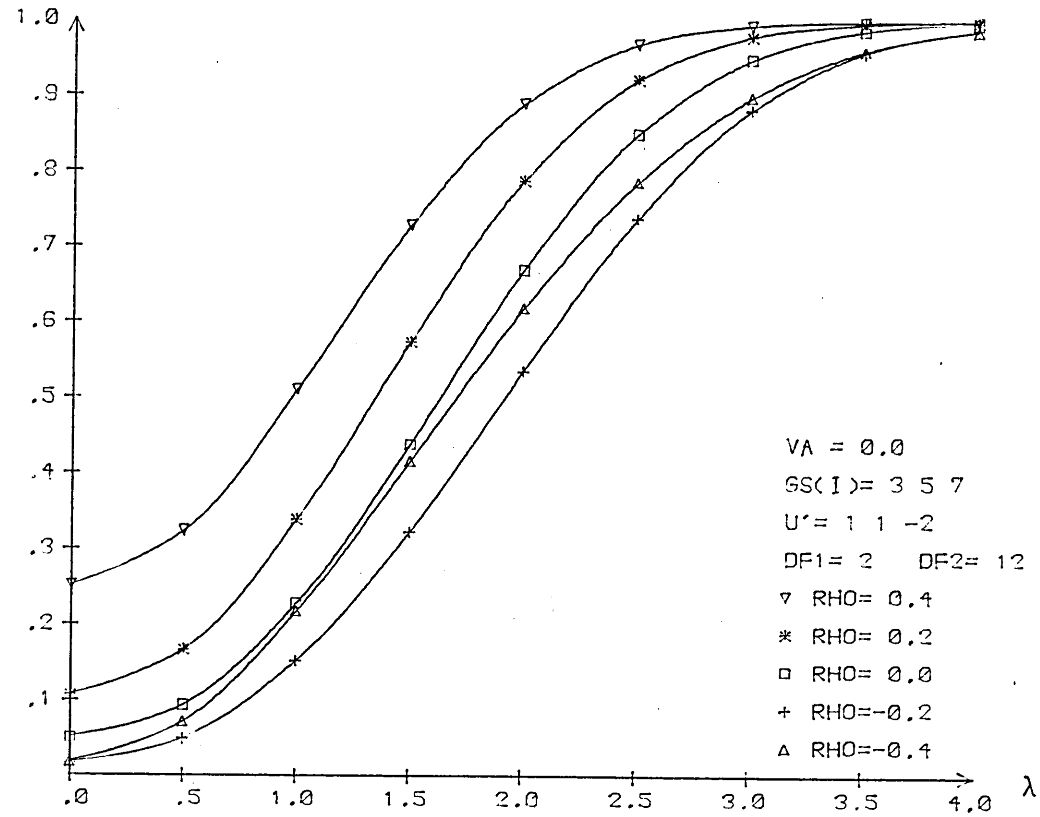

FIG. 2.1.11 EFFECTS OF WITHIN TREATMENT SERIAL CORRELATION ON POWER.

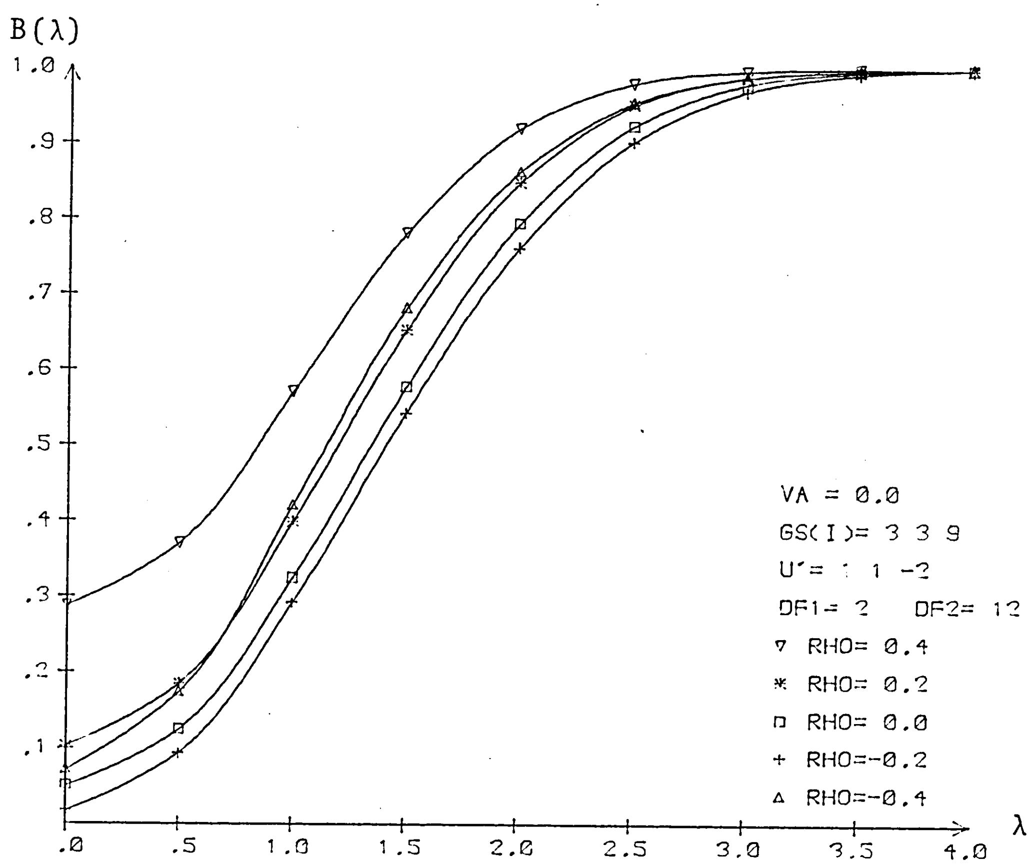

FIG. 2.1.12 EFFECTS OF WITHIN TREATMENT SERIAL CORRELATION ON POWER.

POWER ASPECTS IN THE ONE-WAY LAYOUTS

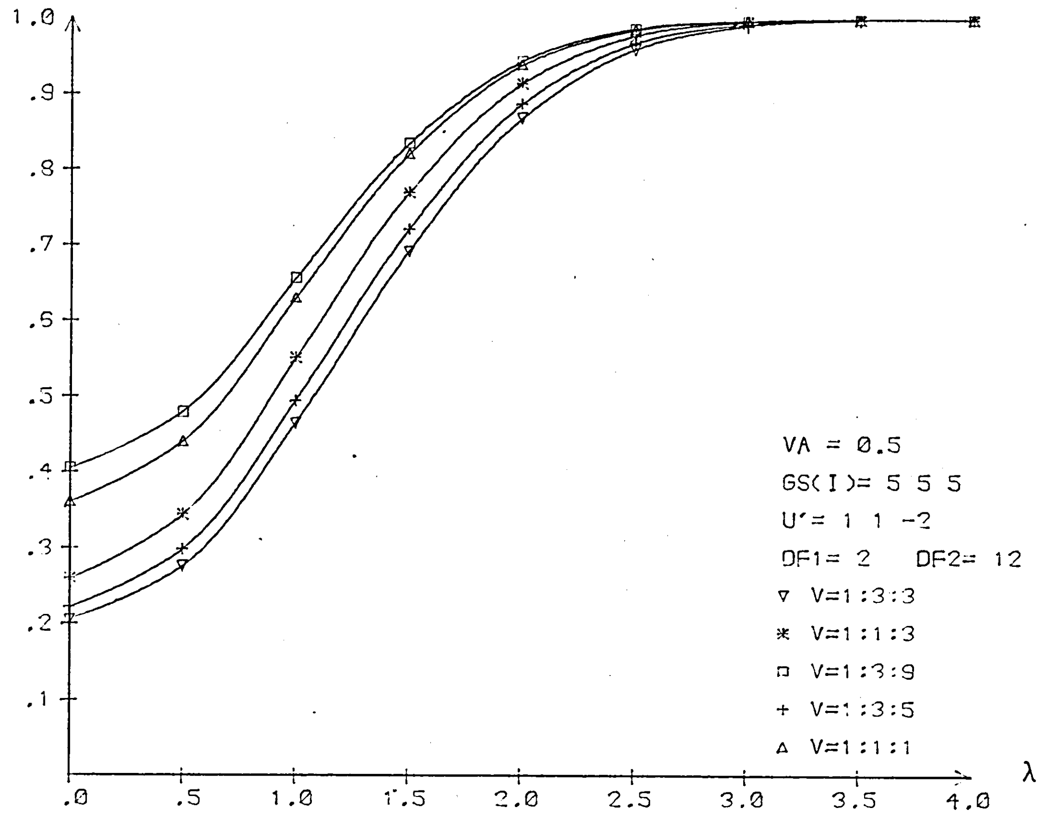

FIG. 2.2.1 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

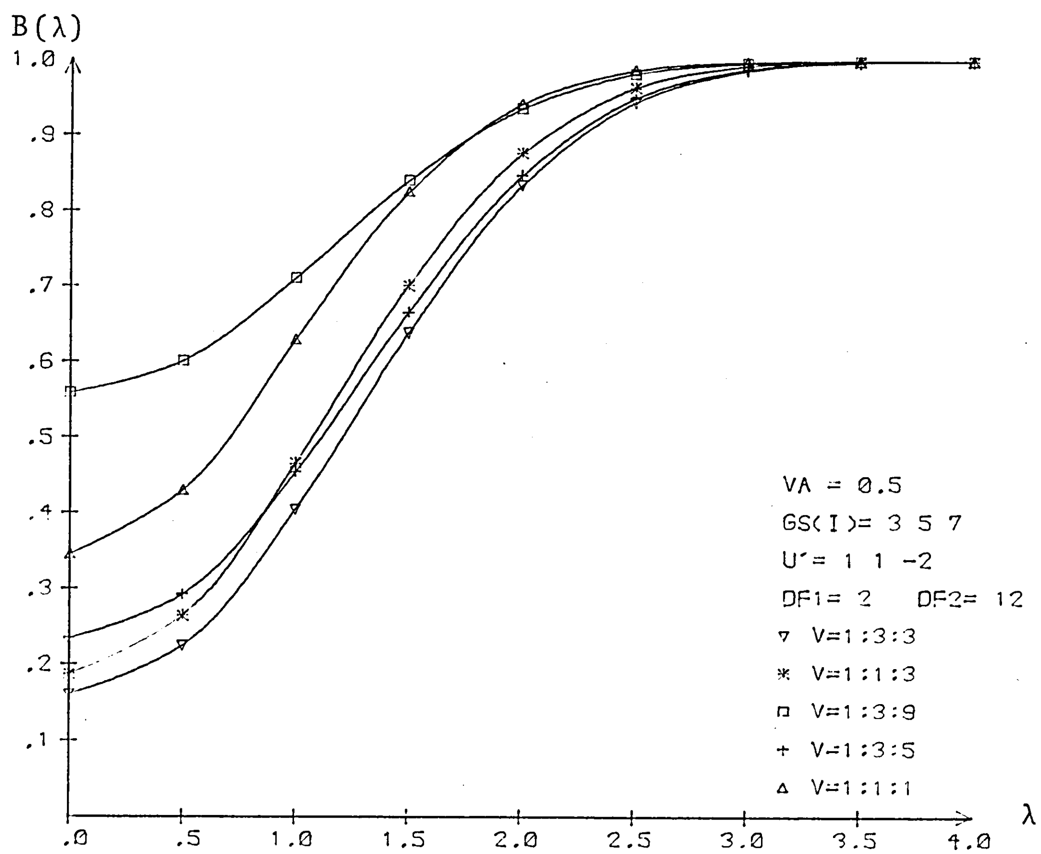

FIG. 2.2.2 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

POWER ASPECTS IN THE ONE-WAY LAYOUTS

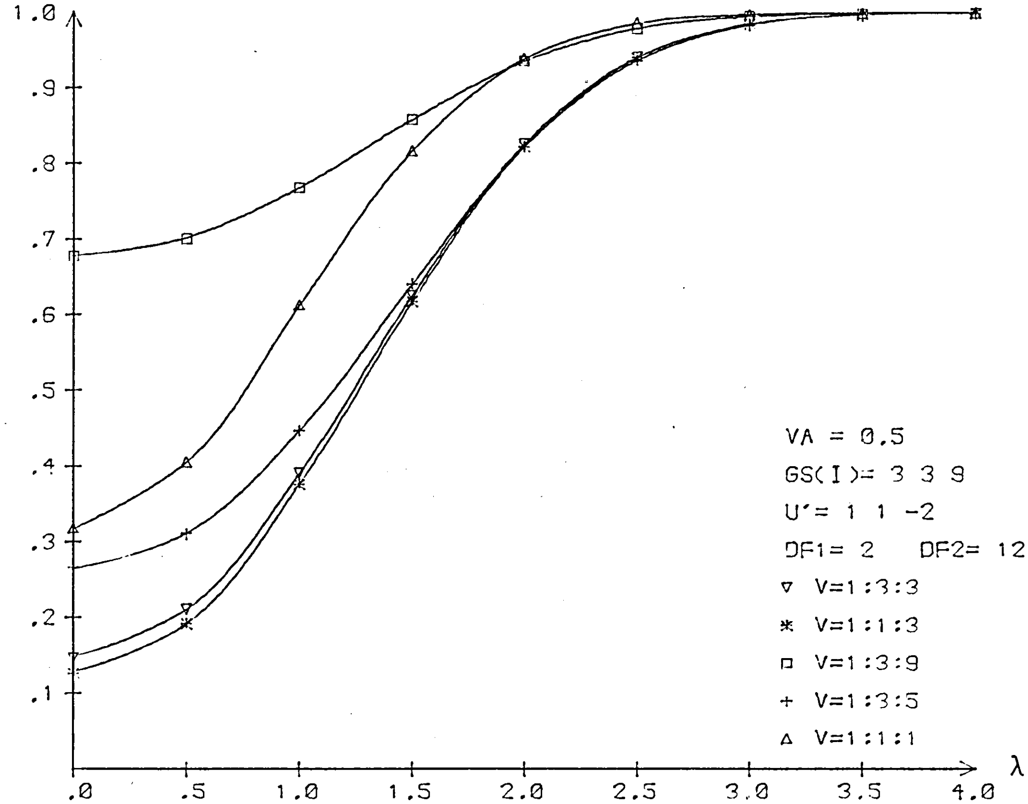

FIG. 2.2.3 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

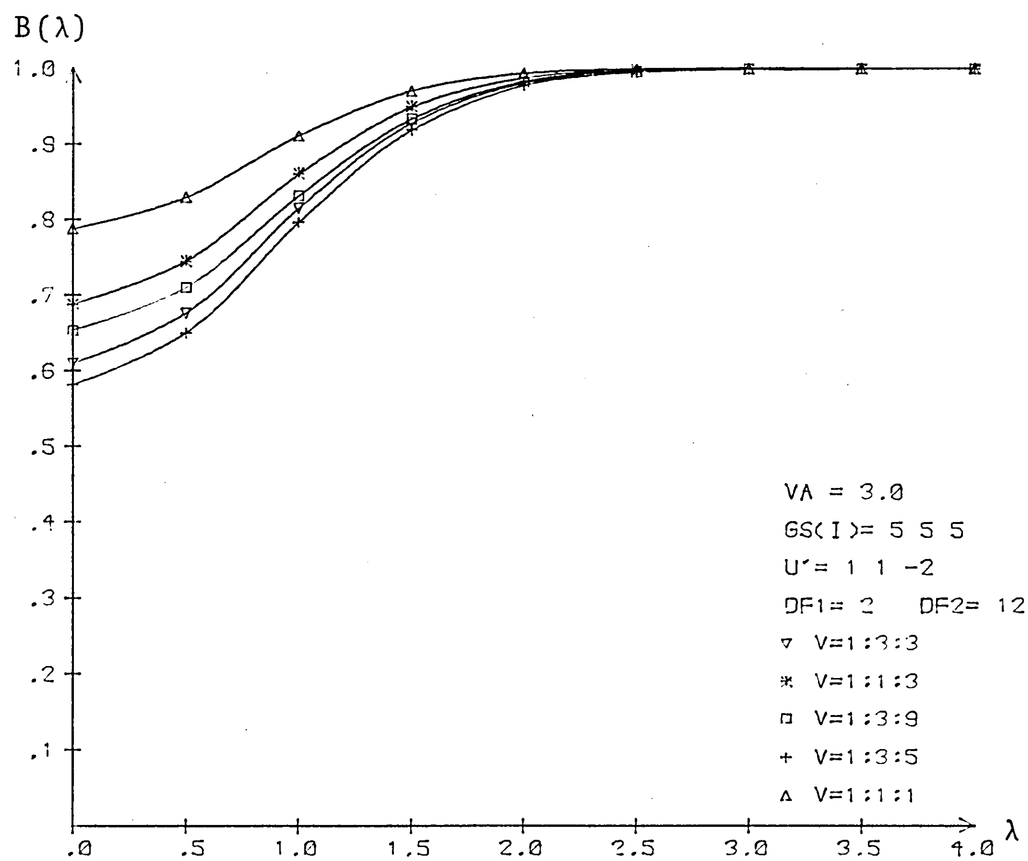

FIG. 2.2.4 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

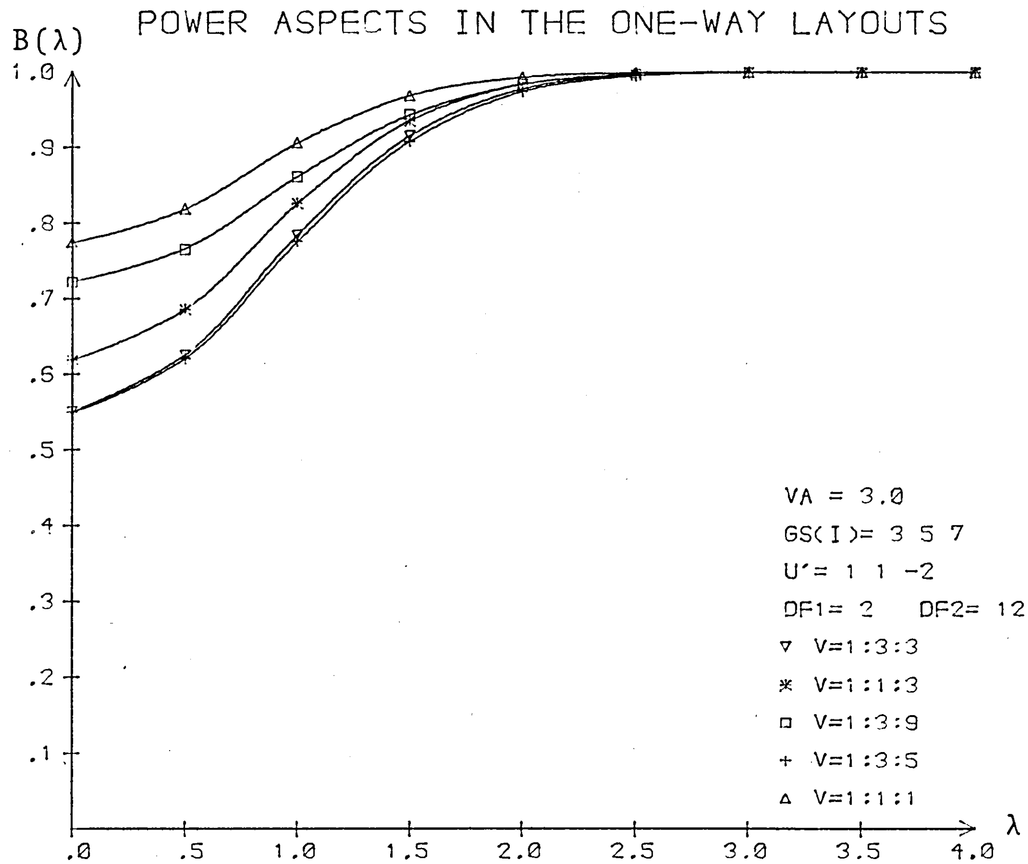

FIG. 2.2.5 EFFECTS OF UNQUAL GROUP ERROR VARIANCES ON POWER.

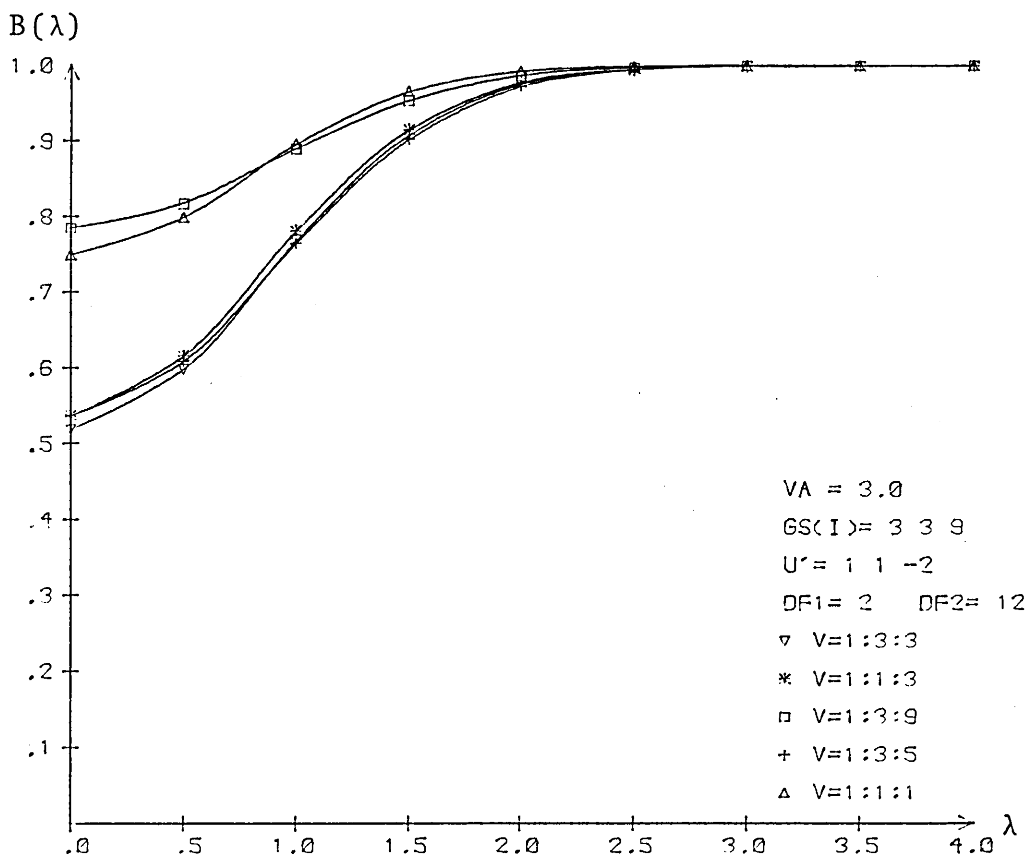

FIG. 2.2.6 EFFECTS OF UNEQUAL GROUP ERROR VARIANCES ON POWER.

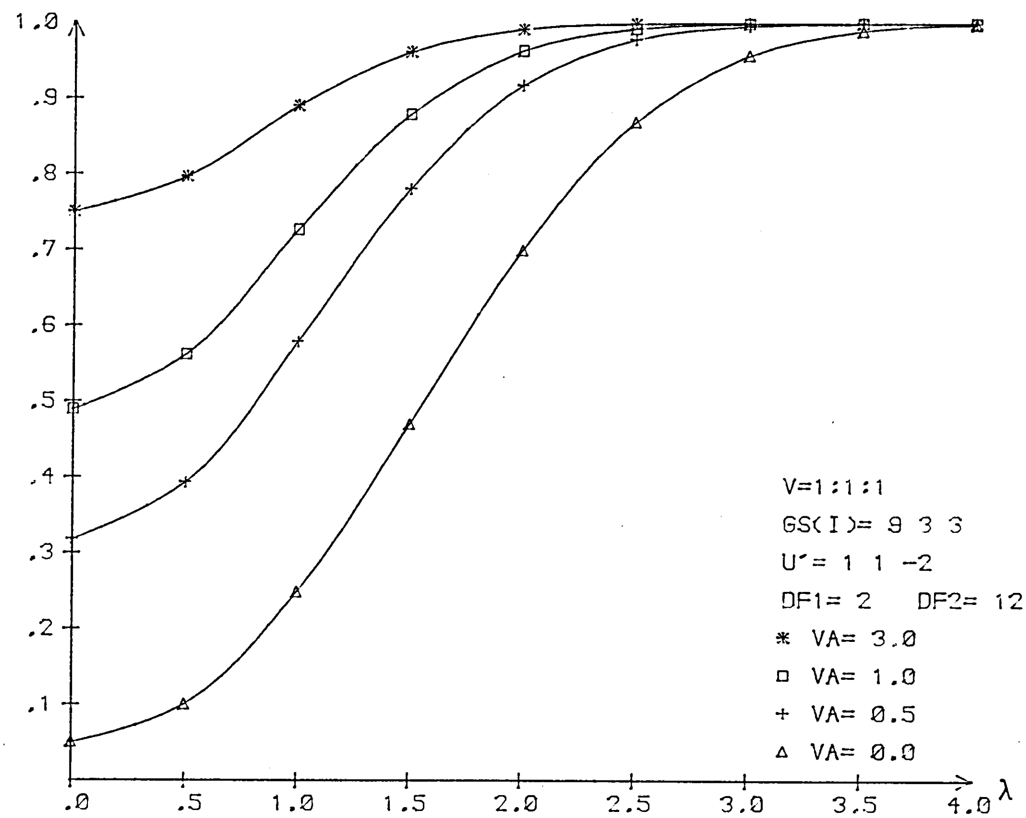

FIG. 2.2.7 EFFECTS OF VARIABILITIES OF TREATMENT MEANS ABOUT THEIR TRUE MEANS ON POWER.

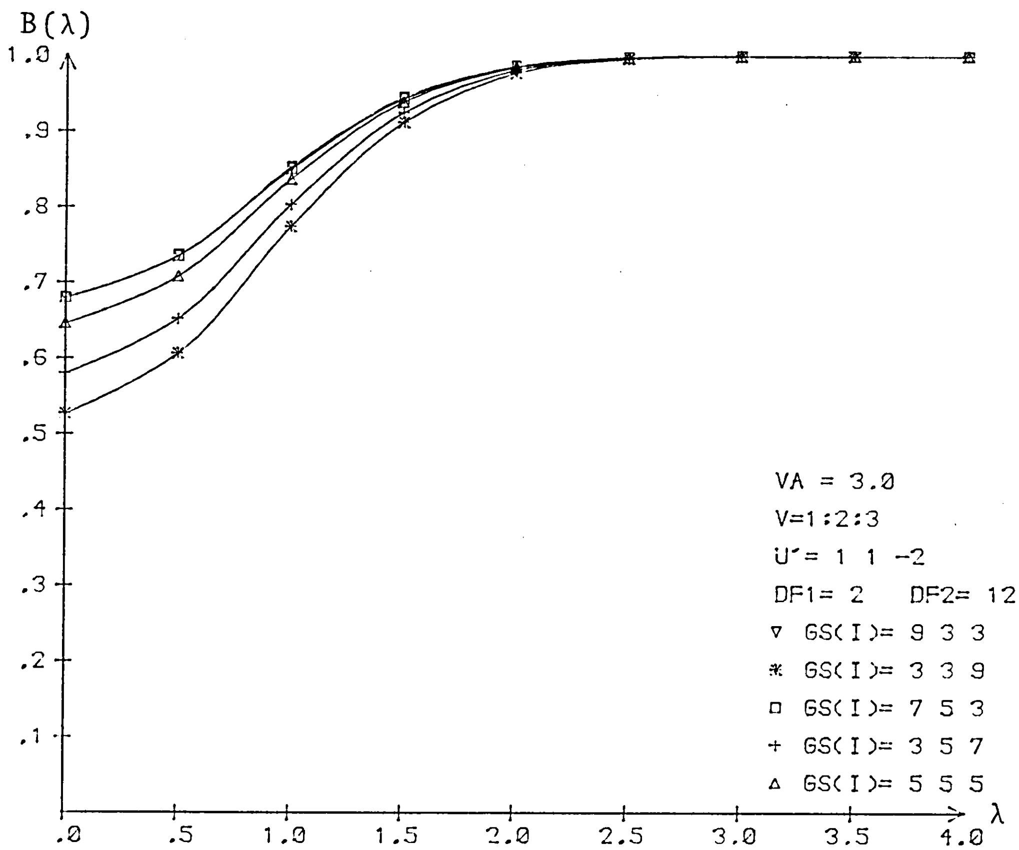

FIG. 2.2.8 EFFECTS OF GROUP SIZES ON POWER.

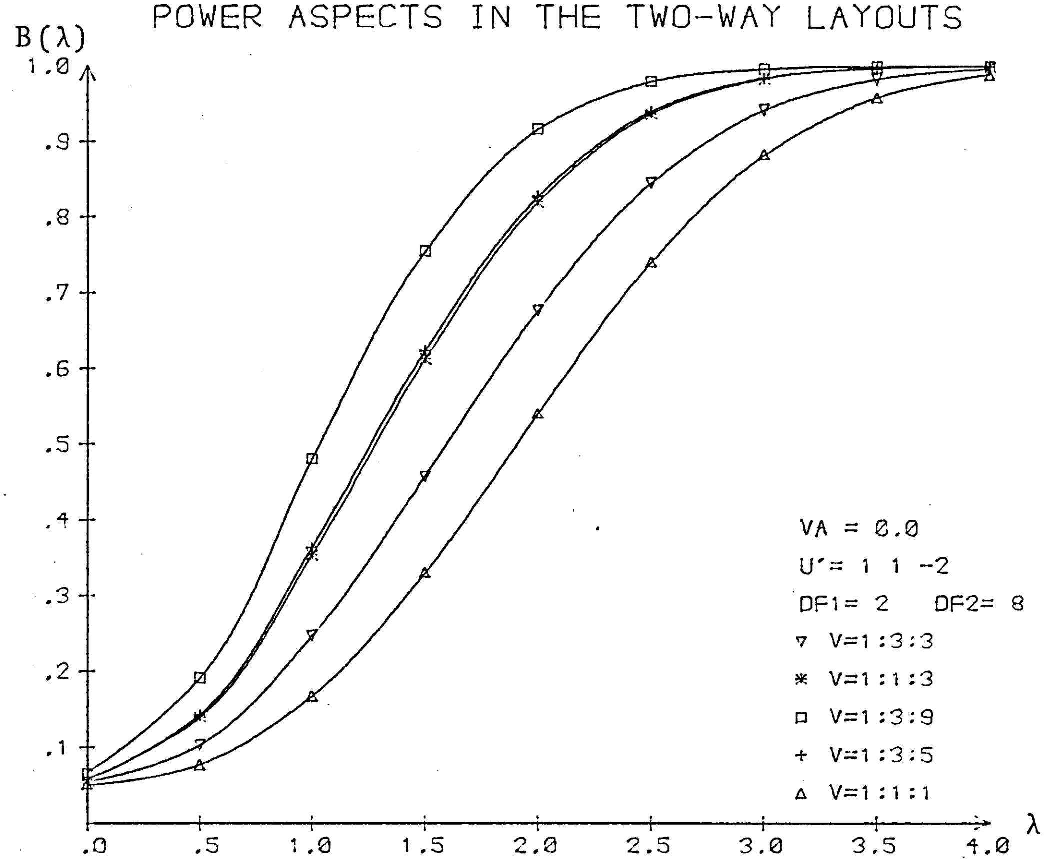

FIG. 3.1.1 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

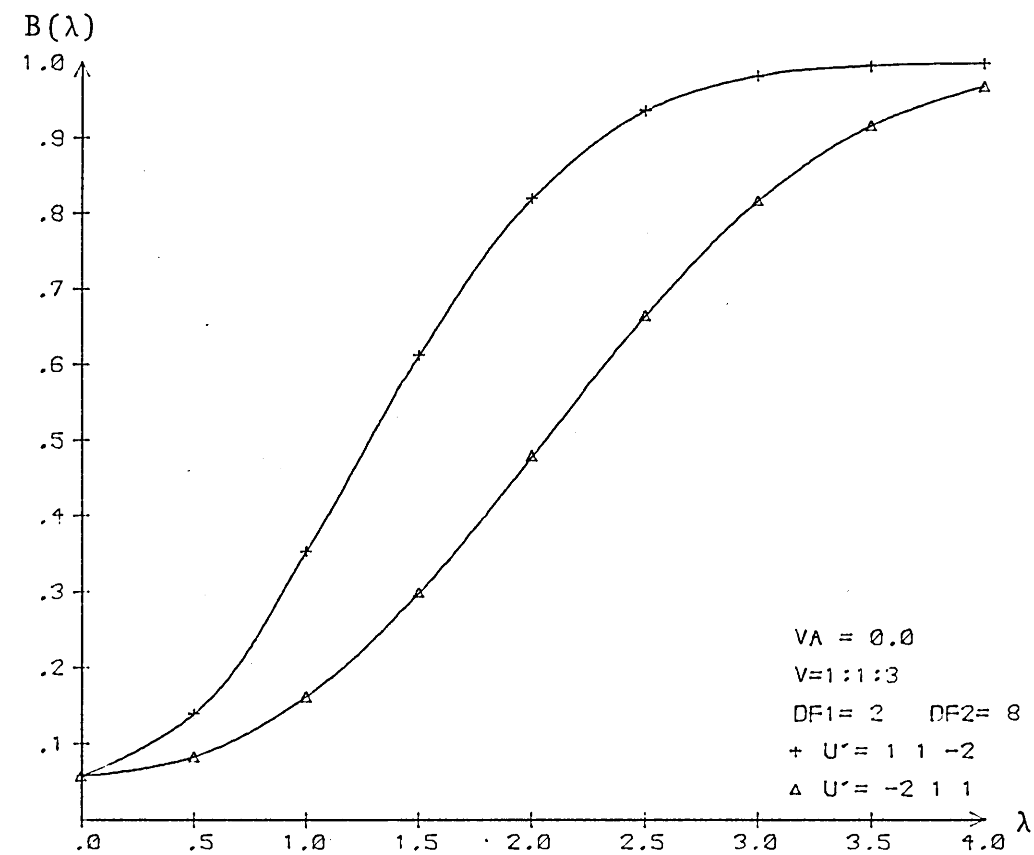

FIG. 3.1.2 EFFECTS OF GROUP CONTAINING DIVERGENT MEAN ON POWER.

POWER ASPECTS IN THE TWO-WAY LAYOUTS

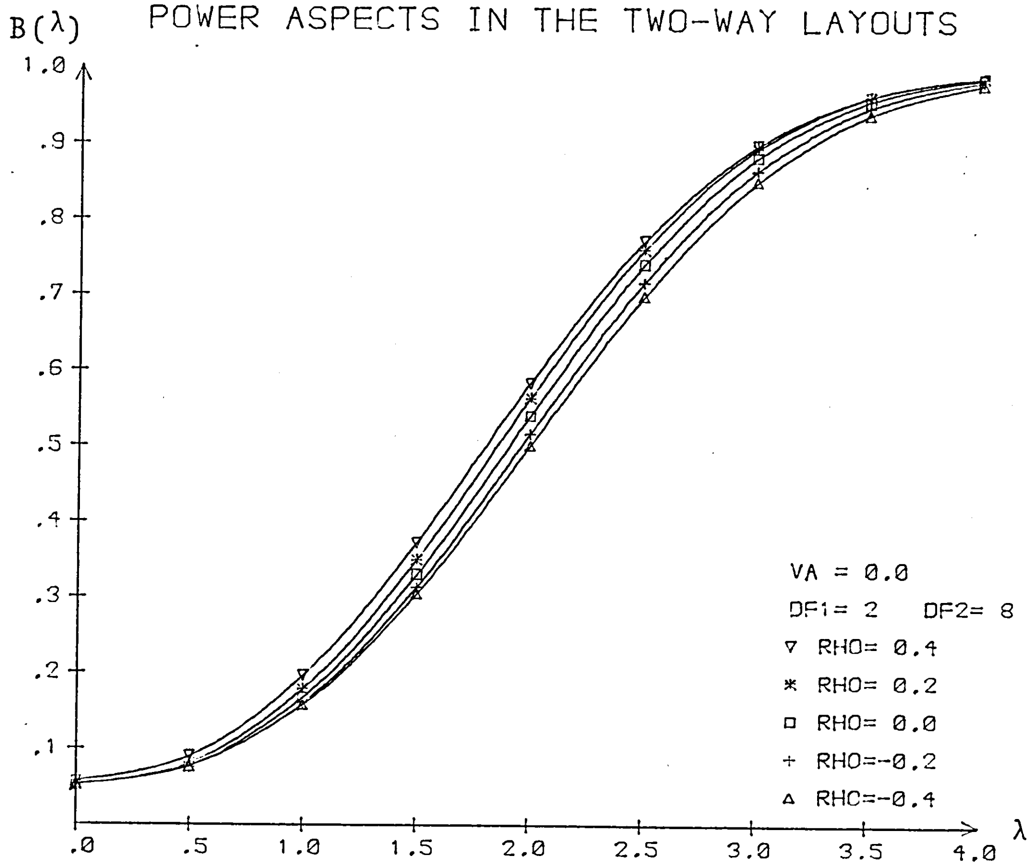

FIG. 3.1.3 EFFECTS OF WITHIN ROW SERIAL CORRELATION ON POWER FOR THE BETWEEN-COLUMNS COMPARISON.

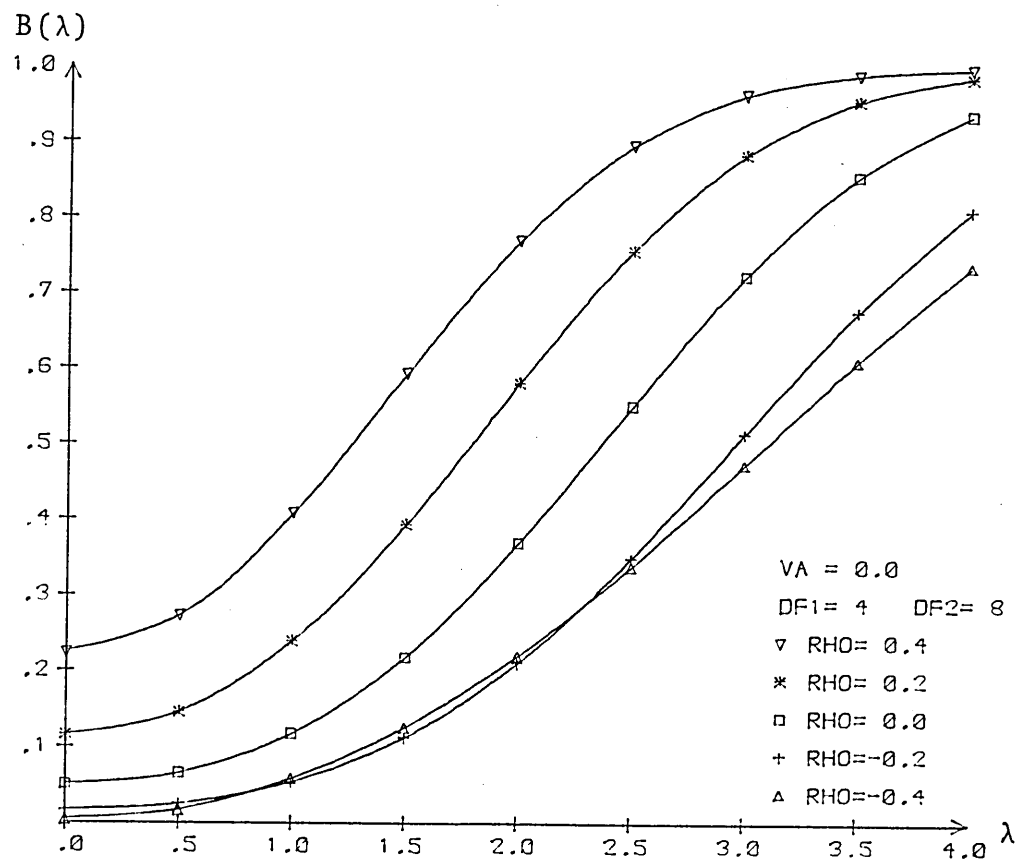

FIG. 3.1.4 EFFECTS OF WITHIN ROW SERIAL CORRELATION ON POWER FOR THE BETWEEN-ROWS COMPARISON.

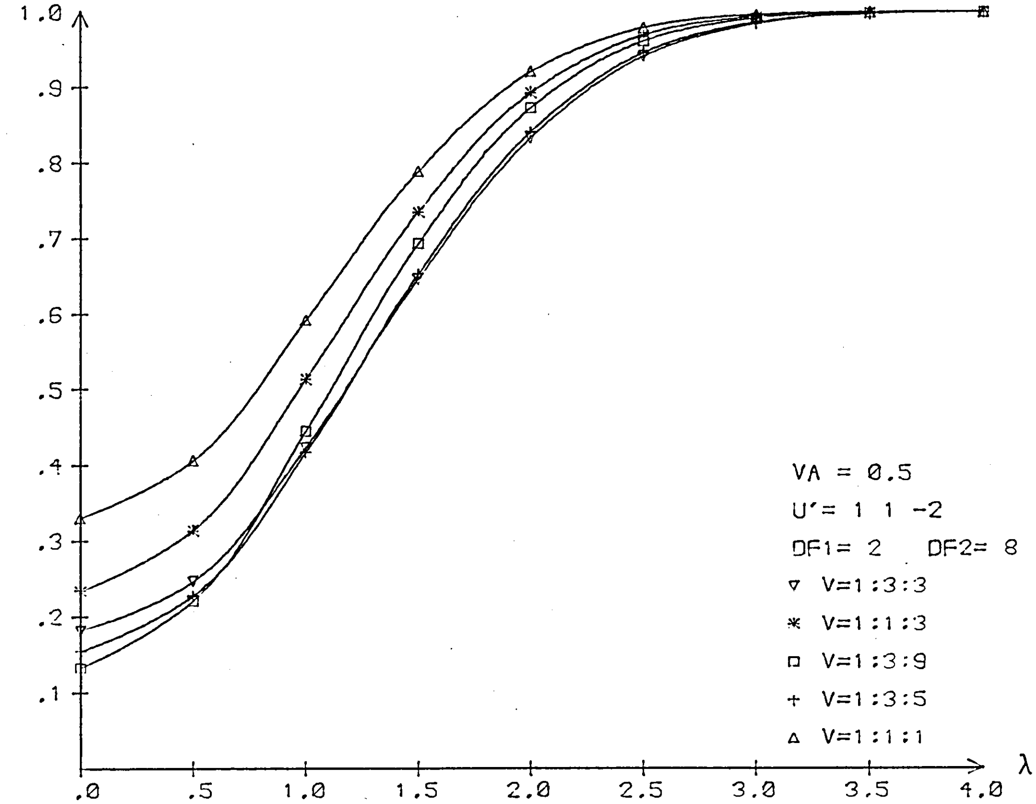

FIG. 3.2.1 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

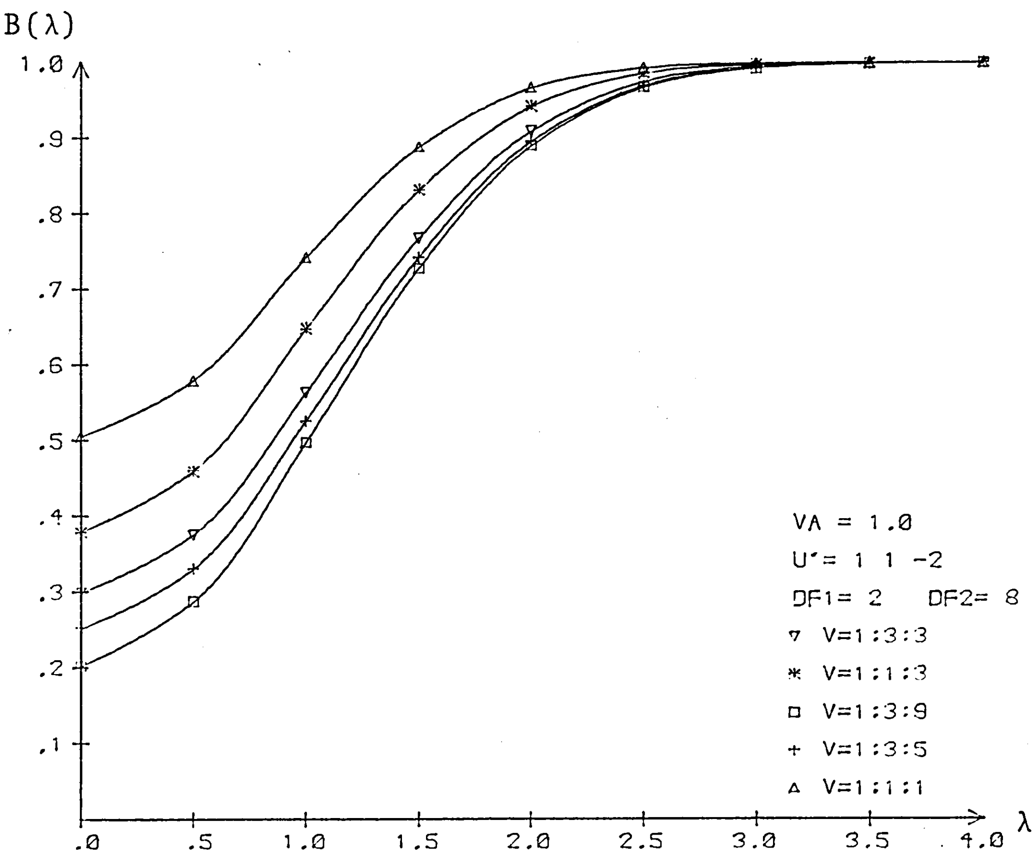

FIG. 3.2.2 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

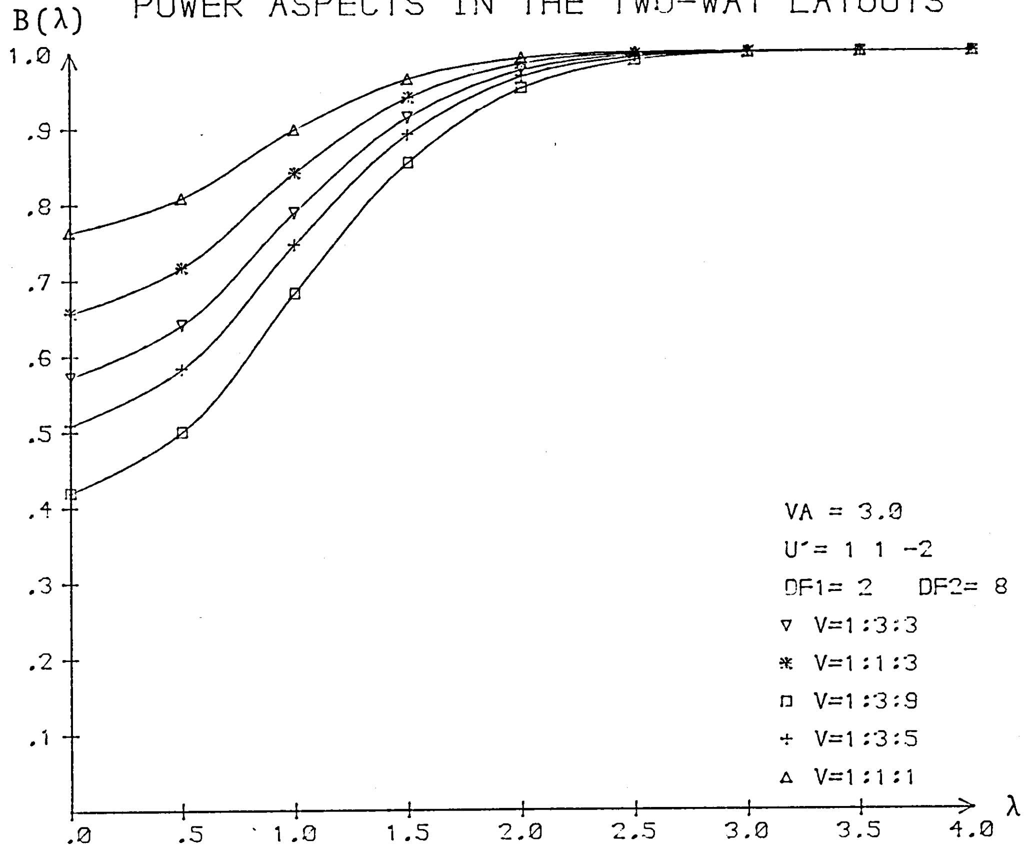

FIG. 3.2.3 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

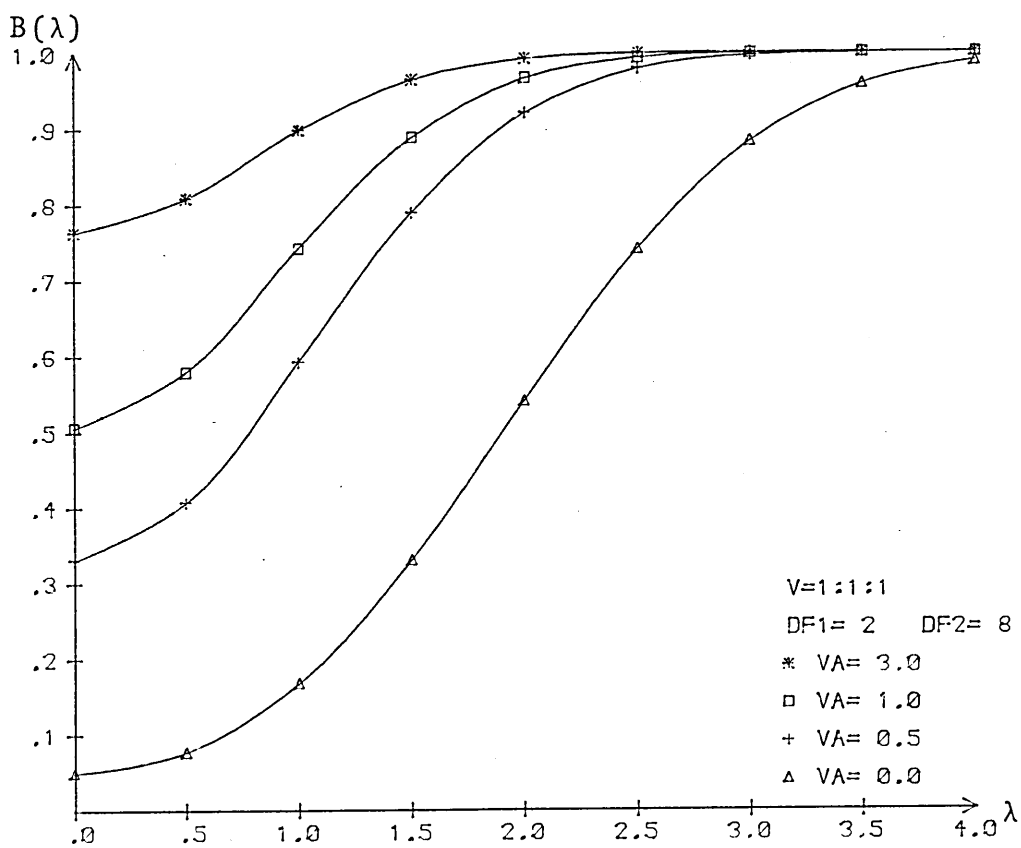

FIG. 3.2.4 EFFECTS OF VARIABILITIES OF TREATMENT MEANS ABOUT THEIR TRUE MEANS ON POWER.

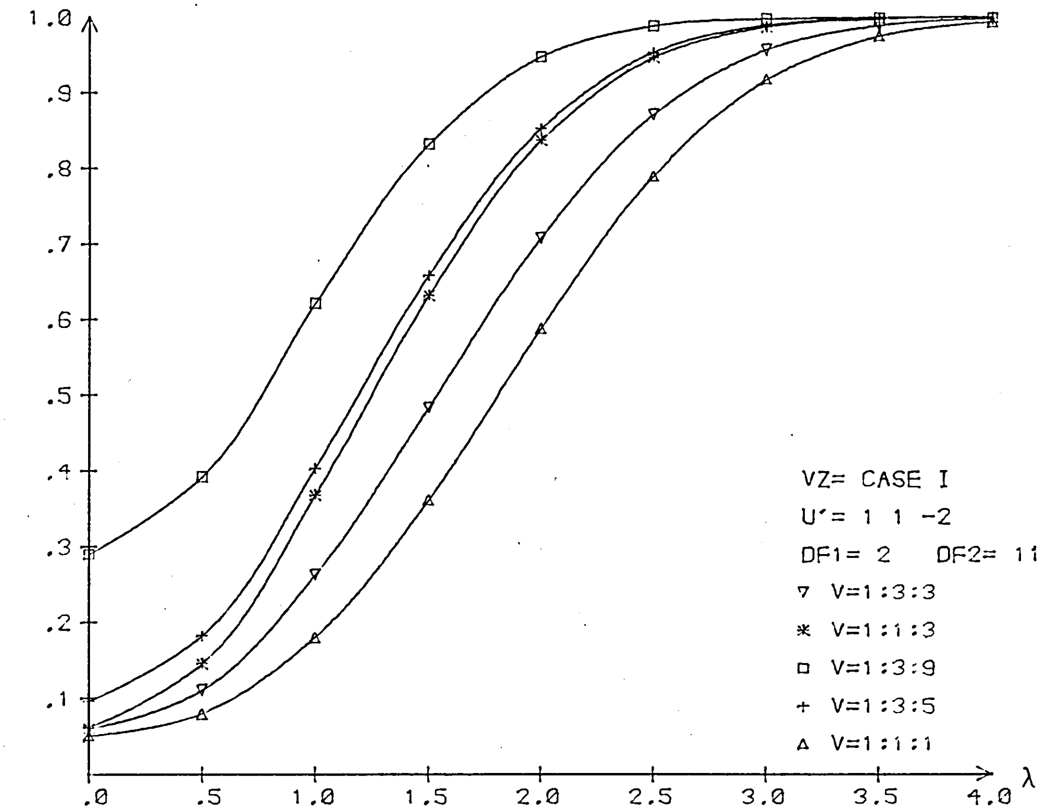

FIG. 4.1 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

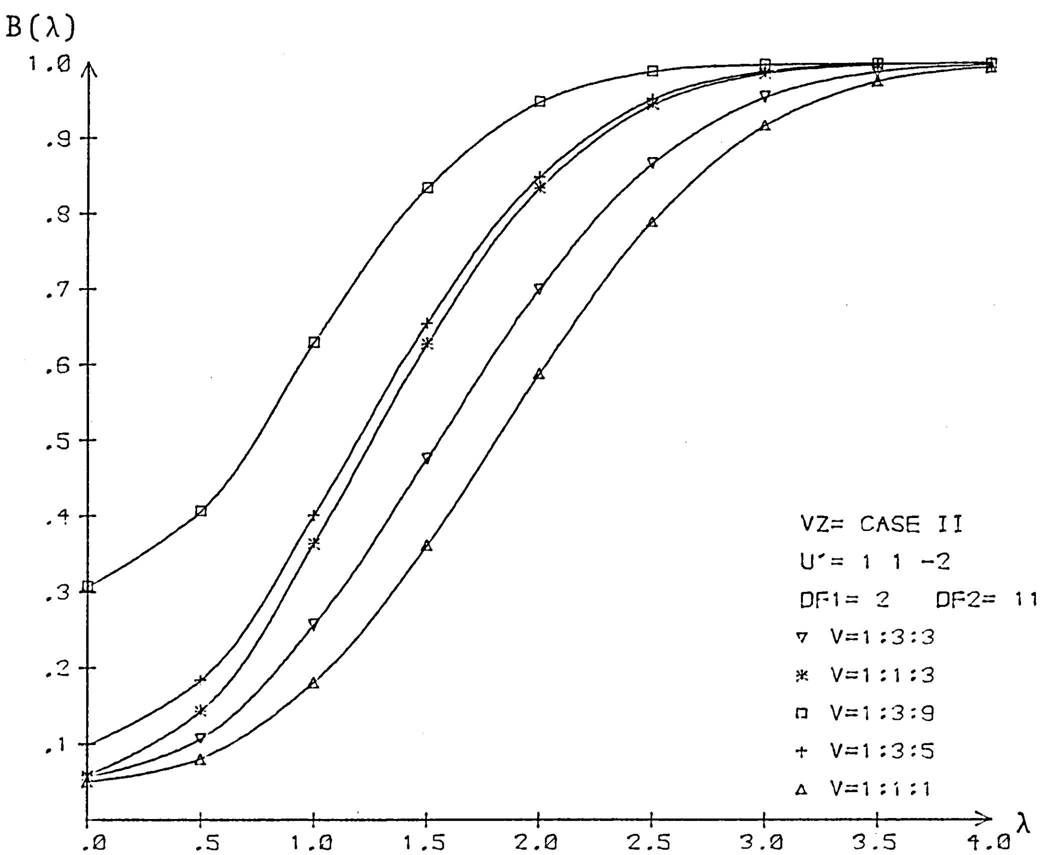

FIG. 4.2 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

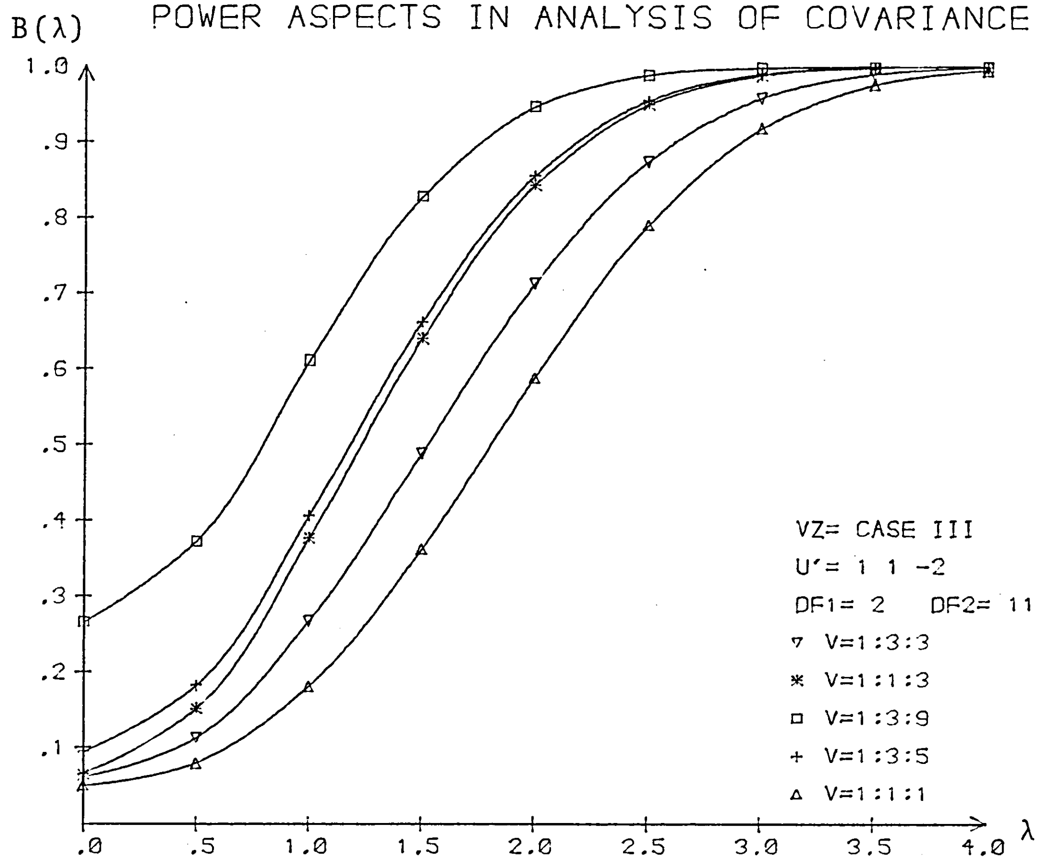

FIG. 4.3 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

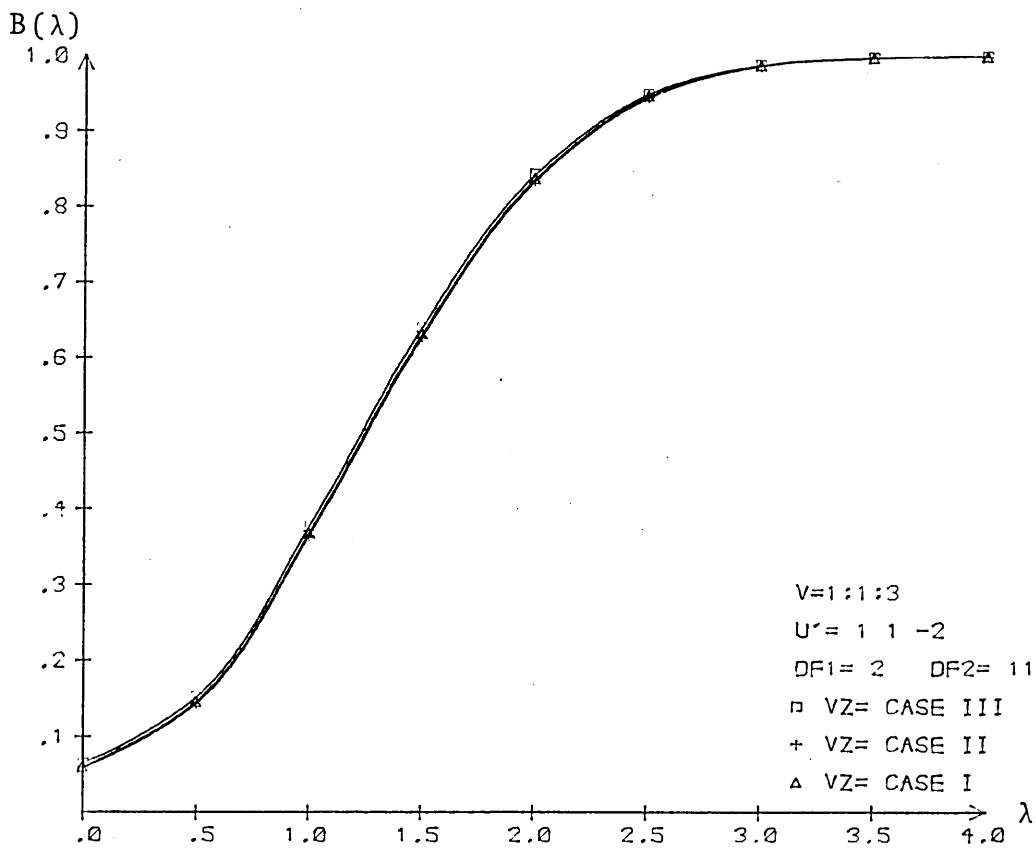

FIG. 4.4 EFFECTS OF UNEQUAL GROUP VARIABILITIES OF COVARIATE ON POWER.

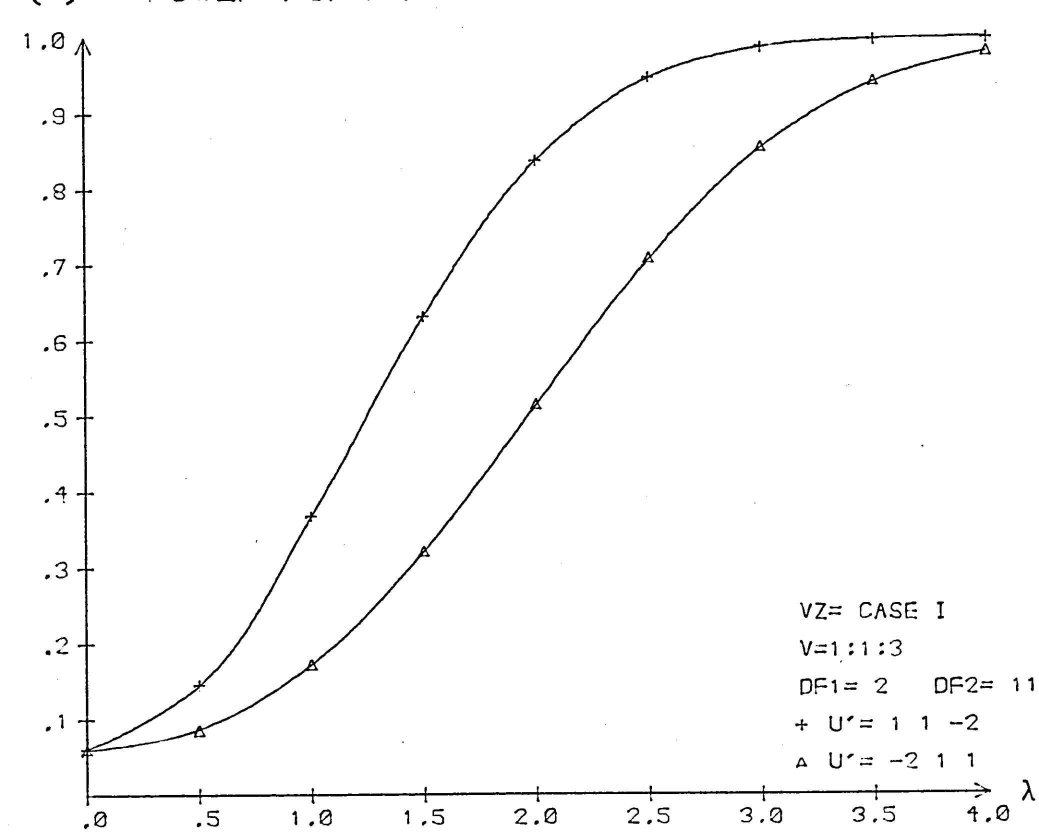

FIG. 4.5 EFFECTS OF GROUP CONTAINING DIVERGENT MEAN ON POWER.

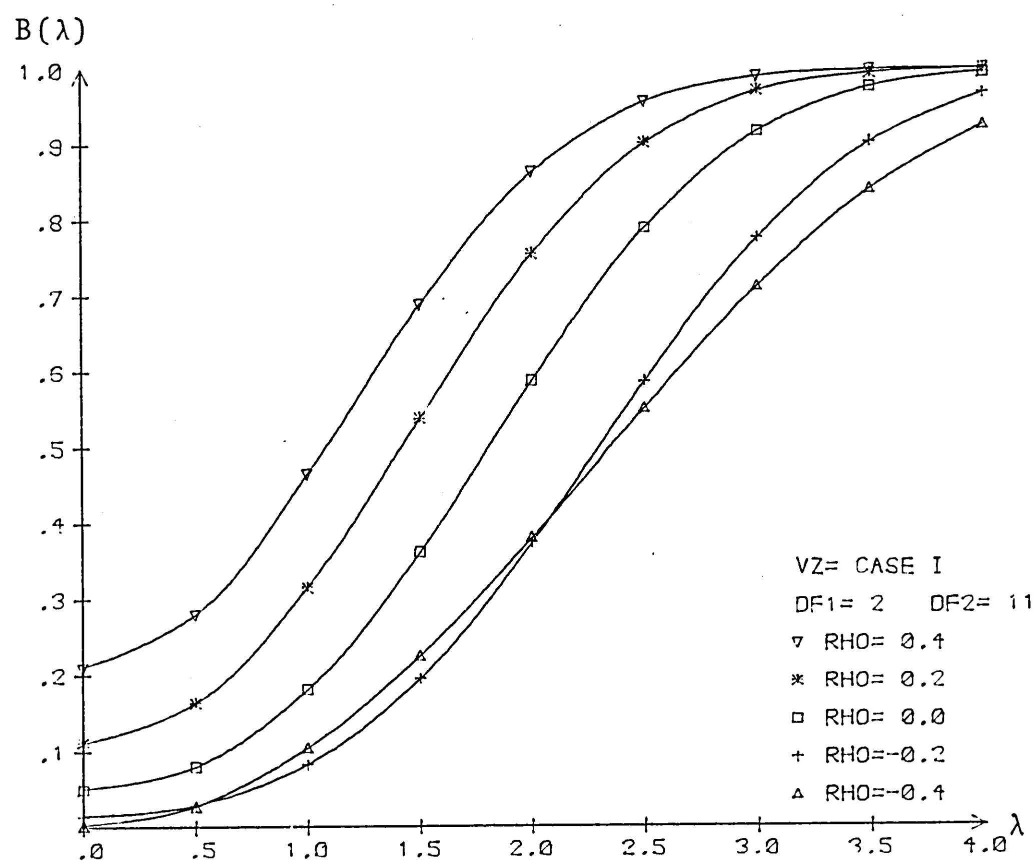

FIG. 4.6 EFFECTS OF WITHIN TREATMENT SERIAL CORRELATION ON POWER.

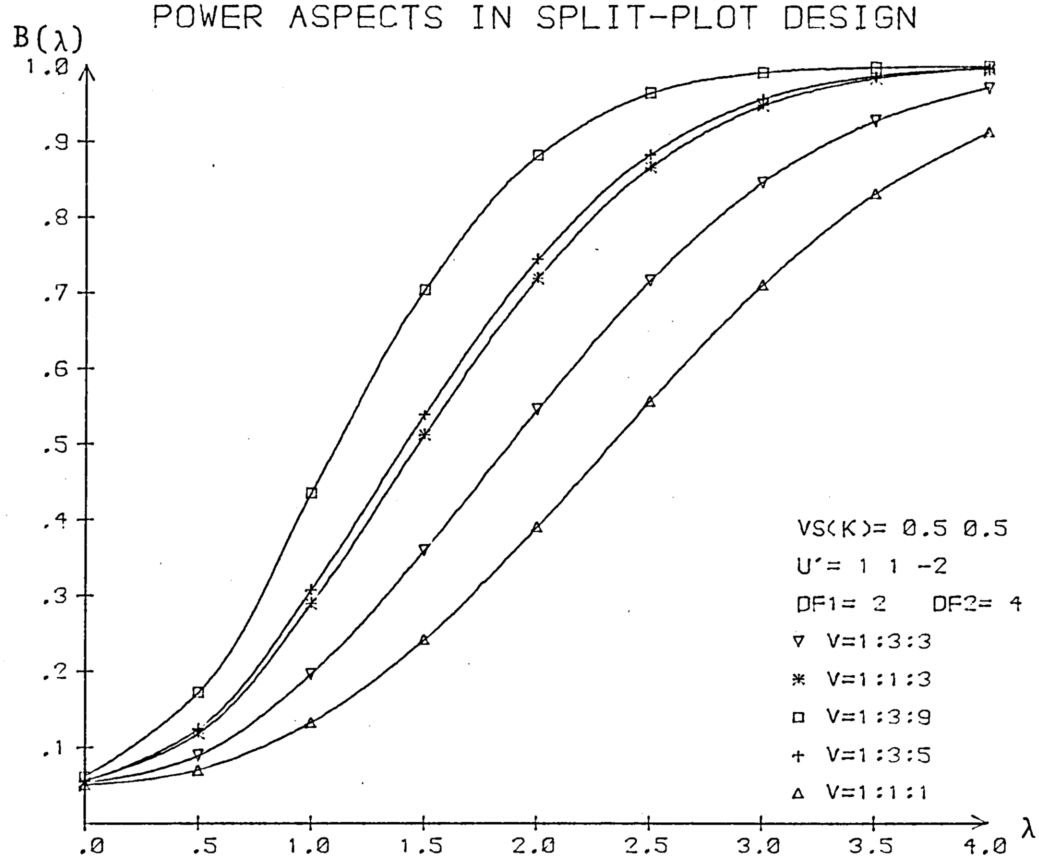

FIG. 5.1.1 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

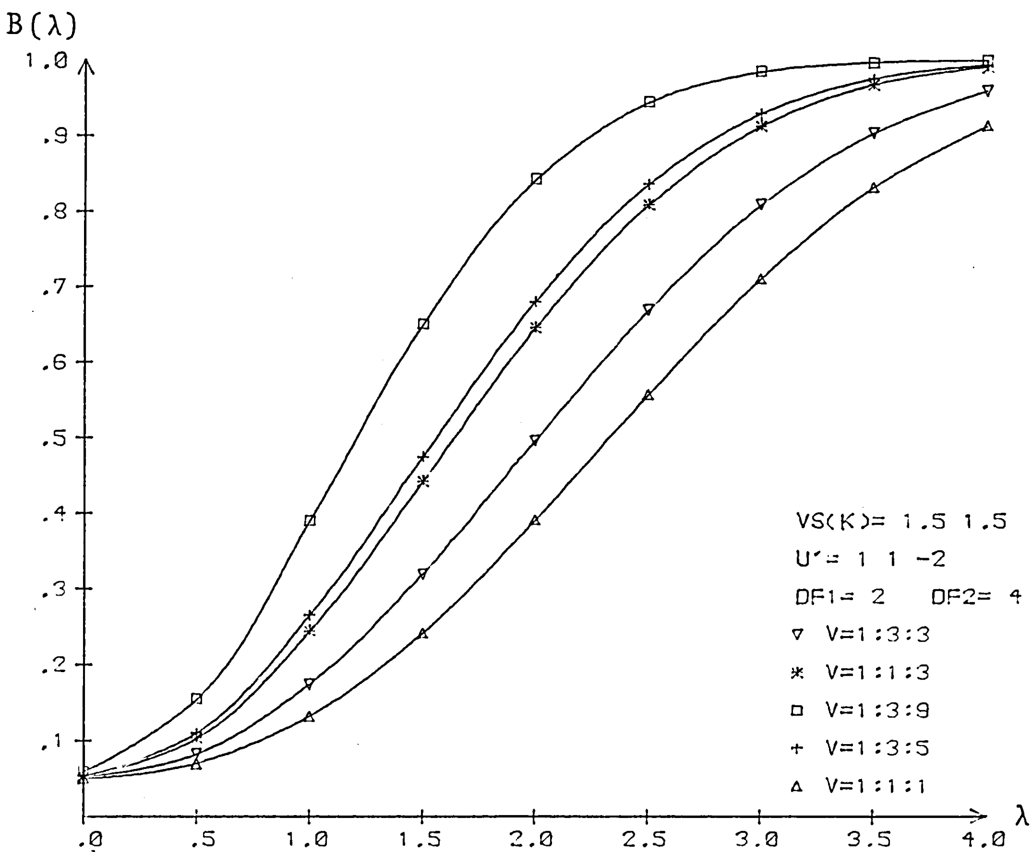

FIG. 5.1.2 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

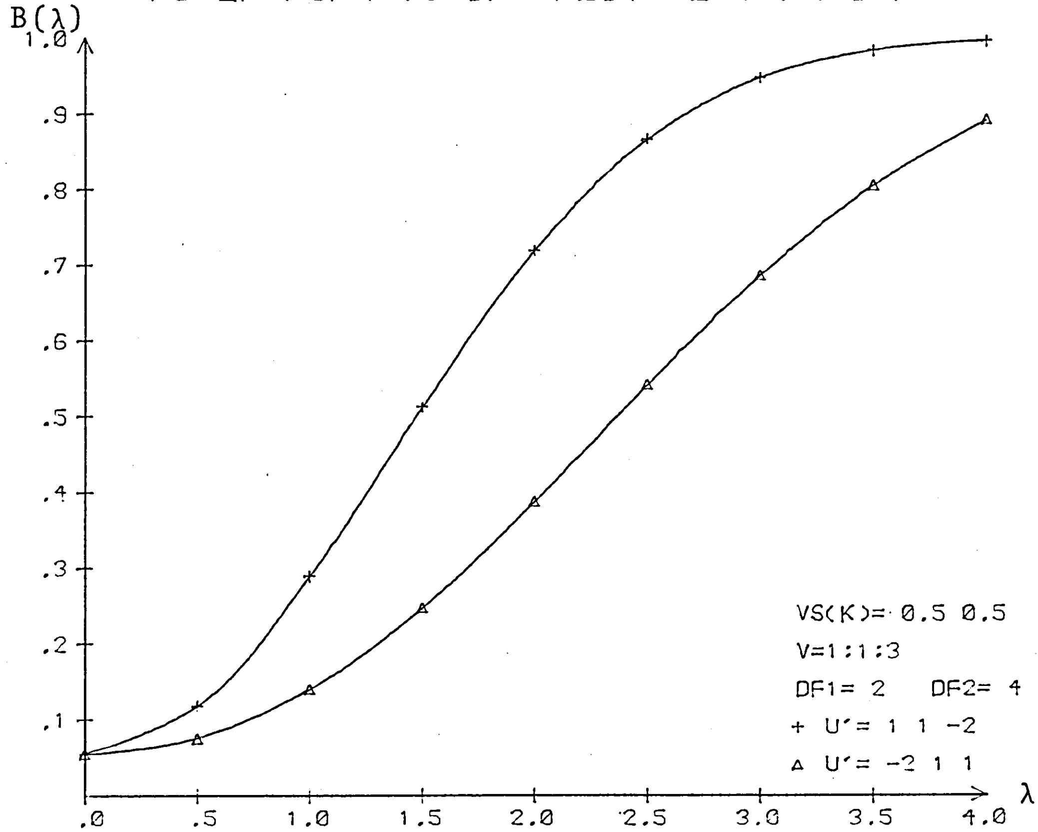

FIG. 5.1.3 EFFECTS OF GROUP CONTAINING DIVERGENT MEAN ON POWER.

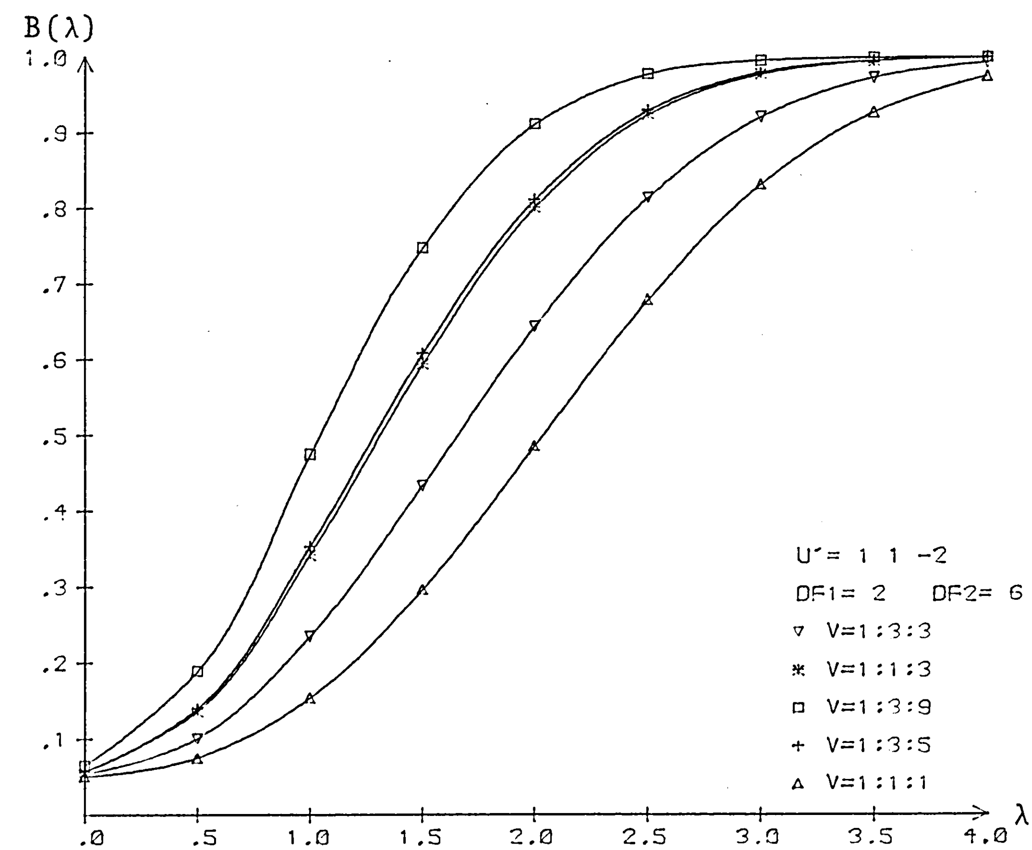

FIG. 5.2.1 EFFECTS OF UNEQUAL ERROR VARIANCES ON POWER.

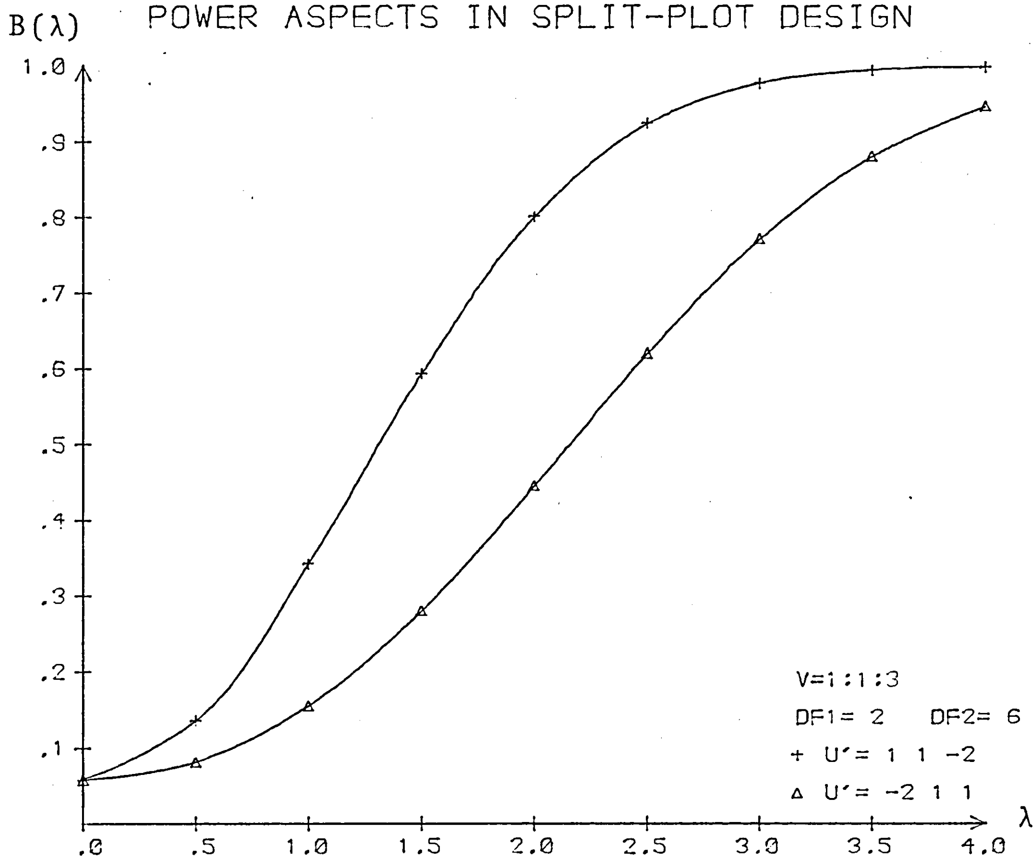

FIG. 5.2.2 EFFECTS OF GROUP CONTAINING DIVERGENT MEAN ON POWER.

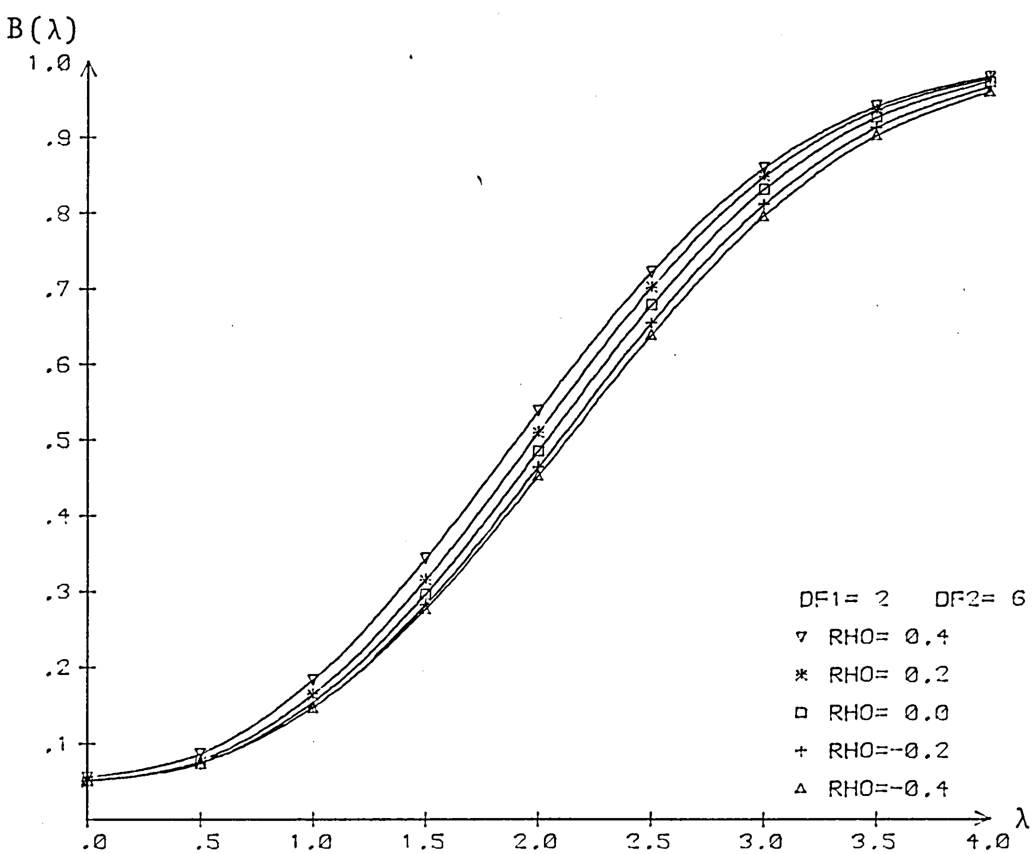

FIG. 5.2.3 EFFECTS OF SUB-PLOT SERIAL CORRELATION ON POWER.

Table 1A

ANALYSIS OF VARIANCE --- GENERAL LINEAR MODEL

WITH U* = 1.00 1.00 -1.00 -1.00

DF1 = 2 DF2 = 2

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

ERROR VARIANCES				NON CENTRALITY PARAMETER								
V1	V2	V3	V4	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.	1.	1.	1.	0.05000	0.06180	0.09633	0.15108	0.22221	0.30497	0.39426	0.48521	0.57623
1.	2.	3.	4.	0.05383	0.08341	0.16667	0.28887	0.43033	0.57196	0.70017	0.80909	0.89655
1.	3.	5.	7.	0.05642	0.11097	0.25639	0.44780	0.63601	0.78737	0.89064	0.95142	0.98213
1.	2.	4.	8.	0.06031	0.09389	0.18763	0.32306	0.47660	0.62665	0.75804	0.86211	0.93465
1.	3.	9.	27.	0.09647	0.15682	0.31506	0.51643	0.70419	0.84407	0.92978	0.97336	0.99166
1.	1.	1.	3.	0.05257	0.08562	0.17800	0.31161	0.46287	0.60957	0.73632	0.83721	0.91300
1.	1.	1.	5.	0.05642	0.10287	0.22892	0.40083	0.57918	0.73339	0.84886	0.92509	0.96910
1.	3.	3.	3.	0.05088	0.09883	0.22863	0.40473	0.58583	0.74017	0.85303	0.92521	0.96634
1.	5.	5.	5.	0.05140	0.13422	0.34178	0.58313	0.78006	0.90332	0.96459	0.98920	0.99727

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

ERROR VARIANCES				NON CENTRALITY PARAMETER								
V1	V2	V3	V4	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.	1.	1.	1.	0.01000	0.01247	0.01985	0.03203	0.04882	0.06998	0.09521	0.12446	0.16626
1.	2.	3.	4.	0.01089	0.03388	0.09970	0.19960	0.32130	0.45211	0.58296	0.71071	0.83093
1.	3.	5.	7.	0.01152	0.06241	0.19992	0.38586	0.57628	0.73802	0.85625	0.93173	0.97330
1.	2.	4.	8.	0.01264	0.04148	0.12322	0.24504	0.38996	0.54136	0.68553	0.81082	0.90607
1.	3.	9.	27.	0.04219	0.10311	0.26408	0.47205	0.67021	0.82185	0.91764	0.96791	0.98970
1.	1.	1.	3.	0.01060	0.03707	0.11230	0.22486	0.35891	0.49810	0.62982	0.74867	0.85335
1.	1.	1.	5.	0.01152	0.05357	0.16931	0.33174	0.50772	0.66911	0.79943	0.89361	0.95336
1.	3.	3.	3.	0.01020	0.05253	0.16897	0.33210	0.50814	0.66810	0.79485	0.88428	0.94188
1.	5.	5.	5.	0.01032	0.09092	0.29543	0.53925	0.74577	0.88164	0.95351	0.98462	0.99575

Table 1A

ANALYSIS OF VARIANCE --- GENERAL LINEAR MODEL

WITH U* = 1.00 1.00 1.00 -1.00 -1.00 -1.00

DF1 = 2 DF2 = 4

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

ERROR VARIANCES						NON CENTRALITY PARAMETER								
V1	V2	V3	V4	V5	V6	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.	1.	1.	1.	1.	1.	0.05000	0.06978	0.13257	0.24222	0.39117	0.55691	0.71088	0.83191	0.91328
1.	2.	3.	4.	5.	6.	0.05882	0.10593	0.23623	0.41830	0.60895	0.76990	0.88228	0.94816	0.98086
1.	3.	5.	7.	9.	11.	0.06575	0.14166	0.33571	0.56923	0.76746	0.89614	0.96182	0.98853	0.99723
1.	2.	4.	8.	16.	32.	0.21692	0.27405	0.42228	0.60659	0.77183	0.88798	0.95380	0.98418	0.99558
1.	1.	1.	1.	1.	3.	0.05531	0.09579	0.21097	0.37973	0.56656	0.73352	0.85669	0.93279	0.97281
1.	1.	1.	1.	1.	5.	0.06367	0.11879	0.26791	0.46753	0.66399	0.81723	0.91459	0.96584	0.98851
1.	3.	3.	3.	3.	3.	0.05178	0.10142	0.23897	0.43086	0.62938	0.79235	0.90072	0.95968	0.98615
1.	5.	5.	5.	5.	5.	0.05285	0.13234	0.33516	0.57745	0.77953	0.90644	0.96792	0.99116	0.99804

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

ERROR VARIANCES						NON CENTRALITY PARAMETER								
V1	V2	V3	V4	V5	V6	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.	1.	1.	1.	1.	1.	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30111	0.41778	0.54105
1.	2.	3.	4.	5.	6.	0.01308	0.05132	0.15848	0.31358	0.48761	0.65203	0.78703	0.88515	0.94815
1.	3.	5.	7.	9.	11.	0.01766	0.08919	0.27461	0.50486	0.71130	0.85683	0.94002	0.97907	0.99408
1.	2.	4.	8.	16.	32.	0.15893	0.21593	0.36530	0.55503	0.73104	0.86082	0.93896	0.97766	0.99332
1.	1.	1.	1.	1.	3.	0.01154	0.04020	0.12287	0.24921	0.40188	0.55932	0.70149	0.81604	0.90059
1.	1.	1.	1.	1.	5.	0.01419	0.06051	0.18792	0.36567	0.55441	0.72003	0.84376	0.92381	0.96882
1.	3.	3.	3.	3.	3.	0.01053	0.04918	0.15778	0.31549	0.49268	0.65929	0.79380	0.88808	0.94610
1.	5.	5.	5.	5.	5.	0.01085	0.08341	0.27154	0.50506	0.71380	0.85982	0.94208	0.97989	0.99416

Table 1A

ANALYSIS OF VARIANCE --- GENERAL LINEAR MODEL

WITH U* = 1.00 1.00 1.00 1.00 -2.00 -2.00

DF1 = 3 DF2 = 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

ERROR VARIANCES						NON CENTRALITY PARAMETER								
V1	V2	V3	V4	V5	V6	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.	1.	1.	1.	1.	1.	0.05000	0.06116	0.09571	0.15536	0.23951	0.34333	0.45829	0.57418	0.68298
1.	2.	3.	4.	5.	6.	0.05856	0.08304	0.15447	0.26669	0.41065	0.57516	0.74106	0.87681	0.95790
1.	3.	5.	7.	9.	11.	0.06404	0.10717	0.22699	0.39795	0.58617	0.75731	0.88441	0.95782	0.98889
1.	2.	4.	8.	16.	32.	0.21092	0.24740	0.34919	0.49477	0.65368	0.79521	0.89863	0.95951	0.98751
1.	1.	1.	1.	1.	3.	0.05375	0.09795	0.21984	0.39040	0.57178	0.73082	0.84959	0.92675	0.97054
1.	1.	1.	1.	1.	5.	0.05982	0.12486	0.29502	0.50999	0.70733	0.85065	0.93562	0.97714	0.99361
1.	3.	3.	3.	3.	3.	0.05111	0.07866	0.15816	0.27947	0.42544	0.57520	0.71045	0.82159	0.90711
1.	5.	5.	5.	5.	5.	0.05172	0.09993	0.23146	0.41187	0.59849	0.75652	0.86966	0.93960	0.97712

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

ERROR VARIANCES						NON CENTRALITY PARAMETER								
V1	V2	V3	V4	V5	V6	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.	1.	1.	1.	1.	1.	0.01000	0.01245	0.02032	0.03492	0.05774	0.08990	0.13183	0.18339	0.25044
1.	2.	3.	4.	5.	6.	0.01240	0.02856	0.07671	0.15713	0.27428	0.43527	0.63041	0.81376	0.93358
1.	3.	5.	7.	9.	11.	0.01537	0.05309	0.16007	0.31991	0.50905	0.69675	0.84851	0.94249	0.98438
1.	2.	4.	8.	16.	32.	0.16510	0.20099	0.30226	0.45016	0.61609	0.76343	0.88311	0.95248	0.98511
1.	1.	1.	1.	1.	3.	0.01097	0.04819	0.15209	0.30175	0.46948	0.62921	0.76387	0.86742	0.93920
1.	1.	1.	1.	1.	5.	0.01263	0.07305	0.23335	0.44216	0.64395	0.80208	0.90586	0.96305	0.98870
1.	3.	3.	3.	3.	3.	0.01028	0.03019	0.08802	0.17813	0.29147	0.41693	0.54483	0.67347	0.80443
1.	5.	5.	5.	5.	5.	0.01044	0.05295	0.17017	0.33506	0.51350	0.67571	0.80454	0.89670	0.95578

Table 1A

ANALYSIS OF VARIANCE --- GENERAL LINEAR MODEL

WITH U* = -2.00 -2.00 1.00 1.00 1.00 1.00

DF1 = 3 DF2 = 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

ERROR VARIANCES						NON CENTRALITY PARAMETER								
V1	V2	V3	V4	V5	V6	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.	1.	1.	1.	1.	1.	0.05000	0.06116	0.09571	0.15536	0.23951	0.34333	0.45829	0.57418	0.68298
1.	2.	3.	4.	5.	6.	0.05856	0.08713	0.16834	0.28947	0.43223	0.57717	0.70859	0.81753	0.90079
1.	3.	5.	7.	9.	11.	0.06404	0.12015	0.26942	0.46484	0.65490	0.80475	0.90367	0.95909	0.98543
1.	2.	4.	8.	16.	32.	0.21092	0.23677	0.30976	0.41745	0.54280	0.66836	0.78006	0.86927	0.93291
1.	1.	1.	1.	1.	3.	0.05375	0.06980	0.11762	0.19529	0.29751	0.41516	0.53696	0.65277	0.75835
1.	1.	1.	1.	1.	5.	0.05982	0.07878	0.13433	0.22201	0.33347	0.45721	0.58106	0.69569	0.79736
1.	3.	3.	3.	3.	3.	0.05111	0.10455	0.24829	0.44017	0.63139	0.78613	0.89095	0.95125	0.98102
1.	5.	5.	5.	5.	5.	0.05172	0.14290	0.36750	0.61952	0.81383	0.92606	0.97621	0.99381	0.99870

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

ERROR VARIANCES						NON CENTRALITY PARAMETER								
V1	V2	V3	V4	V5	V6	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.	1.	1.	1.	1.	1.	0.01000	0.01245	0.02032	0.03492	0.05774	0.08990	0.13183	0.18339	0.25044
1.	2.	3.	4.	5.	6.	0.01240	0.03764	0.10977	0.21878	0.35055	0.49016	0.62531	0.74823	0.85346
1.	3.	5.	7.	9.	11.	0.01537	0.07118	0.22052	0.41848	0.61496	0.77450	0.88404	0.94843	0.98076
1.	2.	4.	8.	16.	32.	0.16510	0.19092	0.26410	0.37293	0.50119	0.63199	0.75109	0.84889	0.92082
1.	1.	1.	1.	1.	3.	0.01097	0.02024	0.04791	0.09341	0.15531	0.23104	0.31725	0.41229	0.52518
1.	1.	1.	1.	1.	5.	0.01263	0.02610	0.06570	0.12901	0.21192	0.30906	0.41500	0.52691	0.64792
1.	3.	3.	3.	3.	3.	0.01028	0.06012	0.19529	0.37932	0.56917	0.73118	0.84938	0.92437	0.96633
1.	5.	5.	5.	5.	5.	0.01044	0.10144	0.32733	0.58504	0.78919	0.91187	0.96970	0.99144	0.99802

Table 1B

ANALYSIS OF VARIANCE --- GENERAL LINEAR MODEL

FOR EQUAL ERROR VARIANCES WITH SERIAL CORRELATION

DF1 = 2 DF2 = 2

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.02225	0.08243	0.24164	0.44802	0.64643	0.80179	0.90513	0.96359	0.98981
-0.2	0.03400	0.05500	0.11531	0.20738	0.32041	0.44238	0.56262	0.67644	0.78920
0.0	0.05000	0.06180	0.09633	0.15108	0.22221	0.30497	0.39426	0.48521	0.57623
0.2	0.07365	0.10016	0.17520	0.28660	0.41771	0.55145	0.67388	0.77620	0.85545
0.4	0.11442	0.17984	0.34842	0.55582	0.74004	0.86928	0.94347	0.97896	0.99325

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.00436	0.06139	0.21363	0.41454	0.61301	0.77444	0.88740	0.95511	0.98707
-0.2	0.00671	0.02125	0.06358	0.13012	0.21540	0.31291	0.41677	0.52883	0.66685
0.0	0.01000	0.01247	0.01985	0.03203	0.04882	0.06998	0.09521	0.12446	0.16626
0.2	0.01504	0.03087	0.07686	0.14870	0.23998	0.34310	0.45033	0.55480	0.65304
0.4	0.02435	0.08269	0.23759	0.43983	0.63615	0.79107	0.89393	0.95239	0.98111

Table 1B

ANALYSIS OF VARIANCE --- GENERAL LINEAR MODEL

FOR EQUAL ERROR VARIANCES WITH SERIAL CORRELATION

DF1 = 2 DF2 = 4

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.01004	0.12692	0.40162	0.68208	0.86951	0.95878	0.99003	0.99816	0.99975
-0.2	0.02511	0.06045	0.16239	0.31635	0.49551	0.66718	0.80536	0.89974	0.95515
0.0	0.05000	0.06978	0.13257	0.24222	0.39117	0.55691	0.71088	0.83191	0.91328
0.2	0.08929	0.13406	0.26070	0.44259	0.63558	0.79637	0.90363	0.96154	0.98707
0.4	0.15238	0.24156	0.45875	0.69487	0.86556	0.95407	0.98789	0.99754	0.99961

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.00172	0.11727	0.38980	0.67045	0.86109	0.95435	0.98834	0.99770	0.99966
-0.2	0.00460	0.03211	0.11120	0.23167	0.37753	0.52964	0.67005	0.78665	0.87668
0.0	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30111	0.41778	0.54105
0.2	0.02004	0.04691	0.12586	0.24989	0.40372	0.56499	0.71088	0.82584	0.90532
0.4	0.04058	0.12072	0.32483	0.56838	0.77208	0.90130	0.96512	0.98997	0.99766

Table 1B

ANALYSIS OF VARIANCE --- GENERAL LINEAR MODEL

FOR EQUAL ERROR VARIANCES WITH SERIAL CORRELATION

DF1 = 3 DF2 = 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.01609	0.11837	0.36589	0.63420	0.83095	0.93756	0.98168	0.99580	0.99927
-0.2	0.02910	0.05775	0.13979	0.26355	0.41100	0.56150	0.69717	0.80800	0.89343
0.0	0.05000	0.08868	0.19680	0.35221	0.52425	0.68323	0.80945	0.89669	0.94964
0.2	0.08533	0.16716	0.37209	0.60927	0.80014	0.91630	0.97139	0.99203	0.99820
0.4	0.15342	0.28312	0.56490	0.81096	0.94129	0.98699	0.99795	0.99977	0.99998

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.00303	0.10515	0.35295	0.62317	0.82334	0.93344	0.97998	0.99528	0.99916
-0.2	0.00561	0.02977	0.09908	0.20448	0.33274	0.46897	0.59988	0.71843	0.82635
0.0	0.01000	0.04253	0.13423	0.26893	0.42440	0.57809	0.71249	0.81309	0.89343
0.2	0.01811	0.09727	0.29876	0.54026	0.74598	0.88190	0.95387	0.98488	0.99584
0.4	0.03663	0.17712	0.48728	0.76710	0.92294	0.98144	0.99675	0.99959	0.99996

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = 1.00 -1.00

DF1 = 1 DF2 = 8 GROUP SIZES GS(I) = 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES		NON CENTRALITY PARAMETER								
V1	V2	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	0.05000	0.09595	0.23900	0.46272	0.69846	0.87068	0.95867	0.99030	0.99834
0.9	1.0	0.05006	0.09653	0.24068	0.46513	0.70063	0.87200	0.95921	0.99045	0.99837
0.8	1.0	0.05026	0.09851	0.24648	0.47341	0.70803	0.87644	0.96105	0.99098	0.99848
0.7	1.0	0.05065	0.10239	0.25774	0.48930	0.72208	0.88477	0.96444	0.99194	0.99867
0.6	1.0	0.05132	0.10883	0.27617	0.51484	0.74415	0.89754	0.96952	0.99335	0.99894
0.5	1.0	0.05239	0.11872	0.30387	0.55209	0.77521	0.91483	0.97612	0.99510	0.99927
0.4	1.0	0.05407	0.13332	0.34334	0.60279	0.81520	0.93573	0.98359	0.99695	0.99959
0.3	1.0	0.05749	0.15504	0.39786	0.66785	0.86227	0.95807	0.99078	0.99855	0.99984

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES		NON CENTRALITY PARAMETER								
V1	V2	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	0.01000	0.02359	0.07640	0.19227	0.37582	0.59070	0.77886	0.90337	0.96621
0.9	1.0	0.01002	0.02427	0.07882	0.19682	0.38172	0.59637	0.78298	0.90567	0.96719
0.8	1.0	0.01010	0.02660	0.08716	0.21233	0.40167	0.61539	0.79671	0.91322	0.97038
0.7	1.0	0.01025	0.03117	0.10331	0.24192	0.43902	0.65023	0.82125	0.92640	0.97580
0.6	1.0	0.01051	0.03874	0.12962	0.28888	0.49633	0.70165	0.85598	0.94423	0.98281
0.5	1.0	0.01093	0.05036	0.16889	0.35607	0.57406	0.76718	0.89728	0.96394	0.98999
0.4	1.0	0.01163	0.06749	0.22425	0.44492	0.66878	0.83975	0.93840	0.98142	0.99563
0.3	1.0	0.01356	0.09277	0.29932	0.55407	0.77167	0.90801	0.97132	0.99316	0.99876

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = 1.00 -1.00

DF1 = 1 DF2 = 8 GROUP SIZES GS(I) = 3 7

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES		NON CENTRALITY PARAMETER								
V1	V2	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	0.05000	0.12423	0.32545	0.58289	0.80164	0.92987	0.98199	0.99669	0.99957
0.9	1.0	0.04592	0.11211	0.29723	0.54656	0.77205	0.91384	0.97608	0.99520	0.99931
0.8	1.0	0.04177	0.09938	0.26645	0.50490	0.73592	0.89271	0.96759	0.99283	0.99885
0.7	1.0	0.03759	0.08629	0.23361	0.45803	0.69239	0.86510	0.95540	0.98904	0.99802
0.6	1.0	0.03339	0.07333	0.20015	0.40756	0.64201	0.83022	0.93835	0.98310	0.99653
0.5	1.0	0.02920	0.06152	0.16940	0.35856	0.58919	0.79013	0.91657	0.97454	0.99408
0.4	1.0	0.02518	0.05303	0.14862	0.32352	0.54787	0.75535	0.89541	0.96516	0.99102
0.3	1.0	0.02483	0.05534	0.15574	0.33192	0.55278	0.75600	0.89427	0.96426	0.99071

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES		NON CENTRALITY PARAMETER								
V1	V2	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	0.01000	0.05964	0.20222	0.41146	0.63533	0.81641	0.92683	0.97732	0.99460
0.9	1.0	0.00890	0.04994	0.17171	0.36099	0.57907	0.77121	0.90010	0.96560	0.99076
0.8	1.0	0.00783	0.04001	0.13933	0.30462	0.51182	0.71247	0.86175	0.94673	0.98374
0.7	1.0	0.00680	0.03015	0.10611	0.24366	0.43372	0.63795	0.80773	0.91674	0.97092
0.6	1.0	0.00583	0.02100	0.07431	0.18204	0.34876	0.54911	0.73594	0.87157	0.94866
0.5	1.0	0.00492	0.01373	0.04853	0.12921	0.27003	0.45861	0.65427	0.81326	0.91557
0.4	1.0	0.00419	0.01072	0.03794	0.10499	0.22878	0.40419	0.59790	0.76700	0.88528
0.3	1.0	0.00710	0.01974	0.06287	0.14871	0.28504	0.46061	0.64319	0.79663	0.90136

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = 1.00 -1.00

DF1 = 1 DF2 = 8 GROUP SIZES GS(I) = 7 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES		NON CENTRALITY PARAMETER								
V1	V2	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	0.05000	0.12423	0.32545	0.58289	0.80164	0.92987	0.98199	0.99669	0.99957
0.9	1.0	0.05445	0.13688	0.35373	0.61756	0.82819	0.94327	0.98653	0.99773	0.99973
0.8	1.0	0.05988	0.15146	0.38485	0.65371	0.85414	0.95539	0.99030	0.99852	0.99984
0.7	1.0	0.06661	0.16831	0.41884	0.69088	0.87893	0.96603	0.99330	0.99908	0.99991
0.6	1.0	0.07513	0.18784	0.45568	0.72848	0.90203	0.97504	0.99559	0.99946	0.99996
0.5	1.0	0.08620	0.21066	0.49532	0.76585	0.92298	0.98240	0.99725	0.99971	0.99998
0.4	1.0	0.10102	0.23761	0.53758	0.80223	0.94138	0.98814	0.99838	0.99985	0.99999
0.3	1.0	0.12180	0.27013	0.58238	0.83688	0.95698	0.99242	0.99911	0.99993	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES		NON CENTRALITY PARAMETER								
V1	V2	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	0.01000	0.05964	0.20221	0.41146	0.63533	0.81641	0.92683	0.97732	0.99460
0.9	1.0	0.01126	0.06994	0.23345	0.46059	0.68655	0.85430	0.94716	0.98531	0.99690
0.8	1.0	0.01288	0.08198	0.26847	0.51267	0.73702	0.88845	0.96367	0.99107	0.99836
0.7	1.0	0.01501	0.09606	0.30742	0.56698	0.78543	0.91803	0.97639	0.99495	0.99921
0.6	1.0	0.01791	0.11257	0.35038	0.62258	0.83045	0.94255	0.98560	0.99737	0.99965
0.5	1.0	0.02199	0.13204	0.39735	0.67830	0.87089	0.96186	0.99185	0.99875	0.99986
0.4	1.0	0.02805	0.15521	0.44819	0.73282	0.90578	0.97621	0.99576	0.99947	0.99995
0.3	1.0	0.03774	0.18342	0.50274	0.78472	0.93454	0.98619	0.99800	0.99980	0.99999

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.08077	0.18439	0.36931	0.59880	0.79990	0.92438	0.97881	0.99566
1.0	2.0	3.0	0.05664	0.12128	0.30176	0.54567	0.76870	0.91125	0.97500	0.99492	0.99926
1.0	3.0	5.0	0.11157	0.19782	0.41690	0.66929	0.85899	0.95628	0.99041	0.99854	0.99985
1.0	2.0	4.0	0.06800	0.15233	0.37108	0.63205	0.83665	0.94674	0.98755	0.99795	0.99977
1.0	3.0	9.0	0.33636	0.43324	0.64950	0.84592	0.95295	0.99024	0.99865	0.99988	0.99999
1.0	1.0	3.0	0.06078	0.14748	0.37146	0.63624	0.84086	0.94894	0.98824	0.99808	0.99978
1.0	1.0	5.0	0.09017	0.20852	0.48314	0.75171	0.91436	0.97925	0.99653	0.99961	0.99997
1.0	3.0	3.0	0.06050	0.11368	0.26783	0.49117	0.71593	0.87757	0.96045	0.99062	0.99839
1.0	5.0	5.0	0.19980	0.26835	0.44776	0.66682	0.84559	0.94706	0.98699	0.99776	0.99974

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.01891	0.05563	0.14462	0.30344	0.51360	0.71997	0.87073	0.95300
1.0	2.0	3.0	0.01361	0.05769	0.18754	0.38648	0.61000	0.79916	0.91874	0.97476	0.99412
1.0	3.0	5.0	0.06638	0.13738	0.32553	0.56416	0.77454	0.90966	0.97277	0.99398	0.99905
1.0	2.0	4.0	0.02304	0.08946	0.27013	0.50998	0.73376	0.88678	0.96336	0.99120	0.99848
1.0	3.0	9.0	0.28882	0.37926	0.58992	0.79851	0.92808	0.98181	0.99681	0.99962	0.99997
1.0	1.0	3.0	0.01541	0.08325	0.26782	0.51219	0.73827	0.89059	0.96534	0.99190	0.99865
1.0	1.0	5.0	0.03999	0.14717	0.40622	0.68188	0.87203	0.96236	0.99213	0.99886	0.99989
1.0	3.0	3.0	0.01741	0.05167	0.15563	0.32477	0.53270	0.73053	0.87459	0.95405	0.98705
1.0	5.0	5.0	0.15540	0.21099	0.36176	0.56265	0.75398	0.89028	0.96247	0.99044	0.99823

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.08077	0.18439	0.36931	0.59880	0.79990	0.92438	0.97881	0.99566
1.0	2.0	3.0	0.05664	0.10889	0.25680	0.46790	0.68469	0.85069	0.94505	0.98459	0.99675
1.0	3.0	5.0	0.11157	0.18871	0.38600	0.62141	0.81438	0.92954	0.97981	0.99573	0.99935
1.0	2.0	4.0	0.06800	0.12499	0.28196	0.49660	0.70758	0.86354	0.95015	0.98603	0.99704
1.0	3.0	9.0	0.33636	0.40320	0.56779	0.75095	0.88791	0.96146	0.99012	0.99815	0.99975
1.0	1.0	3.0	0.06078	0.08815	0.17539	0.32665	0.52259	0.71644	0.86251	0.94642	0.98335
1.0	1.0	5.0	0.09017	0.11614	0.19544	0.32704	0.49643	0.67186	0.81796	0.91557	0.96783
1.0	3.0	3.0	0.06050	0.12703	0.30571	0.53831	0.75122	0.89477	0.96598	0.99177	0.99853
1.0	5.0	5.0	0.19980	0.28760	0.49979	0.72684	0.88634	0.96479	0.99207	0.99873	0.99986

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.01891	0.05563	0.14462	0.30344	0.51360	0.71997	0.87073	0.95300
1.0	2.0	3.0	0.01361	0.05532	0.17385	0.34929	0.54864	0.73173	0.86697	0.94616	0.98249
1.0	3.0	5.0	0.06638	0.13895	0.32616	0.55589	0.75662	0.89097	0.96082	0.98892	0.99757
1.0	2.0	4.0	0.02304	0.07191	0.20705	0.39715	0.59932	0.77231	0.89185	0.95788	0.98676
1.0	3.0	9.0	0.28882	0.35509	0.51986	0.70796	0.85614	0.94330	0.98239	0.99576	0.99922
1.0	1.0	3.0	0.01541	0.02987	0.07683	0.16494	0.29977	0.47134	0.65001	0.80092	0.90443
1.0	1.0	5.0	0.03999	0.05774	0.11165	0.20273	0.32894	0.48007	0.63627	0.77464	0.87956
1.0	3.0	3.0	0.01741	0.07581	0.23373	0.44607	0.65720	0.82254	0.92496	0.97461	0.99324
1.0	5.0	5.0	0.15540	0.24117	0.45071	0.68154	0.85363	0.94741	0.98548	0.99697	0.99953

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 5 7

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.09387	0.22793	0.43831	0.66888	0.84877	0.94820	0.98698	0.99763
1.0	2.0	3.0	0.03600	0.06525	0.16484	0.34554	0.57469	0.78130	0.91396	0.97471	0.99455
1.0	3.0	5.0	0.16067	0.19662	0.30894	0.49082	0.69645	0.86090	0.95295	0.98861	0.99808
1.0	2.0	4.0	0.05916	0.09635	0.21480	0.41162	0.64010	0.82862	0.93873	0.98402	0.99704
1.0	3.0	9.0	0.52200	0.56553	0.67917	0.81531	0.92098	0.97590	0.99493	0.99928	0.99993
1.0	1.0	3.0	0.03353	0.07668	0.21009	0.42190	0.65593	0.84015	0.94364	0.98524	0.99719
1.0	1.0	5.0	0.09190	0.16174	0.35004	0.59149	0.80050	0.92718	0.98079	0.99645	0.99955
1.0	3.0	3.0	0.04770	0.07299	0.16016	0.32321	0.54036	0.74925	0.89410	0.96631	0.99211
1.0	5.0	5.0	0.28848	0.31402	0.39607	0.53604	0.70605	0.85437	0.94599	0.98551	0.99726

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.03449	0.11294	0.25331	0.44700	0.65488	0.82506	0.92991	0.97819
1.0	2.0	3.0	0.00965	0.01898	0.05625	0.14423	0.29923	0.50474	0.70984	0.86487	0.95274
1.0	3.0	5.0	0.13666	0.15571	0.21822	0.33418	0.50051	0.68590	0.84268	0.94055	0.98402
1.0	2.0	4.0	0.03477	0.05309	0.11508	0.23438	0.41320	0.61884	0.80012	0.91998	0.97713
1.0	3.0	9.0	0.50189	0.53541	0.62729	0.75085	0.86727	0.94631	0.98426	0.99679	0.99956
1.0	1.0	3.0	0.00772	0.03136	0.10830	0.24819	0.44242	0.65105	0.82302	0.93073	0.98041
1.0	1.0	5.0	0.06797	0.12323	0.27609	0.48756	0.69995	0.86122	0.95200	0.98830	0.99810
1.0	3.0	3.0	0.01932	0.02652	0.05615	0.12911	0.26445	0.45532	0.66052	0.82919	0.93427
1.0	5.0	5.0	0.26234	0.27371	0.31301	0.39228	0.51763	0.67279	0.81940	0.92271	0.97560

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 5 7

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.10036	0.24889	0.47008	0.69940	0.86868	0.95720	0.98981	0.99825
1.0	2.0	3.0	0.03600	0.05021	0.10091	0.20562	0.37110	0.57225	0.75870	0.89002	0.96025
1.0	3.0	5.0	0.16067	0.18699	0.26581	0.39370	0.55609	0.72255	0.85762	0.94214	0.98196
1.0	2.0	4.0	0.05916	0.07441	0.12569	0.22532	0.37816	0.56497	0.74405	0.87713	0.95308
1.0	3.0	9.0	0.52200	0.54448	0.60763	0.69900	0.79951	0.88796	0.94945	0.98228	0.99533
1.0	1.0	3.0	0.03353	0.04832	0.10048	0.20631	0.37064	0.56815	0.75116	0.88208	0.95468
1.0	1.0	5.0	0.09190	0.09976	0.12792	0.18839	0.29308	0.44109	0.61081	0.76802	0.88511
1.0	3.0	3.0	0.04770	0.06658	0.12885	0.24565	0.41645	0.61291	0.78773	0.90658	0.96776
1.0	5.0	5.0	0.28848	0.32321	0.42090	0.56209	0.71574	0.84735	0.93478	0.97863	0.99480

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.04219	0.14033	0.30251	0.50756	0.70962	0.86198	0.94851	0.98519
1.0	2.0	3.0	0.00965	0.01471	0.03283	0.07341	0.15092	0.27622	0.44298	0.62315	0.78081
1.0	3.0	5.0	0.13666	0.15814	0.22071	0.31921	0.44530	0.58625	0.72421	0.84010	0.92162
1.0	2.0	4.0	0.03477	0.04297	0.06928	0.11925	0.20135	0.32137	0.47347	0.63637	0.78219
1.0	3.0	9.0	0.50189	0.52237	0.57940	0.66129	0.75269	0.83864	0.90786	0.95515	0.98196
1.0	1.0	3.0	0.00772	0.01291	0.03169	0.07388	0.15358	0.27992	0.44483	0.62111	0.77679
1.0	1.0	5.0	0.06797	0.07005	0.07787	0.09659	0.13517	0.20414	0.31009	0.45076	0.61468
1.0	3.0	3.0	0.01932	0.03024	0.06475	0.12833	0.22845	0.36746	0.53314	0.69808	0.83293
1.0	5.0	5.0	0.26234	0.29363	0.38066	0.50532	0.64384	0.77279	0.87456	0.94170	0.97787

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 7 5 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.10036	0.24889	0.47008	0.69940	0.86868	0.95720	0.98981	0.99825
1.0	2.0	3.0	0.09263	0.20864	0.47955	0.74746	0.91192	0.97842	0.99635	0.99958	0.99997
1.0	3.0	5.0	0.12737	0.26359	0.55950	0.81552	0.94674	0.98957	0.99863	0.99988	0.99999
1.0	2.0	4.0	0.11190	0.24499	0.53877	0.80052	0.94003	0.98768	0.99830	0.99984	0.99999
1.0	3.0	9.0	0.23958	0.38242	0.66971	0.88422	0.97356	0.99610	0.99963	0.99998	1.00000
1.0	1.0	3.0	0.10567	0.23788	0.53139	0.79547	0.93787	0.98710	0.99820	0.99983	0.99999
1.0	1.0	5.0	0.14925	0.30039	0.61190	0.85572	0.96436	0.99420	0.99938	0.99996	1.00000
1.0	3.0	3.0	0.08893	0.19492	0.44941	0.71507	0.89143	0.97029	0.99427	0.99923	0.99993
1.0	5.0	5.0	0.16591	0.28816	0.55980	0.80543	0.93961	0.98708	0.99812	0.99982	0.99999

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.04219	0.14033	0.30251	0.50756	0.70962	0.86198	0.94851	0.98519
1.0	2.0	3.0	0.02562	0.13057	0.38683	0.66478	0.86151	0.95783	0.99073	0.99855	0.99984
1.0	3.0	5.0	0.04870	0.18196	0.48220	0.76166	0.92151	0.98181	0.99708	0.99968	0.99998
1.0	2.0	4.0	0.03567	0.16278	0.45525	0.73834	0.90902	0.97753	0.99612	0.99954	0.99996
1.0	3.0	9.0	0.14589	0.29663	0.60802	0.85303	0.96322	0.99391	0.99934	0.99995	1.00000
1.0	1.0	3.0	0.03269	0.15711	0.44594	0.72987	0.90441	0.97595	0.99577	0.99949	0.99996
1.0	1.0	5.0	0.05974	0.21395	0.54219	0.81581	0.94937	0.99060	0.99883	0.99990	0.99999
1.0	3.0	3.0	0.02491	0.12022	0.35805	0.62788	0.83272	0.94310	0.98567	0.99737	0.99965
1.0	5.0	5.0	0.09326	0.21262	0.48656	0.75143	0.91206	0.97766	0.99599	0.99950	0.99996

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 7 5 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.09387	0.22793	0.43831	0.66887	0.84877	0.94820	0.98698	0.99763
1.0	2.0	3.0	0.09263	0.18446	0.41266	0.66822	0.85693	0.95412	0.98928	0.99821	0.99979
1.0	3.0	5.0	0.12737	0.24222	0.50597	0.76106	0.91564	0.97862	0.99617	0.99952	0.99996
1.0	2.0	4.0	0.11190	0.20612	0.43675	0.68844	0.86871	0.95879	0.99054	0.99843	0.99981
1.0	3.0	9.0	0.23958	0.34521	0.58321	0.80554	0.93429	0.98413	0.99730	0.99968	0.99997
1.0	1.0	3.0	0.10567	0.16028	0.31252	0.52297	0.72913	0.87802	0.95739	0.98859	0.99767
1.0	1.0	5.0	0.14925	0.20213	0.34679	0.54227	0.73221	0.87207	0.95081	0.98489	0.99630
1.0	3.0	3.0	0.08893	0.19866	0.45800	0.72258	0.89477	0.97104	0.99432	0.99922	0.99992
1.0	5.0	5.0	0.16591	0.29377	0.57259	0.81662	0.94486	0.98853	0.99837	0.99984	0.99999

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.03449	0.11294	0.25331	0.44700	0.65488	0.82506	0.92991	0.97819
1.0	2.0	3.0	0.02562	0.11012	0.32519	0.58062	0.79055	0.91781	0.97519	0.99434	0.99904
1.0	3.0	5.0	0.04870	0.16385	0.43365	0.70653	0.88495	0.96633	0.99274	0.99886	0.99987
1.0	2.0	4.0	0.03567	0.12531	0.34971	0.60802	0.81154	0.92909	0.97949	0.99551	0.99926
1.0	3.0	9.0	0.14589	0.25717	0.51214	0.75923	0.91139	0.97590	0.99521	0.99931	0.99993
1.0	1.0	3.0	0.03269	0.07542	0.19731	0.37769	0.57992	0.75990	0.88662	0.95651	0.98659
1.0	1.0	5.0	0.05974	0.10575	0.23366	0.41485	0.60859	0.77497	0.89064	0.95558	0.98505
1.0	3.0	3.0	0.02491	0.13050	0.38555	0.65924	0.85387	0.95238	0.98841	0.99792	0.99973
1.0	5.0	5.0	0.09326	0.22442	0.51546	0.78001	0.92797	0.98315	0.99722	0.99968	0.99997

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 3 9

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.12498	0.32487	0.57755	0.79395	0.92446	0.97976	0.99612	0.99947
1.0	2.0	3.0	0.03120	0.05527	0.13825	0.29516	0.50920	0.72240	0.87697	0.95839	0.98949
1.0	3.0	5.0	0.21021	0.22738	0.28911	0.41226	0.58813	0.76878	0.90079	0.96864	0.99291
1.0	2.0	4.0	0.07548	0.09316	0.15878	0.29426	0.49369	0.70530	0.86670	0.95473	0.98880
1.0	3.0	9.0	0.65801	0.67613	0.73049	0.81274	0.89778	0.95848	0.98798	0.99759	0.99967
1.0	1.0	3.0	0.02016	0.03778	0.10434	0.24393	0.45143	0.67376	0.84658	0.94455	0.98510
1.0	1.0	5.0	0.15141	0.17654	0.25958	0.40885	0.60347	0.78854	0.91474	0.97523	0.99506
1.0	3.0	3.0	0.04770	0.07619	0.16860	0.33135	0.54167	0.74396	0.88756	0.96224	0.99051
1.0	5.0	5.0	0.28848	0.30514	0.36246	0.47212	0.62611	0.78537	0.90472	0.96849	0.99247

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.07133	0.23848	0.46453	0.68637	0.85193	0.94533	0.98459	0.99674
1.0	2.0	3.0	0.01106	0.02035	0.05426	0.12903	0.26038	0.44328	0.64222	0.81073	0.92154
1.0	3.0	5.0	0.19345	0.19803	0.21719	0.26645	0.36411	0.51328	0.68722	0.84020	0.93910
1.0	2.0	4.0	0.06027	0.06438	0.08289	0.13370	0.23861	0.40349	0.60230	0.78659	0.91447
1.0	3.0	9.0	0.64882	0.66006	0.69476	0.75342	0.82918	0.90408	0.95872	0.98708	0.99720
1.0	1.0	3.0	0.00694	0.01089	0.02925	0.08090	0.18885	0.35950	0.56747	0.76502	0.90597
1.0	1.0	5.0	0.14214	0.15698	0.20471	0.29376	0.43099	0.60767	0.78655	0.91642	0.97829
1.0	3.0	3.0	0.01932	0.03347	0.08054	0.17181	0.31502	0.49838	0.68610	0.83781	0.93362
1.0	5.0	5.0	0.26234	0.26715	0.28615	0.33218	0.42007	0.55226	0.70655	0.84418	0.93624

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 3 9

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.10036	0.24889	0.47008	0.69940	0.86868	0.95720	0.98981	0.99825
1.0	2.0	3.0	0.03120	0.04572	0.09672	0.20069	0.36449	0.56469	0.75226	0.88609	0.95857
1.0	3.0	5.0	0.21021	0.23888	0.32286	0.45403	0.61293	0.76773	0.88665	0.95667	0.98745
1.0	2.0	4.0	0.07548	0.09344	0.15139	0.25785	0.41359	0.59747	0.76894	0.89278	0.96094
1.0	3.0	9.0	0.65801	0.67920	0.73643	0.81306	0.88837	0.94573	0.97932	0.99405	0.99875
1.0	1.0	3.0	0.02016	0.02936	0.06503	0.14697	0.29026	0.48258	0.68057	0.83726	0.93302
1.0	1.0	5.0	0.15141	0.15844	0.18329	0.23642	0.32998	0.46643	0.62813	0.78136	0.89576
1.0	3.0	3.0	0.04770	0.06657	0.12884	0.24565	0.41645	0.61291	0.78773	0.90657	0.96776
1.0	5.0	5.0	0.28848	0.32321	0.42090	0.56209	0.71574	0.84735	0.93478	0.97863	0.99480

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.04219	0.14033	0.30251	0.50756	0.70962	0.86198	0.94851	0.98519
1.0	2.0	3.0	0.01106	0.01753	0.03939	0.08453	0.16522	0.29063	0.45448	0.63047	0.78460
1.0	3.0	5.0	0.19345	0.21815	0.28884	0.39617	0.52654	0.66318	0.78771	0.88470	0.94761
1.0	2.0	4.0	0.06027	0.07269	0.11060	0.17635	0.27326	0.40151	0.55149	0.70220	0.82967
1.0	3.0	9.0	0.64882	0.66875	0.72231	0.79389	0.86565	0.92416	0.96368	0.98564	0.99545
1.0	1.0	3.0	0.00694	0.00873	0.01669	0.03955	0.09235	0.19052	0.33736	0.51597	0.69677
1.0	1.0	5.0	0.14214	0.14537	0.15603	0.17748	0.21617	0.28084	0.37917	0.51349	0.67480
1.0	3.0	3.0	0.01932	0.03024	0.06475	0.12833	0.22844	0.36745	0.53313	0.69807	0.83293
1.0	5.0	5.0	0.26234	0.29363	0.38066	0.50532	0.64384	0.77279	0.87456	0.94170	0.97787

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 9 3 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.10036	0.24889	0.47008	0.69940	0.86868	0.95720	0.98981	0.99825
1.0	2.0	3.0	0.11938	0.24105	0.51770	0.77814	0.92775	0.98368	0.99748	0.99974	0.99998
1.0	3.0	5.0	0.16746	0.30688	0.60136	0.84299	0.95813	0.99253	0.99912	0.99993	1.00000
1.0	2.0	4.0	0.13810	0.27450	0.56932	0.82184	0.94941	0.99028	0.99875	0.99989	0.99999
1.0	3.0	9.0	0.26009	0.40345	0.68768	0.89414	0.97687	0.99676	0.99971	0.99998	1.00000
1.0	1.0	3.0	0.10567	0.23788	0.53139	0.79547	0.93787	0.98710	0.99820	0.99983	0.99999
1.0	1.0	5.0	0.14925	0.30039	0.61190	0.85572	0.96436	0.99420	0.99938	0.99996	1.00000
1.0	3.0	3.0	0.13482	0.24963	0.51400	0.76921	0.92141	0.98120	0.99689	0.99965	0.99997
1.0	5.0	5.0	0.19770	0.32825	0.60705	0.84085	0.95590	0.99174	0.99897	0.99991	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.04219	0.14033	0.30251	0.50756	0.70962	0.86198	0.94851	0.98519
1.0	2.0	3.0	0.03616	0.14984	0.42057	0.70031	0.88508	0.96805	0.99368	0.99912	0.99992
1.0	3.0	5.0	0.06455	0.20694	0.51857	0.79280	0.93760	0.98703	0.99816	0.99982	0.99999
1.0	2.0	4.0	0.04699	0.18115	0.48319	0.76356	0.92293	0.98240	0.99722	0.99970	0.99998
1.0	3.0	9.0	0.14890	0.30533	0.62284	0.86435	0.96786	0.99502	0.99950	0.99997	1.00000
1.0	1.0	3.0	0.03269	0.15711	0.44594	0.72987	0.90441	0.97595	0.99577	0.99949	0.99996
1.0	1.0	5.0	0.05974	0.21395	0.54219	0.81581	0.94937	0.99060	0.99883	0.99990	0.99999
1.0	3.0	3.0	0.04303	0.15133	0.41183	0.68679	0.87464	0.96310	0.99216	0.99881	0.99987
1.0	5.0	5.0	0.08645	0.22173	0.52045	0.78824	0.93382	0.98555	0.99782	0.99978	0.99998

Table 2.1A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.0 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 9 3 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.12498	0.32487	0.57755	0.79395	0.92446	0.97976	0.99612	0.99947
1.0	2.0	3.0	0.11938	0.24815	0.53413	0.79291	0.93496	0.98579	0.99787	0.99978	0.99999
1.0	3.0	5.0	0.16746	0.30955	0.60695	0.84726	0.95979	0.99289	0.99916	0.99993	1.00000
1.0	2.0	4.0	0.13810	0.26902	0.55559	0.80807	0.94183	0.98779	0.99824	0.99983	0.99999
1.0	3.0	9.0	0.26009	0.39118	0.66123	0.87296	0.96805	0.99464	0.99940	0.99996	1.00000
1.0	1.0	3.0	0.10567	0.20396	0.44214	0.69730	0.87557	0.96207	0.99158	0.99865	0.99985
1.0	1.0	5.0	0.14925	0.24720	0.48049	0.72336	0.88797	0.96599	0.99235	0.99874	0.99985
1.0	3.0	3.0	0.13482	0.27323	0.57057	0.82304	0.94972	0.99027	0.99873	0.99989	0.99999
1.0	5.0	5.0	0.19770	0.34486	0.64373	0.87144	0.96937	0.99521	0.99951	0.99997	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.07133	0.23848	0.46453	0.68637	0.85193	0.94533	0.98459	0.99674
1.0	2.0	3.0	0.03616	0.16532	0.45956	0.74059	0.90884	0.97688	0.99583	0.99947	0.99995
1.0	3.0	5.0	0.06455	0.21584	0.53882	0.81056	0.94600	0.98940	0.99858	0.99987	0.99999
1.0	2.0	4.0	0.04699	0.18150	0.48270	0.76102	0.92010	0.98088	0.99676	0.99962	0.99997
1.0	3.0	9.0	0.14890	0.29397	0.59732	0.84251	0.95792	0.99236	0.99906	0.99992	1.00000
1.0	1.0	3.0	0.03269	0.12661	0.35943	0.62233	0.82380	0.93613	0.98232	0.99632	0.99943
1.0	1.0	5.0	0.05974	0.15888	0.39920	0.65954	0.84843	0.94760	0.98610	0.99720	0.99957
1.0	3.0	3.0	0.04303	0.18558	0.49919	0.77898	0.93068	0.98472	0.99766	0.99975	0.99998
1.0	5.0	5.0	0.08645	0.24702	0.57883	0.84063	0.95939	0.99307	0.99921	0.99994	1.00000

Table 2.1B

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

FOR EQUAL ERROR VARIANCES AND WITHIN TREATMENT SERIAL CORRELATION

WITH VA= 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.00176	0.02820	0.10557	0.22827	0.38597	0.56003	0.72353	0.85130	0.93281
-0.2	0.01478	0.03003	0.08640	0.20530	0.39143	0.60849	0.79607	0.91613	0.97318
0.0	0.05000	0.08077	0.18439	0.36931	0.59880	0.79990	0.92438	0.97881	0.99566
0.2	0.10861	0.16035	0.31348	0.53703	0.75600	0.90363	0.97227	0.99429	0.99917
0.4	0.20944	0.27850	0.46160	0.68539	0.86255	0.95675	0.99047	0.99856	0.99985

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.00048	0.02572	0.09799	0.20799	0.34297	0.48897	0.63182	0.75809	0.85753
-0.2	0.00203	0.00764	0.02816	0.07529	0.16631	0.31136	0.49659	0.68368	0.83276
0.0	0.01000	0.01891	0.05563	0.14462	0.30344	0.51360	0.71997	0.87073	0.95300
0.2	0.02985	0.05256	0.13268	0.28800	0.50325	0.71908	0.87559	0.95779	0.98917
0.4	0.09034	0.13308	0.26413	0.46918	0.69127	0.86152	0.95367	0.98873	0.99805

Table 2.1B ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

FOR EQUAL ERROR VARIANCES AND WITHIN TREATMENT SERIAL CORRELATION

WITH VA= 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 5 7

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.01736	0.07133	0.21750	0.41576	0.61803	0.78517	0.89822	0.96023	0.98742
-0.2	0.01596	0.04939	0.15227	0.32281	0.53512	0.73699	0.88151	0.95851	0.98888
0.0	0.05000	0.09387	0.22793	0.43831	0.66888	0.84877	0.94820	0.98698	0.99763
0.2	0.10582	0.16672	0.33880	0.57351	0.78726	0.92113	0.97885	0.99597	0.99946
0.4	0.25151	0.32423	0.51128	0.72832	0.88903	0.96792	0.99362	0.99914	0.99992

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.01550	0.06646	0.21106	0.40258	0.59656	0.75831	0.87264	0.94163	0.97706
-0.2	0.00225	0.02717	0.10127	0.22219	0.38250	0.56308	0.73283	0.86258	0.94175
0.0	0.01000	0.03449	0.11294	0.25331	0.44700	0.65488	0.82506	0.92991	0.97819
0.2	0.02878	0.06372	0.17404	0.35930	0.58394	0.78364	0.91284	0.97338	0.99392
0.4	0.13687	0.18693	0.33294	0.54462	0.75454	0.90021	0.97047	0.99381	0.99910

Table 2.1B ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

FOR EQUAL ERROR VARIANCES AND WITHIN TREATMENT SERIAL CORRELATION

WITH VA= 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 7 5 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.01736	0.08421	0.26066	0.48742	0.69952	0.85419	0.94277	0.98223	0.99572
-0.2	0.01596	0.06040	0.19081	0.38976	0.61291	0.80159	0.92048	0.97565	0.99439
0.0	0.05000	0.10036	0.24889	0.47008	0.69940	0.86868	0.95720	0.98981	0.99825
0.2	0.10582	0.16970	0.34738	0.58438	0.79557	0.92530	0.98026	0.99629	0.99951
0.4	0.25152	0.32552	0.51449	0.73155	0.89083	0.96853	0.99374	0.99916	0.99992

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.01550	0.08083	0.25229	0.47100	0.67583	0.82924	0.92357	0.97135	0.99121
-0.2	0.00225	0.03802	0.14082	0.29739	0.48488	0.67090	0.82219	0.92086	0.97155
0.0	0.01000	0.04219	0.14033	0.30251	0.50756	0.70962	0.86198	0.94851	0.98519
0.2	0.02878	0.06882	0.19075	0.38544	0.61057	0.80269	0.92262	0.97702	0.99490
0.4	0.13687	0.19050	0.34339	0.55821	0.76526	0.90575	0.97239	0.99426	0.99917

Table 2.1B

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

FOR EQUAL ERROR VARIANCES AND WITHIN TREATMENT SERIAL CORRELATION

WITH VA= 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 3 9

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.07071	0.17424	0.42132	0.68145	0.86325	0.95470	0.98858	0.99784	0.99970
-0.2	0.01757	0.09336	0.29251	0.54247	0.76172	0.90309	0.97005	0.99311	0.99884
0.0	0.05000	0.12498	0.32487	0.57755	0.79395	0.92446	0.97976	0.99612	0.99947
0.2	0.10212	0.18494	0.39904	0.65246	0.84852	0.95189	0.98914	0.99829	0.99981
0.4	0.28841	0.37082	0.57091	0.78157	0.92006	0.97964	0.99648	0.99960	0.99997

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.06799	0.17080	0.41617	0.67492	0.85709	0.95054	0.98659	0.99717	0.99954
-0.2	0.00254	0.07230	0.25532	0.48791	0.70245	0.85672	0.94408	0.98269	0.99582
0.0	0.01000	0.07133	0.23848	0.46453	0.68637	0.85193	0.94533	0.98459	0.99674
0.2	0.02736	0.09190	0.26900	0.50721	0.73210	0.88675	0.96384	0.99146	0.99853
0.4	0.17945	0.24717	0.42693	0.65092	0.83710	0.94404	0.98631	0.99767	0.99973

Table 2.1B

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

FOR EQUAL ERROR VARIANCES AND WITHIN TREATMENT SERIAL CORRELATION

WITH VA= 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 9 3 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.07071	0.13614	0.30801	0.52666	0.72793	0.87145	0.95129	0.98556	0.99672
-0.2	0.01757	0.06221	0.19307	0.39234	0.61524	0.80318	0.92127	0.97594	0.99447
0.0	0.05000	0.10036	0.24889	0.47008	0.69940	0.86868	0.95720	0.98981	0.99825
0.2	0.10212	0.16586	0.34343	0.58097	0.79333	0.92423	0.97990	0.99621	0.99950
0.4	0.28841	0.36000	0.54214	0.74969	0.89996	0.97184	0.99457	0.99930	0.99994

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.06799	0.13178	0.29851	0.50934	0.70420	0.84751	0.93357	0.97590	0.99284
-0.2	0.00254	0.03835	0.14128	0.29808	0.48580	0.67187	0.82296	0.92132	0.97175
0.0	0.01000	0.04219	0.14033	0.30251	0.50756	0.70962	0.86198	0.94851	0.98519
0.2	0.02736	0.06717	0.18852	0.38274	0.60796	0.80078	0.92160	0.97662	0.99478
0.4	0.17945	0.23121	0.37873	0.58543	0.78297	0.91486	0.97587	0.99519	0.99934

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.50 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.36112	0.44102	0.63054	0.82125	0.93884	0.98561	0.99772	0.99976	0.99998
1.0	2.0	3.0	0.22508	0.30358	0.50295	0.72906	0.89174	0.96929	0.99395	0.99918	0.99993
1.0	3.0	5.0	0.22269	0.29934	0.49571	0.72183	0.88750	0.96783	0.99367	0.99916	0.99993
1.0	2.0	4.0	0.21235	0.29355	0.49845	0.72856	0.89241	0.96975	0.99411	0.99922	0.99993
1.0	3.0	9.0	0.40611	0.48059	0.65714	0.83461	0.94377	0.98694	0.99798	0.99979	0.99999
1.0	1.0	3.0	0.26011	0.34486	0.55141	0.77000	0.91468	0.97770	0.99597	0.99950	0.99996
1.0	1.0	5.0	0.23321	0.32352	0.54118	0.76769	0.91500	0.97813	0.99612	0.99953	0.99996
1.0	3.0	3.0	0.20529	0.27710	0.46586	0.69285	0.86860	0.95964	0.99132	0.99872	0.99987
1.0	5.0	5.0	0.28775	0.35021	0.51623	0.71938	0.87937	0.96313	0.99223	0.99890	0.99990

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.18080	0.24686	0.42682	0.65581	0.84485	0.94949	0.98843	0.99817	0.99980
1.0	2.0	3.0	0.08938	0.14228	0.29825	0.52522	0.74775	0.89889	0.97023	0.99367	0.99904
1.0	3.0	5.0	0.11312	0.16484	0.31620	0.53564	0.75185	0.90020	0.97080	0.99395	0.99913
1.0	2.0	4.0	0.08682	0.14320	0.30621	0.53714	0.75785	0.90450	0.97238	0.99426	0.99915
1.0	3.0	9.0	0.31986	0.38036	0.53933	0.73179	0.88334	0.96360	0.99211	0.99884	0.99989
1.0	1.0	3.0	0.11254	0.17673	0.35537	0.59248	0.80128	0.92774	0.98082	0.99633	0.99950
1.0	1.0	5.0	0.10777	0.17925	0.37134	0.61395	0.81751	0.93575	0.98356	0.99700	0.99962
1.0	3.0	3.0	0.07986	0.12408	0.26002	0.47196	0.69830	0.86782	0.95692	0.98978	0.99826
1.0	5.0	5.0	0.19146	0.22995	0.34795	0.53269	0.73231	0.88349	0.96297	0.99167	0.99870

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.50 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.36112	0.44102	0.63054	0.82125	0.93884	0.98561	0.99772	0.99976	0.99998
1.0	2.0	3.0	0.22508	0.29280	0.47196	0.69052	0.86373	0.95645	0.99013	0.99844	0.99983
1.0	3.0	5.0	0.22269	0.28358	0.44879	0.66049	0.84027	0.94485	0.98646	0.99769	0.99973
1.0	2.0	4.0	0.21235	0.27622	0.44818	0.66500	0.84508	0.94733	0.98718	0.99780	0.99974
1.0	3.0	9.0	0.40611	0.45355	0.58114	0.74302	0.87962	0.95874	0.99000	0.99833	0.99981
1.0	1.0	3.0	0.26011	0.32944	0.50888	0.72008	0.88063	0.96304	0.99185	0.99873	0.99986
1.0	1.0	5.0	0.23321	0.29176	0.45081	0.65573	0.83254	0.93890	0.98371	0.99689	0.99958
1.0	3.0	3.0	0.20529	0.27100	0.44734	0.66806	0.84906	0.94990	0.98818	0.99805	0.99978
1.0	5.0	5.0	0.28775	0.34662	0.50408	0.70116	0.86367	0.95484	0.98949	0.99832	0.99982

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.18080	0.24686	0.42682	0.65581	0.84485	0.94949	0.98843	0.99817	0.99980
1.0	2.0	3.0	0.08938	0.13224	0.26324	0.46760	0.68869	0.85864	0.95154	0.98769	0.99771
1.0	3.0	5.0	0.11312	0.15277	0.27229	0.45891	0.66762	0.83857	0.94021	0.98360	0.99675
1.0	2.0	4.0	0.08682	0.12670	0.24916	0.44340	0.66082	0.83684	0.93985	0.98337	0.99661
1.0	3.0	9.0	0.31986	0.35408	0.45339	0.60099	0.75947	0.88554	0.95870	0.98908	0.99794
1.0	1.0	3.0	0.11254	0.15870	0.29692	0.50480	0.71968	0.87700	0.95910	0.98982	0.99812
1.0	1.0	5.0	0.10777	0.14395	0.25545	0.43447	0.64030	0.81512	0.92528	0.97678	0.99457
1.0	3.0	3.0	0.07986	0.12108	0.24736	0.44666	0.66762	0.84365	0.94417	0.98521	0.99714
1.0	5.0	5.0	0.19146	0.23298	0.35390	0.53355	0.72438	0.87268	0.95580	0.98884	0.99800

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.50 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 5 7

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.34575	0.43089	0.63006	0.82557	0.94227	0.98694	0.99802	0.99980	0.99999
1.0	2.0	3.0	0.16640	0.23786	0.42920	0.66569	0.85406	0.95424	0.98996	0.99848	0.99984
1.0	3.0	5.0	0.23621	0.29397	0.45493	0.66664	0.84727	0.94987	0.98859	0.99824	0.99982
1.0	2.0	4.0	0.16330	0.23110	0.41575	0.65038	0.84340	0.94957	0.98865	0.99825	0.99982
1.0	3.0	9.0	0.55945	0.60166	0.71164	0.84032	0.93636	0.98232	0.99669	0.99959	0.99997
1.0	1.0	3.0	0.18747	0.26537	0.46673	0.70176	0.87685	0.96365	0.99250	0.99893	0.99990
1.0	1.0	5.0	0.18904	0.26122	0.45212	0.68373	0.86449	0.95853	0.99119	0.99873	0.99988
1.0	3.0	3.0	0.16055	0.22595	0.40579	0.63825	0.83403	0.94488	0.98713	0.99793	0.99977
1.0	5.0	5.0	0.34815	0.39365	0.52320	0.69981	0.85728	0.95114	0.98837	0.99812	0.99980

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.17009	0.24169	0.43329	0.66955	0.85681	0.95559	0.99039	0.99857	0.99986
1.0	2.0	3.0	0.05982	0.10007	0.22833	0.43778	0.67117	0.85245	0.95078	0.98805	0.99792
1.0	3.0	5.0	0.16280	0.19244	0.29080	0.46248	0.66956	0.84397	0.94574	0.98654	0.99767
1.0	2.0	4.0	0.07268	0.10945	0.22832	0.42739	0.65658	0.84138	0.94556	0.98648	0.99762
1.0	3.0	9.0	0.51557	0.54244	0.62296	0.74331	0.86433	0.94723	0.98549	0.99726	0.99965
1.0	1.0	3.0	0.07092	0.11953	0.26697	0.49042	0.71936	0.88236	0.96343	0.99171	0.99865
1.0	1.0	5.0	0.10452	0.14863	0.28304	0.49043	0.71045	0.87432	0.95978	0.99078	0.99852
1.0	3.0	3.0	0.06168	0.09630	0.20975	0.40403	0.63403	0.82560	0.93775	0.98378	0.99697
1.0	5.0	5.0	0.28342	0.30544	0.38060	0.51785	0.69252	0.84833	0.94470	0.98560	0.99739

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.50 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 5 7

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.34575	0.41866	0.59833	0.79183	0.92216	0.97965	0.99636	0.99956	0.99996
1.0	2.0	3.0	0.16640	0.21288	0.35037	0.55299	0.75644	0.89927	0.96931	0.99326	0.99895
1.0	3.0	5.0	0.23621	0.26931	0.37195	0.53708	0.72341	0.87279	0.95680	0.98951	0.99822
1.0	2.0	4.0	0.16330	0.20272	0.32318	0.51134	0.71539	0.87227	0.95736	0.98970	0.99824
1.0	3.0	9.0	0.55945	0.57931	0.63984	0.73559	0.84274	0.92826	0.97601	0.99432	0.99907
1.0	1.0	3.0	0.18747	0.23848	0.38480	0.59009	0.78510	0.91460	0.97492	0.99465	0.99918
1.0	1.0	5.0	0.18904	0.22406	0.33204	0.50440	0.69860	0.85642	0.94836	0.98639	0.99744
1.0	3.0	3.0	0.16055	0.20347	0.33275	0.52939	0.73503	0.88616	0.96392	0.99177	0.99867
1.0	5.0	5.0	0.34815	0.37894	0.47248	0.61862	0.77834	0.90182	0.96825	0.99275	0.99886

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.17009	0.22610	0.38531	0.60381	0.80322	0.92771	0.98091	0.99644	0.99954
1.0	2.0	3.0	0.05982	0.08113	0.15500	0.29694	0.49610	0.70264	0.86047	0.94921	0.98592
1.0	3.0	5.0	0.16280	0.17803	0.23003	0.33192	0.48593	0.66580	0.82461	0.92857	0.97814
1.0	2.0	4.0	0.07268	0.08964	0.14936	0.26870	0.44714	0.64870	0.81944	0.92724	0.97759
1.0	3.0	9.0	0.51557	0.52671	0.56225	0.62620	0.71697	0.81915	0.90723	0.96346	0.98934
1.0	1.0	3.0	0.07092	0.09668	0.18286	0.33924	0.54445	0.74291	0.88465	0.95962	0.98911
1.0	1.0	5.0	0.10452	0.11930	0.17139	0.27625	0.43634	0.62441	0.79366	0.90953	0.96925
1.0	3.0	3.0	0.06168	0.08091	0.14790	0.27896	0.46904	0.67519	0.84111	0.93965	0.98261
1.0	5.0	5.0	0.28342	0.30006	0.35382	0.45174	0.59055	0.74404	0.87244	0.95141	0.98633

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.50 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 7 5 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.34575	0.41866	0.59833	0.79183	0.92216	0.97965	0.99636	0.99956	0.99996
1.0	2.0	3.0	0.28148	0.36616	0.57047	0.78315	0.92113	0.97989	0.99647	0.99958	0.99997
1.0	3.0	5.0	0.26439	0.35802	0.57781	0.79612	0.92980	0.98320	0.99726	0.99970	0.99998
1.0	2.0	4.0	0.28293	0.37519	0.59098	0.80388	0.93304	0.98410	0.99742	0.99972	0.99998
1.0	3.0	9.0	0.34176	0.44615	0.67197	0.86525	0.96231	0.99295	0.99913	0.99993	1.00000
1.0	1.0	3.0	0.33082	0.42040	0.62706	0.82590	0.94256	0.98689	0.99796	0.99979	0.99998
1.0	1.0	5.0	0.32804	0.42895	0.65160	0.84965	0.95489	0.99073	0.99871	0.99988	0.99999
1.0	3.0	3.0	0.24997	0.32824	0.52441	0.74291	0.89779	0.97100	0.99425	0.99921	0.99993
1.0	5.0	5.0	0.27396	0.35533	0.55466	0.76825	0.91242	0.97672	0.99575	0.99948	0.99996

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.17009	0.22610	0.38531	0.60382	0.80322	0.92771	0.98091	0.99644	0.99954
1.0	2.0	3.0	0.12452	0.19327	0.37961	0.61776	0.81940	0.93679	0.98398	0.99710	0.99963
1.0	3.0	5.0	0.12012	0.20157	0.41170	0.65970	0.85117	0.95232	0.98907	0.99824	0.99980
1.0	2.0	4.0	0.12738	0.20798	0.41654	0.66318	0.85331	0.95322	0.98930	0.99826	0.99980
1.0	3.0	9.0	0.20318	0.30802	0.55076	0.78672	0.92788	0.98304	0.99728	0.99971	0.99998
1.0	1.0	3.0	0.16073	0.24178	0.44928	0.68956	0.86918	0.95994	0.99124	0.99864	0.99985
1.0	1.0	5.0	0.16515	0.26521	0.50390	0.74901	0.90723	0.97544	0.99540	0.99940	0.99994
1.0	3.0	3.0	0.10532	0.16376	0.32898	0.55654	0.76934	0.90897	0.97342	0.99435	0.99914
1.0	5.0	5.0	0.14695	0.21247	0.38953	0.61698	0.81365	0.93233	0.98221	0.99670	0.99958

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.50 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 7 5 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.34575	0.43089	0.63006	0.82557	0.94227	0.98694	0.99802	0.99980	0.99999
1.0	2.0	3.0	0.28148	0.36326	0.56294	0.77510	0.91624	0.97805	0.99603	0.99951	0.99996
1.0	3.0	5.0	0.26439	0.34576	0.54559	0.76097	0.90798	0.97481	0.99520	0.99937	0.99994
1.0	2.0	4.0	0.28293	0.36332	0.56016	0.77083	0.91293	0.97651	0.99558	0.99943	0.99995
1.0	3.0	9.0	0.34176	0.41535	0.59499	0.78726	0.91802	0.97750	0.99571	0.99944	0.99995
1.0	1.0	3.0	0.33082	0.41127	0.60405	0.80229	0.92896	0.98207	0.99687	0.99962	0.99997
1.0	1.0	5.0	0.32804	0.40224	0.58394	0.77936	0.91329	0.97527	0.99495	0.99927	0.99993
1.0	3.0	3.0	0.24997	0.33173	0.53387	0.75377	0.90498	0.97398	0.99505	0.99935	0.99994
1.0	5.0	5.0	0.27396	0.35637	0.55708	0.77039	0.91340	0.97696	0.99578	0.99948	0.99996

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.17009	0.24169	0.43329	0.66955	0.85681	0.95559	0.99039	0.99857	0.99986
1.0	2.0	3.0	0.12452	0.18828	0.36489	0.59843	0.80404	0.92878	0.98117	0.99643	0.99952
1.0	3.0	5.0	0.12012	0.18610	0.36527	0.59735	0.80044	0.92533	0.97944	0.99591	0.99942
1.0	2.0	4.0	0.12738	0.19100	0.36622	0.59688	0.80051	0.92569	0.97960	0.99593	0.99941
1.0	3.0	9.0	0.20318	0.26700	0.43617	0.64804	0.82802	0.93637	0.98267	0.99661	0.99953
1.0	1.0	3.0	0.16073	0.22640	0.40521	0.63432	0.82783	0.93983	0.98467	0.99717	0.99962
1.0	1.0	5.0	0.16515	0.22521	0.39003	0.60662	0.79936	0.92102	0.97631	0.99463	0.99909
1.0	3.0	3.0	0.10532	0.16831	0.34324	0.57698	0.78740	0.91957	0.97765	0.99551	0.99936
1.0	5.0	5.0	0.14695	0.21635	0.40024	0.62971	0.82260	0.93638	0.98342	0.99693	0.99961

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.50 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 3 9

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.31795	0.40614	0.61299	0.81689	0.93916	0.98619	0.99790	0.99979	0.99999
1.0	2.0	3.0	0.13480	0.20061	0.38317	0.62195	0.82525	0.94147	0.98619	0.99775	0.99975
1.0	3.0	5.0	0.26587	0.31178	0.44705	0.64076	0.82256	0.93659	0.98418	0.99731	0.99970
1.0	2.0	4.0	0.15052	0.20631	0.36799	0.59414	0.80161	0.92950	0.98238	0.99697	0.99965
1.0	3.0	9.0	0.67873	0.70201	0.76842	0.85807	0.93557	0.97938	0.99550	0.99935	0.99994
1.0	1.0	3.0	0.12663	0.19284	0.37673	0.61752	0.82276	0.94034	0.98580	0.99765	0.99973
1.0	1.0	5.0	0.20752	0.25700	0.40277	0.61147	0.80749	0.93080	0.98258	0.99700	0.99965
1.0	3.0	3.0	0.14691	0.21167	0.39098	0.62548	0.82587	0.94124	0.98602	0.99770	0.99974
1.0	5.0	5.0	0.34056	0.38269	0.50538	0.67905	0.84119	0.94297	0.98567	0.99755	0.99972

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.14946	0.22210	0.41716	0.65896	0.85164	0.95380	0.98996	0.99850	0.99985
1.0	2.0	3.0	0.04639	0.07990	0.19134	0.38564	0.61927	0.81651	0.93356	0.98235	0.99662
1.0	3.0	5.0	0.21014	0.22952	0.29955	0.43709	0.62505	0.80485	0.92427	0.97884	0.99586
1.0	2.0	4.0	0.08326	0.10803	0.19544	0.36136	0.58023	0.78346	0.91591	0.97618	0.99520
1.0	3.0	9.0	0.65497	0.66606	0.70428	0.77420	0.86150	0.93591	0.97867	0.99506	0.99922
1.0	1.0	3.0	0.04231	0.07542	0.18632	0.38073	0.61514	0.81350	0.93178	0.98158	0.99640
1.0	1.0	5.0	0.15806	0.17998	0.25743	0.40584	0.60505	0.79388	0.91932	0.97716	0.99547
1.0	3.0	3.0	0.05480	0.08907	0.20120	0.39375	0.62376	0.81803	0.93383	0.98237	0.99663
1.0	5.0	5.0	0.27983	0.29900	0.36600	0.49336	0.66390	0.82541	0.93224	0.98104	0.99628

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.50 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 3 9

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.31795	0.39300	0.57877	0.78029	0.91720	0.97816	0.99606	0.99952	0.99996
1.0	2.0	3.0	0.13480	0.17950	0.31411	0.51824	0.73036	0.88490	0.96371	0.99174	0.99867
1.0	3.0	5.0	0.26587	0.29717	0.39459	0.55233	0.73170	0.87644	0.95811	0.98989	0.99830
1.0	2.0	4.0	0.15052	0.18623	0.29813	0.48010	0.68705	0.85427	0.94950	0.98736	0.99777
1.0	3.0	9.0	0.67873	0.69380	0.73930	0.81031	0.88862	0.95006	0.98367	0.99624	0.99941
1.0	1.0	3.0	0.12663	0.17087	0.30436	0.50769	0.72078	0.87832	0.96047	0.99063	0.99841
1.0	1.0	5.0	0.20752	0.23359	0.31870	0.46747	0.65356	0.82190	0.93069	0.98027	0.99600
1.0	3.0	3.0	0.14691	0.19182	0.32633	0.52886	0.73788	0.88908	0.96547	0.99229	0.99879
1.0	5.0	5.0	0.34056	0.37361	0.47281	0.62459	0.78627	0.90770	0.97102	0.99359	0.99903

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.14946	0.20552	0.36604	0.58864	0.79402	0.92364	0.97963	0.99616	0.99949
1.0	2.0	3.0	0.04639	0.06589	0.13452	0.26972	0.46543	0.67576	0.84289	0.94079	0.98300
1.0	3.0	5.0	0.21014	0.22519	0.27570	0.37290	0.51839	0.68773	0.83698	0.93424	0.98018
1.0	2.0	4.0	0.08326	0.09795	0.15030	0.25767	0.42468	0.62255	0.79898	0.91610	0.97334
1.0	3.0	9.0	0.65497	0.66408	0.69238	0.74131	0.80803	0.88041	0.94056	0.97748	0.99372
1.0	1.0	3.0	0.04231	0.06126	0.12837	0.26141	0.45505	0.66487	0.83395	0.93531	0.98054
1.0	1.0	5.0	0.15806	0.16732	0.20176	0.27755	0.40657	0.57701	0.74951	0.88148	0.95671
1.0	3.0	3.0	0.05480	0.07553	0.14690	0.28416	0.47945	0.68685	0.84997	0.94440	0.98442
1.0	5.0	5.0	0.27983	0.29858	0.35815	0.46362	0.60803	0.76175	0.88522	0.95795	0.98867

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.50 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 9 3 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.31795	0.39300	0.57877	0.78029	0.91721	0.97816	0.99606	0.99952	0.99996
1.0	2.0	3.0	0.30134	0.38724	0.59154	0.79891	0.92914	0.98256	0.99706	0.99966	0.99997
1.0	3.0	5.0	0.30282	0.39613	0.61116	0.81798	0.93960	0.98610	0.99782	0.99977	0.99998
1.0	2.0	4.0	0.30078	0.39312	0.60706	0.81463	0.93793	0.98556	0.99770	0.99975	0.99998
1.0	3.0	9.0	0.35803	0.46114	0.68293	0.87091	0.96423	0.99336	0.99919	0.99993	1.00000
1.0	1.0	3.0	0.30668	0.39776	0.60934	0.81541	0.93818	0.98565	0.99772	0.99976	0.99998
1.0	1.0	5.0	0.30713	0.40941	0.63658	0.84110	0.95153	0.98985	0.99856	0.99986	0.99999
1.0	3.0	3.0	0.29889	0.37995	0.57660	0.78348	0.91977	0.97901	0.99619	0.99953	0.99996
1.0	5.0	5.0	0.31312	0.39834	0.59988	0.80310	0.93036	0.98274	0.99706	0.99966	0.99997

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.14946	0.20552	0.36604	0.58864	0.79402	0.92364	0.97963	0.99616	0.99949
1.0	2.0	3.0	0.13922	0.21056	0.40155	0.63993	0.83523	0.94448	0.98651	0.99766	0.99971
1.0	3.0	5.0	0.14566	0.22984	0.44337	0.68758	0.86843	0.95955	0.99110	0.99862	0.99985
1.0	2.0	4.0	0.14125	0.22300	0.43289	0.67746	0.86217	0.95695	0.99034	0.99846	0.99983
1.0	3.0	9.0	0.21061	0.31605	0.55875	0.79228	0.93035	0.98373	0.99740	0.99972	0.99998
1.0	1.0	3.0	0.14468	0.22457	0.43124	0.67471	0.86044	0.95637	0.99024	0.99845	0.99983
1.0	1.0	5.0	0.15201	0.25082	0.48877	0.73715	0.90086	0.97312	0.99483	0.99930	0.99993
1.0	3.0	3.0	0.13795	0.20265	0.38010	0.61125	0.81167	0.93180	0.98192	0.99654	0.99952
1.0	5.0	5.0	0.15763	0.23156	0.42483	0.65846	0.84496	0.94785	0.98731	0.99781	0.99974

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 0.50 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 9 3 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.31795	0.40614	0.61299	0.81689	0.93916	0.98619	0.99790	0.99979	0.99999
1.0	2.0	3.0	0.30134	0.39017	0.59895	0.80652	0.93352	0.98412	0.99740	0.99971	0.99998
1.0	3.0	5.0	0.30282	0.39472	0.60737	0.81376	0.93698	0.98511	0.99758	0.99973	0.99998
1.0	2.0	4.0	0.30078	0.38880	0.59598	0.80299	0.93105	0.98306	0.99712	0.99967	0.99997
1.0	3.0	9.0	0.35803	0.44334	0.63977	0.82928	0.94209	0.98624	0.99775	0.99975	0.99998
1.0	1.0	3.0	0.30668	0.39066	0.59129	0.79666	0.92723	0.98171	0.99682	0.99962	0.99997
1.0	1.0	5.0	0.30713	0.38523	0.57509	0.77689	0.91334	0.97560	0.99509	0.99930	0.99993
1.0	3.0	3.0	0.29889	0.39004	0.60243	0.81059	0.93585	0.98490	0.99757	0.99974	0.99998
1.0	5.0	5.0	0.31312	0.40941	0.62739	0.83068	0.94581	0.98804	0.99821	0.99982	0.99999

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.14946	0.22210	0.41716	0.65896	0.85164	0.95380	0.98996	0.99850	0.99985
1.0	2.0	3.0	0.13922	0.21576	0.41639	0.65846	0.84903	0.95115	0.98866	0.99813	0.99978
1.0	3.0	5.0	0.14566	0.23078	0.44507	0.68818	0.86777	0.95877	0.99073	0.99851	0.99983
1.0	2.0	4.0	0.14125	0.21845	0.41925	0.65939	0.84795	0.94976	0.98793	0.99791	0.99974
1.0	3.0	9.0	0.21061	0.29389	0.49901	0.72414	0.88518	0.96474	0.99218	0.99877	0.99986
1.0	1.0	3.0	0.14468	0.21402	0.40061	0.63563	0.83066	0.94166	0.98537	0.99735	0.99965
1.0	1.0	5.0	0.15201	0.21746	0.39341	0.61747	0.81015	0.92759	0.97906	0.99544	0.99926
1.0	3.0	3.0	0.13795	0.21893	0.42738	0.67182	0.85836	0.95530	0.98989	0.99838	0.99982
1.0	5.0	5.0	0.15763	0.25125	0.47926	0.72337	0.89087	0.96882	0.99368	0.99910	0.99991

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 1.00 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.54068	0.61349	0.77127	0.90642	0.97407	0.99522	0.99942	0.99995	1.00000
1.0	2.0	3.0	0.36582	0.44811	0.64051	0.82957	0.94299	0.98689	0.99796	0.99979	0.99999
1.0	3.0	5.0	0.32776	0.40794	0.60128	0.80154	0.92968	0.98280	0.99717	0.99969	0.99998
1.0	2.0	4.0	0.33991	0.42350	0.62057	0.81720	0.93757	0.98529	0.99765	0.99975	0.99998
1.0	3.0	9.0	0.47403	0.54396	0.70642	0.86384	0.95602	0.99039	0.99861	0.99987	0.99999
1.0	1.0	3.0	0.41324	0.49565	0.68260	0.85696	0.95498	0.99031	0.99860	0.99986	0.99999
1.0	1.0	5.0	0.35866	0.44450	0.64257	0.83322	0.94510	0.98755	0.99809	0.99980	0.99999
1.0	3.0	3.0	0.33351	0.41355	0.60590	0.80416	0.93054	0.98292	0.99715	0.99968	0.99998
1.0	5.0	5.0	0.37296	0.44210	0.61359	0.79974	0.92561	0.98088	0.99669	0.99962	0.99997

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.34790	0.42763	0.61825	0.81276	0.93482	0.98436	0.99746	0.99973	0.99998
1.0	2.0	3.0	0.18718	0.25772	0.44538	0.67548	0.85791	0.95504	0.98996	0.99844	0.99983
1.0	3.0	5.0	0.17624	0.23854	0.41085	0.63634	0.82989	0.94217	0.98615	0.99771	0.99974
1.0	2.0	4.0	0.17063	0.24020	0.42680	0.65916	0.84739	0.95036	0.98856	0.99817	0.99980
1.0	3.0	9.0	0.35966	0.41867	0.57327	0.75791	0.89895	0.97021	0.99398	0.99919	0.99993
1.0	1.0	3.0	0.22856	0.30582	0.50228	0.72606	0.88865	0.96754	0.99334	0.99905	0.99991
1.0	1.0	5.0	0.19260	0.26848	0.46450	0.69477	0.86977	0.95972	0.99118	0.99866	0.99986
1.0	3.0	3.0	0.16327	0.22685	0.40236	0.63126	0.82712	0.94073	0.98554	0.99753	0.99971
1.0	5.0	5.0	0.24016	0.28988	0.43317	0.63336	0.81852	0.93444	0.98331	0.99708	0.99966

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 1.00 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 = 12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.54068	0.61349	0.77127	0.90642	0.97407	0.99522	0.99942	0.99995	1.00000
1.0	2.0	3.0	0.36582	0.44258	0.62634	0.81479	0.93438	0.98383	0.99728	0.99969	0.99998
1.0	3.0	5.0	0.32776	0.39753	0.57324	0.77002	0.90959	0.97496	0.99524	0.99939	0.99995
1.0	2.0	4.0	0.33991	0.41435	0.59667	0.79145	0.92192	0.97945	0.99628	0.99954	0.99996
1.0	3.0	9.0	0.47403	0.52647	0.66028	0.81351	0.92514	0.97885	0.99592	0.99947	0.99996
1.0	1.0	3.0	0.41324	0.48949	0.66734	0.84177	0.94660	0.98751	0.99801	0.99979	0.99998
1.0	1.0	5.0	0.35866	0.42987	0.60460	0.79257	0.92044	0.97832	0.99590	0.99947	0.99995
1.0	3.0	3.0	0.33351	0.40903	0.59392	0.79102	0.92239	0.97982	0.99641	0.99957	0.99997
1.0	5.0	5.0	0.37296	0.43656	0.59815	0.78159	0.91351	0.97597	0.99544	0.99942	0.99995

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.34790	0.42763	0.61825	0.81276	0.93482	0.98436	0.99746	0.99973	0.99998
1.0	2.0	3.0	0.18718	0.25037	0.42326	0.64605	0.83466	0.94331	0.98608	0.99759	0.99971
1.0	3.0	5.0	0.17624	0.22698	0.37354	0.58154	0.78126	0.91438	0.97574	0.99515	0.99933
1.0	2.0	4.0	0.17063	0.22857	0.39103	0.60986	0.80658	0.92856	0.98086	0.99636	0.99951
1.0	3.0	9.0	0.35966	0.39779	0.50828	0.66701	0.82279	0.92939	0.97973	0.99593	0.99944
1.0	1.0	3.0	0.22856	0.29652	0.47570	0.69312	0.86463	0.95637	0.98993	0.99835	0.99981
1.0	1.0	5.0	0.19260	0.24866	0.40487	0.61458	0.80452	0.92505	0.97884	0.99570	0.99938
1.0	3.0	3.0	0.16327	0.22182	0.38633	0.60819	0.80721	0.92971	0.98153	0.99657	0.99956
1.0	5.0	5.0	0.24016	0.28582	0.41843	0.60875	0.79413	0.91924	0.97724	0.99552	0.99940

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 1.00 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 5 7

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.52175	0.59943	0.76608	0.90624	0.97469	0.99548	0.99947	0.99996	1.00000
1.0	2.0	3.0	0.29272	0.37728	0.58103	0.79174	0.92625	0.98194	0.99700	0.99967	0.99998
1.0	3.0	5.0	0.31857	0.38969	0.56965	0.77125	0.91248	0.97678	0.99584	0.99951	0.99996
1.0	2.0	4.0	0.27178	0.35344	0.55470	0.77039	0.91544	0.97833	0.99624	0.99956	0.99997
1.0	3.0	9.0	0.59993	0.64533	0.75733	0.87715	0.95601	0.98925	0.99825	0.99981	0.99999
1.0	1.0	3.0	0.32782	0.41444	0.61746	0.81781	0.93868	0.98578	0.99777	0.99977	0.99998
1.0	1.0	5.0	0.29190	0.37342	0.57240	0.78287	0.92110	0.98013	0.99661	0.99962	0.99997
1.0	3.0	3.0	0.27395	0.35493	0.55478	0.77008	0.91467	0.97797	0.99614	0.99955	0.99997
1.0	5.0	5.0	0.41236	0.47042	0.62006	0.79286	0.91832	0.97761	0.99586	0.99949	0.99996

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.32970	0.41510	0.61642	0.81673	0.93833	0.98579	0.99780	0.99977	0.99998
1.0	2.0	3.0	0.13528	0.19998	0.38003	0.61701	0.82078	0.93892	0.98525	0.99752	0.99971
1.0	3.0	5.0	0.20401	0.25075	0.39013	0.59433	0.79247	0.92229	0.97945	0.99626	0.99954
1.0	2.0	4.0	0.13202	0.19020	0.35704	0.58759	0.79763	0.92725	0.98143	0.99671	0.99960
1.0	3.0	9.0	0.53538	0.56709	0.65844	0.78467	0.89803	0.96548	0.99194	0.99873	0.99987
1.0	1.0	3.0	0.16152	0.23329	0.42508	0.66182	0.85087	0.95237	0.98923	0.99830	0.99982
1.0	1.0	5.0	0.16072	0.22036	0.38821	0.61401	0.81419	0.93459	0.98369	0.99718	0.99967
1.0	3.0	3.0	0.12584	0.18405	0.35112	0.58249	0.79411	0.92545	0.98077	0.99654	0.99957
1.0	5.0	5.0	0.31507	0.35164	0.46340	0.63365	0.80638	0.92484	0.97938	0.99611	0.99951

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 1.00 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 5 7

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.52175	0.59085	0.74614	0.88832	0.96606	0.99304	0.99905	0.99992	1.00000
1.0	2.0	3.0	0.29272	0.35591	0.52220	0.72309	0.88010	0.96258	0.99180	0.99876	0.99987
1.0	3.0	5.0	0.31857	0.36575	0.49907	0.68050	0.84424	0.94460	0.98612	0.99761	0.99972
1.0	2.0	4.0	0.27178	0.32865	0.48394	0.68378	0.85291	0.95012	0.98804	0.99801	0.99978
1.0	3.0	9.0	0.59993	0.62603	0.70097	0.80575	0.90334	0.96496	0.99110	0.99846	0.99982
1.0	1.0	3.0	0.32782	0.39377	0.56220	0.75602	0.89913	0.97001	0.99373	0.99909	0.99991
1.0	1.0	5.0	0.29190	0.34481	0.49042	0.68108	0.84697	0.94597	0.98640	0.99762	0.99972
1.0	3.0	3.0	0.27395	0.33372	0.49478	0.69723	0.86333	0.95532	0.98972	0.99837	0.99982
1.0	5.0	5.0	0.41236	0.45264	0.56697	0.72352	0.86545	0.95245	0.98824	0.99802	0.99978

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.32970	0.39990	0.57637	0.77306	0.91147	0.97566	0.99539	0.99941	0.99995
1.0	2.0	3.0	0.13528	0.17620	0.30158	0.49740	0.70871	0.86982	0.95652	0.98939	0.99814
1.0	3.0	5.0	0.20401	0.22934	0.31267	0.46013	0.64704	0.81794	0.92912	0.97988	0.99595
1.0	2.0	4.0	0.13202	0.16534	0.27137	0.44831	0.65644	0.83211	0.93794	0.98313	0.99670
1.0	3.0	9.0	0.53538	0.54950	0.59581	0.67855	0.78609	0.88763	0.95565	0.98735	0.99747
1.0	1.0	3.0	0.16152	0.20832	0.34618	0.54837	0.75134	0.89496	0.96684	0.99231	0.99871
1.0	1.0	5.0	0.16072	0.19145	0.28921	0.45339	0.65027	0.82217	0.93081	0.98003	0.99583
1.0	3.0	3.0	0.12584	0.16210	0.27613	0.46228	0.67459	0.84688	0.94592	0.98604	0.99742
1.0	5.0	5.0	0.31507	0.33701	0.40881	0.53569	0.69694	0.84467	0.94037	0.98347	0.99678

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 1.00 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 7 5 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.52175	0.59085	0.74614	0.88832	0.96606	0.99304	0.99905	0.99992	1.00000
1.0	2.0	3.0	0.42048	0.49867	0.67872	0.85119	0.95154	0.98916	0.99836	0.99983	0.99999
1.0	3.0	5.0	0.37594	0.45967	0.65275	0.83832	0.94696	0.98803	0.99818	0.99981	0.99999
1.0	2.0	4.0	0.41217	0.49394	0.68001	0.85451	0.95370	0.98988	0.99851	0.99985	0.99999
1.0	3.0	9.0	0.42815	0.51697	0.71079	0.87928	0.96557	0.99342	0.99917	0.99993	1.00000
1.0	1.0	3.0	0.47992	0.55695	0.72814	0.88203	0.96456	0.99276	0.99901	0.99991	0.99999
1.0	1.0	5.0	0.45653	0.53992	0.72240	0.88227	0.96547	0.99310	0.99907	0.99992	0.99999
1.0	3.0	3.0	0.37746	0.45401	0.63609	0.82091	0.93697	0.98455	0.99741	0.99971	0.99998
1.0	5.0	5.0	0.36725	0.44349	0.62622	0.81415	0.93395	0.98372	0.99728	0.99970	0.99998

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.32970	0.39990	0.57637	0.77306	0.91147	0.97566	0.99539	0.99941	0.99995
1.0	2.0	3.0	0.23341	0.30602	0.49358	0.71339	0.87922	0.96328	0.99211	0.99882	0.99988
1.0	3.0	5.0	0.20049	0.27713	0.47381	0.70255	0.87444	0.96167	0.99174	0.99876	0.99987
1.0	2.0	4.0	0.22748	0.30541	0.50257	0.72597	0.88809	0.96708	0.99316	0.99901	0.99990
1.0	3.0	9.0	0.26579	0.35647	0.57142	0.78887	0.92543	0.98163	0.99691	0.99965	0.99997
1.0	1.0	3.0	0.28937	0.36839	0.56250	0.77121	0.91267	0.97628	0.99549	0.99940	0.99995
1.0	1.0	5.0	0.27201	0.35975	0.56883	0.78293	0.92038	0.97913	0.99614	0.99950	0.99996
1.0	3.0	3.0	0.19804	0.26332	0.43900	0.66020	0.84332	0.94686	0.98705	0.99777	0.99973
1.0	5.0	5.0	0.20906	0.27249	0.44360	0.66058	0.84231	0.94636	0.98704	0.99783	0.99975

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 1.00 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 7 5 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.52175	0.59943	0.76608	0.90624	0.97469	0.99548	0.99947	0.99996	1.00000
1.0	2.0	3.0	0.42048	0.50269	0.68860	0.86089	0.95678	0.99086	0.99871	0.99988	0.99999
1.0	3.0	5.0	0.37594	0.45757	0.64756	0.83318	0.94413	0.98709	0.99798	0.99979	0.99999
1.0	2.0	4.0	0.41217	0.49364	0.67932	0.85403	0.95345	0.98982	0.99850	0.99985	0.99999
1.0	3.0	9.0	0.42815	0.50165	0.67367	0.84360	0.94677	0.98748	0.99801	0.99979	0.99999
1.0	1.0	3.0	0.47992	0.55872	0.73236	0.88600	0.96658	0.99338	0.99912	0.99992	1.00000
1.0	1.0	5.0	0.45653	0.53333	0.70668	0.86744	0.95779	0.99069	0.99859	0.99986	0.99999
1.0	3.0	3.0	0.37746	0.46048	0.65251	0.83786	0.94673	0.98797	0.99817	0.99981	0.99999
1.0	5.0	5.0	0.36725	0.44674	0.63454	0.82285	0.93904	0.98553	0.99768	0.99975	0.99998

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.32970	0.41510	0.61642	0.81673	0.93833	0.98579	0.99780	0.99977	0.99998
1.0	2.0	3.0	0.23341	0.31148	0.50922	0.73269	0.89308	0.96954	0.99394	0.99917	0.99992
1.0	3.0	5.0	0.20049	0.27316	0.46274	0.68924	0.86501	0.95741	0.99047	0.99852	0.99984
1.0	2.0	4.0	0.22748	0.30377	0.49838	0.72152	0.88537	0.96603	0.99289	0.99896	0.99990
1.0	3.0	9.0	0.26579	0.33220	0.50502	0.71162	0.87321	0.95939	0.99079	0.99855	0.99984
1.0	1.0	3.0	0.28937	0.37038	0.56811	0.77791	0.91723	0.97820	0.99601	0.99949	0.99996
1.0	1.0	5.0	0.27201	0.34731	0.53566	0.74557	0.89583	0.96883	0.99328	0.99896	0.99989
1.0	3.0	3.0	0.19804	0.27227	0.46545	0.69455	0.86979	0.95992	0.99129	0.99868	0.99986
1.0	5.0	5.0	0.20906	0.27734	0.45793	0.67921	0.85676	0.95353	0.98937	0.99832	0.99982

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 1.00 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 3 9

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.48910	0.57151	0.74884	0.89878	0.97250	0.99505	0.99942	0.99996	1.00000
1.0	2.0	3.0	0.24584	0.32978	0.53726	0.76111	0.91145	0.97718	0.99601	0.99953	0.99996
1.0	3.0	5.0	0.33209	0.39527	0.56072	0.75635	0.90200	0.97256	0.99480	0.99935	0.99995
1.0	2.0	4.0	0.23945	0.31539	0.51032	0.73393	0.89525	0.97121	0.99462	0.99933	0.99995
1.0	3.0	9.0	0.70317	0.73212	0.80758	0.89558	0.95942	0.98917	0.99807	0.99977	0.99998
1.0	1.0	3.0	0.24536	0.33062	0.54018	0.76425	0.91326	0.97779	0.99613	0.99955	0.99996
1.0	1.0	5.0	0.28132	0.34951	0.52772	0.73798	0.89440	0.97030	0.99433	0.99928	0.99994
1.0	3.0	3.0	0.25066	0.33272	0.53662	0.75865	0.90955	0.97640	0.99582	0.99950	0.99996
1.0	5.0	5.0	0.39864	0.45573	0.60488	0.78083	0.91176	0.97525	0.99530	0.99941	0.99995

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.29717	0.38532	0.59443	0.80457	0.93360	0.98454	0.99758	0.99975	0.99998
1.0	2.0	3.0	0.10551	0.16412	0.33359	0.57018	0.78770	0.92303	0.98011	0.99641	0.99955
1.0	3.0	5.0	0.23928	0.27604	0.39186	0.57556	0.76948	0.90768	0.97378	0.99487	0.99932
1.0	2.0	4.0	0.12488	0.17195	0.31559	0.53332	0.75291	0.90326	0.97296	0.99474	0.99930
1.0	3.0	9.0	0.66512	0.68188	0.73485	0.81848	0.90488	0.96395	0.99051	0.99831	0.99980
1.0	1.0	3.0	0.10557	0.16577	0.33846	0.57660	0.79262	0.92536	0.98080	0.99654	0.99957
1.0	1.0	5.0	0.18969	0.22961	0.35434	0.55022	0.75556	0.90163	0.97178	0.99439	0.99924
1.0	3.0	3.0	0.11039	0.16753	0.33332	0.56661	0.78362	0.92056	0.97921	0.99620	0.99952
1.0	5.0	5.0	0.30681	0.34111	0.44806	0.61587	0.79186	0.91680	0.97642	0.99540	0.99939

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 1.00 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 3 9

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.48910	0.56205	0.72676	0.87877	0.96277	0.99227	0.99893	0.99990	0.99999
1.0	2.0	3.0	0.24584	0.30886	0.47795	0.68896	0.86054	0.95470	0.98963	0.99836	0.99982
1.0	3.0	5.0	0.33209	0.37619	0.50254	0.67818	0.84047	0.94226	0.98529	0.99743	0.99970
1.0	2.0	4.0	0.23945	0.29306	0.44369	0.64679	0.82837	0.93892	0.98460	0.99731	0.99968
1.0	3.0	9.0	0.70317	0.72172	0.77564	0.85245	0.92550	0.97258	0.99293	0.99876	0.99985
1.0	1.0	3.0	0.24536	0.30904	0.47912	0.69012	0.86095	0.95461	0.98950	0.99831	0.99981
1.0	1.0	5.0	0.28132	0.32524	0.45291	0.63542	0.81112	0.92748	0.98010	0.99621	0.99951
1.0	3.0	3.0	0.25066	0.31271	0.47967	0.68904	0.86018	0.95451	0.98959	0.99836	0.99982
1.0	5.0	5.0	0.39864	0.44111	0.56076	0.72250	0.86682	0.95372	0.98877	0.99814	0.99980

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.29717	0.36938	0.55204	0.75775	0.90436	0.97334	0.99487	0.99933	0.99994
1.0	2.0	3.0	0.10551	0.14360	0.26298	0.45626	0.67405	0.84825	0.94693	0.98639	0.99749
1.0	3.0	5.0	0.23928	0.26203	0.33768	0.47417	0.65128	0.81724	0.92773	0.97920	0.99576
1.0	2.0	4.0	0.12488	0.15345	0.24733	0.41223	0.61838	0.80410	0.92366	0.97811	0.99550
1.0	3.0	9.0	0.66512	0.67495	0.70727	0.76554	0.84242	0.91628	0.96658	0.99037	0.99806
1.0	1.0	3.0	0.10557	0.14469	0.26627	0.46079	0.67760	0.84975	0.94709	0.98623	0.99740
1.0	1.0	5.0	0.18969	0.21103	0.28340	0.41794	0.59935	0.77820	0.90553	0.97013	0.99318
1.0	3.0	3.0	0.11039	0.14782	0.26532	0.45632	0.67285	0.84721	0.94652	0.98633	0.99750
1.0	5.0	5.0	0.30681	0.33051	0.40711	0.53978	0.70450	0.85163	0.94440	0.98500	0.99716

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 1.00 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 9 3 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.48910	0.56205	0.72676	0.87877	0.96277	0.99227	0.99893	0.99990	0.99999
1.0	2.0	3.0	0.43186	0.51134	0.69191	0.86075	0.95600	0.99049	0.99861	0.99987	0.99999
1.0	3.0	5.0	0.40702	0.49066	0.67985	0.85569	0.95442	0.99012	0.99855	0.99986	0.99999
1.0	2.0	4.0	0.42125	0.50388	0.69000	0.86158	0.95681	0.99077	0.99866	0.99987	0.99999
1.0	3.0	9.0	0.43791	0.52655	0.71865	0.88374	0.96719	0.99379	0.99922	0.99994	1.00000
1.0	1.0	3.0	0.44840	0.52895	0.70895	0.87237	0.96115	0.99194	0.99888	0.99990	0.99999
1.0	1.0	5.0	0.42710	0.51379	0.70453	0.87330	0.96231	0.99234	0.99895	0.99990	0.99999
1.0	3.0	3.0	0.41949	0.49724	0.67663	0.84921	0.95038	0.98873	0.99826	0.99982	0.99999
1.0	5.0	5.0	0.40435	0.48337	0.66615	0.84303	0.94775	0.98798	0.99812	0.99980	0.99999

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.29717	0.36938	0.55204	0.75775	0.90436	0.97334	0.99487	0.99933	0.99994
1.0	2.0	3.0	0.24475	0.32062	0.51320	0.73213	0.89106	0.96820	0.99346	0.99906	0.99991
1.0	3.0	5.0	0.22722	0.30733	0.50801	0.73187	0.89168	0.96843	0.99349	0.99906	0.99991
1.0	2.0	4.0	0.23731	0.31749	0.51776	0.73964	0.89622	0.97024	0.99396	0.99914	0.99992
1.0	3.0	9.0	0.27240	0.36442	0.58051	0.79580	0.92871	0.98259	0.99708	0.99967	0.99998
1.0	1.0	3.0	0.26102	0.34131	0.54006	0.75655	0.90565	0.97392	0.99494	0.99932	0.99994
1.0	1.0	5.0	0.24738	0.33611	0.54914	0.77010	0.91430	0.97711	0.99568	0.99943	0.99995
1.0	3.0	3.0	0.23420	0.30570	0.49098	0.70946	0.87590	0.96151	0.99150	0.99868	0.99986
1.0	5.0	5.0	0.22837	0.30051	0.48669	0.70566	0.87307	0.96012	0.99109	0.99861	0.99985

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 1.00 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 9 3 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.48910	0.57151	0.74884	0.89878	0.97250	0.99505	0.99942	0.99996	1.00000
1.0	2.0	3.0	0.43186	0.51641	0.70409	0.87231	0.96200	0.99235	0.99897	0.99991	0.99999
1.0	3.0	5.0	0.40702	0.49204	0.68318	0.85886	0.95608	0.99064	0.99865	0.99987	0.99999
1.0	2.0	4.0	0.42125	0.50527	0.69337	0.86482	0.95852	0.99131	0.99877	0.99988	0.99999
1.0	3.0	9.0	0.43791	0.51635	0.69428	0.86080	0.95540	0.99016	0.99853	0.99985	0.99999
1.0	1.0	3.0	0.44840	0.53101	0.71389	0.87703	0.96355	0.99268	0.99902	0.99991	0.99999
1.0	1.0	5.0	0.42710	0.50691	0.68797	0.85746	0.95396	0.98966	0.99841	0.99983	0.99999
1.0	3.0	3.0	0.41949	0.50489	0.69523	0.86720	0.95995	0.99180	0.99888	0.99990	0.99999
1.0	5.0	5.0	0.40435	0.49068	0.68399	0.86040	0.95707	0.99100	0.99873	0.99988	0.99999

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.29717	0.38532	0.59443	0.80457	0.93360	0.98454	0.99758	0.99975	0.99998
1.0	2.0	3.0	0.24475	0.32862	0.53515	0.75769	0.90824	0.97544	0.99544	0.99942	0.99995
1.0	3.0	5.0	0.22722	0.31002	0.51526	0.74016	0.89719	0.97076	0.99414	0.99918	0.99992
1.0	2.0	4.0	0.23731	0.31951	0.52334	0.74622	0.90073	0.97219	0.99451	0.99924	0.99993
1.0	3.0	9.0	0.27240	0.34929	0.53987	0.74982	0.89870	0.97031	0.99385	0.99911	0.99991
1.0	1.0	3.0	0.26102	0.34387	0.54721	0.76501	0.91139	0.97634	0.99560	0.99943	0.99995
1.0	1.0	5.0	0.24738	0.32423	0.51707	0.73338	0.88970	0.96655	0.99266	0.99885	0.99987
1.0	3.0	3.0	0.23420	0.31618	0.52557	0.75043	0.90420	0.97389	0.99504	0.99935	0.99994
1.0	5.0	5.0	0.22837	0.31341	0.52218	0.74744	0.90188	0.97275	0.99471	0.99929	0.99994

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 3.00 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.78817	0.82952	0.91127	0.97025	0.99361	0.99913	0.99992	1.00000	1.00000
1.0	2.0	3.0	0.64579	0.70795	0.83691	0.93891	0.98484	0.99754	0.99974	0.99998	1.00000
1.0	3.0	5.0	0.58192	0.65047	0.79695	0.91926	0.97842	0.99619	0.99956	0.99997	1.00000
1.0	2.0	4.0	0.61468	0.68053	0.81873	0.93040	0.98217	0.99700	0.99967	0.99998	1.00000
1.0	3.0	9.0	0.65382	0.71061	0.83202	0.93337	0.98229	0.99691	0.99965	0.99997	1.00000
1.0	1.0	3.0	0.68872	0.74522	0.86068	0.94946	0.98795	0.99813	0.99981	0.99999	1.00000
1.0	1.0	5.0	0.62630	0.69064	0.82517	0.93323	0.98299	0.99715	0.99969	0.99998	1.00000
1.0	3.0	3.0	0.61065	0.67667	0.81569	0.92875	0.98161	0.99688	0.99966	0.99998	1.00000
1.0	5.0	5.0	0.59379	0.65819	0.79781	0.91745	0.97724	0.99585	0.99951	0.99996	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.65836	0.71884	0.84387	0.94207	0.98581	0.99774	0.99977	0.99998	1.00000
1.0	2.0	3.0	0.46971	0.54748	0.72119	0.87855	0.96349	0.99259	0.99900	0.99991	0.99999
1.0	3.0	5.0	0.40155	0.47919	0.66094	0.83970	0.94677	0.98793	0.99817	0.99982	0.99999
1.0	2.0	4.0	0.43397	0.51324	0.69340	0.86184	0.95664	0.99074	0.99868	0.99988	0.99999
1.0	3.0	9.0	0.51209	0.57523	0.72343	0.86957	0.95700	0.99039	0.99858	0.99986	0.99999
1.0	1.0	3.0	0.52448	0.59862	0.76016	0.90016	0.97160	0.99457	0.99931	0.99994	1.00000
1.0	1.0	5.0	0.45122	0.52931	0.70551	0.86837	0.95899	0.99128	0.99876	0.99988	0.99999
1.0	3.0	3.0	0.42805	0.50695	0.68737	0.85779	0.95490	0.99027	0.99860	0.99987	0.99999
1.0	5.0	5.0	0.42703	0.49679	0.66410	0.83544	0.94307	0.98653	0.99787	0.99978	0.99999

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 3.00 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.78817	0.82952	0.91127	0.97025	0.99361	0.99913	0.99992	1.00000	1.00000
1.0	2.0	3.0	0.64579	0.70713	0.83514	0.93747	0.98423	0.99739	0.99972	0.99998	1.00000
1.0	3.0	5.0	0.58192	0.64829	0.79201	0.91500	0.97648	0.99568	0.99948	0.99996	1.00000
1.0	2.0	4.0	0.61468	0.67907	0.81549	0.92769	0.98099	0.99670	0.99963	0.99997	1.00000
1.0	3.0	9.0	0.65382	0.70670	0.82309	0.92560	0.97871	0.99595	0.99950	0.99996	1.00000
1.0	1.0	3.0	0.68872	0.74452	0.85918	0.94827	0.98747	0.99802	0.99980	0.99999	1.00000
1.0	1.0	5.0	0.62630	0.68858	0.82059	0.92939	0.98130	0.99672	0.99962	0.99997	1.00000
1.0	3.0	3.0	0.61065	0.67578	0.81371	0.92710	0.98088	0.99669	0.99963	0.99997	1.00000
1.0	5.0	5.0	0.59379	0.65632	0.79352	0.91367	0.97548	0.99537	0.99943	0.99995	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.65836	0.71884	0.84387	0.94207	0.98581	0.99774	0.99977	0.99998	1.00000
1.0	2.0	3.0	0.46971	0.54577	0.71709	0.87468	0.96151	0.99198	0.99889	0.99990	0.99999
1.0	3.0	5.0	0.40155	0.47510	0.65052	0.82894	0.94061	0.98581	0.99772	0.99976	0.99998
1.0	2.0	4.0	0.43397	0.51030	0.68617	0.85475	0.95282	0.98951	0.99843	0.99984	0.99999
1.0	3.0	9.0	0.51209	0.56800	0.70483	0.85009	0.94569	0.98644	0.99773	0.99975	0.99998
1.0	1.0	3.0	0.52448	0.59707	0.75655	0.89690	0.97001	0.99412	0.99923	0.99993	1.00000
1.0	1.0	5.0	0.45122	0.52515	0.69527	0.85832	0.95354	0.98951	0.99840	0.99984	0.99999
1.0	3.0	3.0	0.42805	0.50518	0.68300	0.85349	0.95257	0.98951	0.99845	0.99985	0.99999
1.0	5.0	5.0	0.42703	0.49350	0.65550	0.82624	0.93758	0.98456	0.99744	0.99972	0.99998

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 3.00 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 5 7

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.77394	0.81850	0.90618	0.96888	0.99341	0.99911	0.99992	1.00000	1.00000
1.0	2.0	3.0	0.57996	0.65202	0.80304	0.92472	0.98085	0.99681	0.99965	0.99998	1.00000
1.0	3.0	5.0	0.55002	0.62140	0.77618	0.90874	0.97490	0.99544	0.99946	0.99996	1.00000
1.0	2.0	4.0	0.54524	0.62041	0.78050	0.91334	0.97706	0.99600	0.99955	0.99997	1.00000
1.0	3.0	9.0	0.72289	0.76657	0.86162	0.94343	0.98443	0.99718	0.99967	0.99998	1.00000
1.0	1.0	3.0	0.61900	0.68646	0.82586	0.93531	0.98411	0.99745	0.99974	0.99998	1.00000
1.0	1.0	5.0	0.55527	0.62868	0.78509	0.91501	0.97744	0.99605	0.99955	0.99997	1.00000
1.0	3.0	3.0	0.55146	0.62608	0.78455	0.91540	0.97775	0.99615	0.99957	0.99997	1.00000
1.0	5.0	5.0	0.60040	0.66225	0.79779	0.91604	0.97642	0.99562	0.99947	0.99996	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.63879	0.70382	0.83726	0.94059	0.98576	0.99778	0.99978	0.99999	1.00000
1.0	2.0	3.0	0.39460	0.47974	0.67313	0.85352	0.95447	0.99042	0.99866	0.99988	0.99999
1.0	3.0	5.0	0.38299	0.45804	0.63829	0.82306	0.93901	0.98566	0.99775	0.99977	0.99998
1.0	2.0	4.0	0.36098	0.44499	0.64079	0.83177	0.94482	0.98767	0.99816	0.99982	0.99999
1.0	3.0	9.0	0.62595	0.67069	0.77904	0.89140	0.96252	0.99123	0.99864	0.99986	0.99999
1.0	1.0	3.0	0.44036	0.52372	0.70877	0.87457	0.96281	0.99257	0.99901	0.99991	1.00000
1.0	1.0	5.0	0.37861	0.46017	0.65025	0.83582	0.94595	0.98786	0.99818	0.99982	0.99999
1.0	3.0	3.0	0.36434	0.44892	0.64518	0.83511	0.94643	0.98816	0.99825	0.99983	0.99999
1.0	5.0	5.0	0.45671	0.51986	0.67417	0.83683	0.94222	0.98603	0.99775	0.99976	0.99998

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 3.00 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 5 7

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.77394	0.81619	0.90141	0.96534	0.99208	0.99883	0.99989	0.99999	1.00000
1.0	2.0	3.0	0.57996	0.64347	0.78364	0.90792	0.97314	0.99474	0.99932	0.99994	1.00000
1.0	3.0	5.0	0.55002	0.60971	0.74840	0.88295	0.96200	0.99163	0.99878	0.99988	0.99999
1.0	2.0	4.0	0.54524	0.60977	0.75578	0.89113	0.96636	0.99297	0.99903	0.99991	0.99999
1.0	3.0	9.0	0.72289	0.75774	0.84045	0.92351	0.97431	0.99415	0.99912	0.99991	0.99999
1.0	1.0	3.0	0.61900	0.67920	0.80967	0.92166	0.97804	0.99588	0.99949	0.99996	1.00000
1.0	1.0	5.0	0.55527	0.61739	0.75872	0.89110	0.96579	0.99271	0.99897	0.99990	0.99999
1.0	3.0	3.0	0.55146	0.61647	0.76239	0.89571	0.96841	0.99355	0.99913	0.99992	1.00000
1.0	5.0	5.0	0.60040	0.65199	0.77319	0.89289	0.96465	0.99209	0.99883	0.99989	0.99999

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.63879	0.69805	0.82462	0.93024	0.98133	0.99670	0.99962	0.99997	1.00000
1.0	2.0	3.0	0.39460	0.46337	0.63159	0.81066	0.92982	0.98180	0.99677	0.99961	0.99997
1.0	3.0	5.0	0.38299	0.43850	0.58496	0.76196	0.89921	0.96976	0.99376	0.99914	0.99992
1.0	2.0	4.0	0.36098	0.42602	0.59083	0.77733	0.91135	0.97506	0.99517	0.99937	0.99995
1.0	3.0	9.0	0.62595	0.65647	0.73958	0.84515	0.93169	0.97864	0.99542	0.99934	0.99994
1.0	1.0	3.0	0.44036	0.50919	0.67287	0.83897	0.94329	0.98608	0.99766	0.99974	0.99998
1.0	1.0	5.0	0.37861	0.44042	0.59788	0.77809	0.90986	0.97399	0.99481	0.99930	0.99994
1.0	3.0	3.0	0.36434	0.43136	0.59941	0.78603	0.91685	0.97727	0.99574	0.99946	0.99995
1.0	5.0	5.0	0.45671	0.50312	0.62773	0.78247	0.90600	0.97125	0.99397	0.99915	0.99992

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 3.00 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 7 5 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.77394	0.81619	0.90141	0.96534	0.99208	0.99883	0.99989	0.99999	1.00000
1.0	2.0	3.0	0.67956	0.73495	0.85059	0.94319	0.98562	0.99761	0.99974	0.99998	1.00000
1.0	3.0	5.0	0.61922	0.68178	0.81521	0.92642	0.98024	0.99648	0.99959	0.99997	1.00000
1.0	2.0	4.0	0.66423	0.72175	0.84228	0.93947	0.98448	0.99737	0.99971	0.99998	1.00000
1.0	3.0	9.0	0.63085	0.69306	0.82438	0.93169	0.98221	0.99695	0.99966	0.99998	1.00000
1.0	1.0	3.0	0.72843	0.77754	0.87805	0.95558	0.98935	0.99833	0.99983	0.99999	1.00000
1.0	1.0	5.0	0.69465	0.74855	0.85997	0.94763	0.98697	0.99786	0.99977	0.99998	1.00000
1.0	3.0	3.0	0.63808	0.69778	0.82491	0.93053	0.98143	0.99670	0.99962	0.99997	1.00000
1.0	5.0	5.0	0.59205	0.65532	0.79357	0.91393	0.97555	0.99536	0.99942	0.99995	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.63879	0.69805	0.82462	0.93024	0.98133	0.99670	0.99962	0.99997	1.00000
1.0	2.0	3.0	0.51277	0.58264	0.73994	0.88461	0.96442	0.99254	0.99895	0.99990	0.99999
1.0	3.0	5.0	0.44095	0.51451	0.68534	0.85161	0.95054	0.98863	0.99823	0.99982	0.99999
1.0	2.0	4.0	0.49420	0.56575	0.72755	0.87768	0.96164	0.99177	0.99881	0.99989	0.99999
1.0	3.0	9.0	0.46276	0.53674	0.70581	0.86563	0.95706	0.99064	0.99863	0.99987	0.99999
1.0	1.0	3.0	0.57704	0.64274	0.78605	0.91057	0.97439	0.99506	0.99936	0.99995	1.00000
1.0	1.0	5.0	0.53497	0.60460	0.75839	0.89548	0.96854	0.99351	0.99909	0.99992	0.99999
1.0	3.0	3.0	0.46207	0.53324	0.69825	0.85830	0.95303	0.98927	0.99834	0.99983	0.99999
1.0	5.0	5.0	0.41579	0.48515	0.65230	0.82577	0.93752	0.98446	0.99738	0.99971	0.99998

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 3.00 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 7 5 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.77394	0.81850	0.90618	0.96888	0.99341	0.99911	0.99992	1.00000	1.00000
1.0	2.0	3.0	0.67956	0.73848	0.85820	0.94926	0.98813	0.99820	0.99982	0.99999	1.00000
1.0	3.0	5.0	0.61922	0.68533	0.82311	0.93304	0.98315	0.99722	0.99970	0.99998	1.00000
1.0	2.0	4.0	0.66423	0.72501	0.84936	0.94520	0.98689	0.99796	0.99979	0.99999	1.00000
1.0	3.0	9.0	0.63085	0.69355	0.82547	0.93261	0.98262	0.99705	0.99967	0.99998	1.00000
1.0	1.0	3.0	0.72843	0.78007	0.88339	0.95970	0.99098	0.99870	0.99988	0.99999	1.00000
1.0	1.0	5.0	0.69465	0.75065	0.86450	0.95126	0.98848	0.99822	0.99982	0.99999	1.00000
1.0	3.0	3.0	0.63808	0.70235	0.83497	0.93885	0.98503	0.99761	0.99975	0.99998	1.00000
1.0	5.0	5.0	0.59205	0.65999	0.80418	0.92313	0.97978	0.99649	0.99960	0.99997	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.63879	0.70382	0.83726	0.94059	0.98576	0.99778	0.99978	0.99999	1.00000
1.0	2.0	3.0	0.51277	0.59037	0.75808	0.90120	0.97261	0.99494	0.99938	0.99995	1.00000
1.0	3.0	5.0	0.44095	0.52153	0.70262	0.86862	0.95975	0.99164	0.99884	0.99989	0.99999
1.0	2.0	4.0	0.49420	0.57265	0.74395	0.89299	0.96941	0.99412	0.99925	0.99994	1.00000
1.0	3.0	9.0	0.46276	0.53731	0.70730	0.86720	0.95797	0.99095	0.99870	0.99988	0.99999
1.0	1.0	3.0	0.57704	0.64858	0.79932	0.92211	0.97973	0.99651	0.99961	0.99997	1.00000
1.0	1.0	5.0	0.53497	0.60903	0.76879	0.90501	0.97329	0.99493	0.99936	0.99995	1.00000
1.0	3.0	3.0	0.46207	0.54268	0.72118	0.88041	0.96472	0.99299	0.99907	0.99992	1.00000
1.0	5.0	5.0	0.41579	0.49395	0.67474	0.84904	0.95095	0.98914	0.99839	0.99984	0.99999

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 3.00 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 3 9

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.75016	0.79932	0.89612	0.96547	0.99267	0.99901	0.99992	1.00000	1.00000
1.0	2.0	3.0	0.52690	0.60614	0.77396	0.91179	0.97698	0.99605	0.99956	0.99997	1.00000
1.0	3.0	5.0	0.53756	0.60892	0.76550	0.90243	0.97253	0.99488	0.99938	0.99995	1.00000
1.0	2.0	4.0	0.49551	0.57590	0.74986	0.89834	0.97213	0.99495	0.99940	0.99995	1.00000
1.0	3.0	9.0	0.78520	0.81775	0.88980	0.95365	0.98682	0.99753	0.99970	0.99998	1.00000
1.0	1.0	3.0	0.53824	0.61651	0.78140	0.91553	0.97822	0.99631	0.99959	0.99997	1.00000
1.0	1.0	5.0	0.51280	0.58862	0.75436	0.89836	0.97155	0.99473	0.99936	0.99995	1.00000
1.0	3.0	3.0	0.51953	0.59904	0.76833	0.90867	0.97587	0.99580	0.99953	0.99997	1.00000
1.0	5.0	5.0	0.57735	0.64227	0.78501	0.91027	0.97465	0.99526	0.99942	0.99996	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.60583	0.67647	0.82173	0.93465	0.98425	0.99754	0.99975	0.99998	1.00000
1.0	2.0	3.0	0.33820	0.42695	0.63236	0.83015	0.94525	0.98801	0.99825	0.99983	0.99999
1.0	3.0	5.0	0.38399	0.45464	0.62821	0.81270	0.93325	0.98375	0.99737	0.99972	0.99998
1.0	2.0	4.0	0.31626	0.39981	0.60011	0.80481	0.93284	0.98421	0.99752	0.99974	0.99998
1.0	3.0	9.0	0.71916	0.75004	0.82731	0.91161	0.96806	0.99216	0.99872	0.99987	0.99999
1.0	1.0	3.0	0.35080	0.43984	0.64407	0.83780	0.94853	0.98891	0.99841	0.99985	0.99999
1.0	1.0	5.0	0.35170	0.42740	0.61200	0.80600	0.93135	0.98338	0.99731	0.99972	0.99998
1.0	3.0	3.0	0.33101	0.41881	0.62369	0.82379	0.94228	0.98714	0.99809	0.99981	0.99999
1.0	5.0	5.0	0.43499	0.49930	0.65777	0.82699	0.93812	0.98489	0.99755	0.99974	0.99998

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 3.00 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 3 3 9

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.75016	0.79650	0.89031	0.96113	0.99103	0.99866	0.99987	0.99999	1.00000
1.0	2.0	3.0	0.52690	0.59575	0.75003	0.89055	0.96692	0.99326	0.99909	0.99992	1.00000
1.0	3.0	5.0	0.53756	0.59666	0.73596	0.87438	0.95810	0.99050	0.99857	0.99986	0.99999
1.0	2.0	4.0	0.49551	0.56330	0.71994	0.87057	0.95823	0.99084	0.99866	0.99987	0.99999
1.0	3.0	9.0	0.78520	0.81103	0.87334	0.93772	0.97844	0.99492	0.99921	0.99992	0.99999
1.0	1.0	3.0	0.53824	0.60641	0.75823	0.89514	0.96864	0.99367	0.99915	0.99993	1.00000
1.0	1.0	5.0	0.51280	0.57511	0.72177	0.86736	0.95555	0.98984	0.99845	0.99985	0.99999
1.0	3.0	3.0	0.51953	0.58849	0.74388	0.88680	0.96541	0.99286	0.99902	0.99991	0.99999
1.0	5.0	5.0	0.57735	0.63166	0.75946	0.88607	0.96226	0.99152	0.99874	0.99988	0.99999

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.60583	0.66968	0.80677	0.92230	0.97892	0.99621	0.99955	0.99997	1.00000
1.0	2.0	3.0	0.33820	0.40871	0.58485	0.77925	0.91461	0.97674	0.99565	0.99945	0.99995
1.0	3.0	5.0	0.38399	0.43597	0.57587	0.75046	0.89100	0.96616	0.99277	0.99896	0.99990
1.0	2.0	4.0	0.31626	0.37963	0.54503	0.74170	0.89169	0.96773	0.99336	0.99908	0.99991
1.0	3.0	9.0	0.71916	0.74034	0.79942	0.87733	0.94399	0.98181	0.99594	0.99939	0.99994
1.0	1.0	3.0	0.35080	0.42190	0.59775	0.78878	0.91942	0.97835	0.99599	0.99950	0.99996
1.0	1.0	5.0	0.35170	0.40694	0.55475	0.73800	0.88510	0.96399	0.99218	0.99885	0.99989
1.0	3.0	3.0	0.33101	0.40050	0.57557	0.77157	0.91037	0.97522	0.99529	0.99940	0.99995
1.0	5.0	5.0	0.43499	0.48295	0.61198	0.77268	0.90145	0.96974	0.99363	0.99910	0.99992

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 3.00 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 9 3 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.75016	0.79650	0.89031	0.96113	0.99103	0.99866	0.99987	0.99999	1.00000
1.0	2.0	3.0	0.67990	0.73611	0.85264	0.94476	0.98626	0.99776	0.99976	0.99998	1.00000
1.0	3.0	5.0	0.63359	0.69554	0.82603	0.93236	0.98234	0.99694	0.99965	0.99997	1.00000
1.0	2.0	4.0	0.66226	0.72085	0.84293	0.94038	0.98491	0.99748	0.99973	0.99998	1.00000
1.0	3.0	9.0	0.62886	0.69219	0.82511	0.93262	0.98263	0.99704	0.99967	0.99998	1.00000
1.0	1.0	3.0	0.70151	0.75501	0.86494	0.95036	0.98796	0.99809	0.99980	0.99999	1.00000
1.0	1.0	5.0	0.66613	0.72450	0.84565	0.94172	0.98532	0.99756	0.99973	0.99998	1.00000
1.0	3.0	3.0	0.66108	0.71928	0.84110	0.93915	0.98444	0.99738	0.99971	0.99998	1.00000
1.0	5.0	5.0	0.61545	0.67845	0.81294	0.92524	0.97980	0.99637	0.99957	0.99997	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.60583	0.66968	0.80677	0.92230	0.97892	0.99621	0.99955	0.99997	1.00000
1.0	2.0	3.0	0.51401	0.58572	0.74536	0.88928	0.96670	0.99320	0.99907	0.99992	0.99999
1.0	3.0	5.0	0.45926	0.53425	0.70492	0.86533	0.95678	0.99045	0.99857	0.99986	0.99999
1.0	2.0	4.0	0.49300	0.56644	0.73094	0.88110	0.96339	0.99229	0.99890	0.99990	0.99999
1.0	3.0	9.0	0.46125	0.53732	0.70932	0.86909	0.95875	0.99110	0.99871	0.99988	0.99999
1.0	1.0	3.0	0.54215	0.61224	0.76601	0.90105	0.97123	0.99435	0.99926	0.99994	1.00000
1.0	1.0	5.0	0.50013	0.57384	0.73761	0.88514	0.96489	0.99263	0.99895	0.99990	0.99999
1.0	3.0	3.0	0.49079	0.56312	0.72642	0.87754	0.96174	0.99183	0.99882	0.99989	0.99999
1.0	5.0	5.0	0.43929	0.51284	0.68366	0.85017	0.94966	0.98829	0.99815	0.99980	0.99999

Table 2.2A

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH VA= 3.00 AND U* = -2.00 1.00 1.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 9 3 3

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.75016	0.79932	0.89612	0.96547	0.99267	0.99901	0.99992	1.00000	1.00000
1.0	2.0	3.0	0.67990	0.73963	0.86017	0.95071	0.98868	0.99832	0.99984	0.99999	1.00000
1.0	3.0	5.0	0.63359	0.69896	0.83354	0.93853	0.98500	0.99760	0.99975	0.99998	1.00000
1.0	2.0	4.0	0.66226	0.72415	0.85006	0.94610	0.98730	0.99805	0.99981	0.99999	1.00000
1.0	3.0	9.0	0.62886	0.69288	0.82662	0.93389	0.98319	0.99718	0.99969	0.99998	1.00000
1.0	1.0	3.0	0.70151	0.75799	0.87125	0.95527	0.98992	0.99854	0.99986	0.99999	1.00000
1.0	1.0	5.0	0.66613	0.72686	0.85076	0.94585	0.98706	0.99798	0.99980	0.99999	1.00000
1.0	3.0	3.0	0.66108	0.72335	0.84990	0.94622	0.98739	0.99808	0.99981	0.99999	1.00000
1.0	5.0	5.0	0.61545	0.68282	0.82264	0.93338	0.98339	0.99728	0.99971	0.99998	1.00000

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.60583	0.67647	0.82173	0.93465	0.98425	0.99754	0.99975	0.99998	1.00000
1.0	2.0	3.0	0.51401	0.59340	0.76317	0.90529	0.97443	0.99541	0.99946	0.99996	1.00000
1.0	3.0	5.0	0.45926	0.54115	0.72155	0.88120	0.96508	0.99306	0.99908	0.99992	1.00000
1.0	2.0	4.0	0.49300	0.57337	0.74727	0.89614	0.97090	0.99453	0.99932	0.99994	1.00000
1.0	3.0	9.0	0.46125	0.53845	0.71210	0.87184	0.96024	0.99159	0.99881	0.99989	0.99999
1.0	1.0	3.0	0.54215	0.61886	0.78115	0.91435	0.97748	0.99608	0.99955	0.99997	1.00000
1.0	1.0	5.0	0.50013	0.57860	0.74886	0.89559	0.97019	0.99424	0.99925	0.99994	1.00000
1.0	3.0	3.0	0.49079	0.57178	0.74685	0.89639	0.97117	0.99464	0.99934	0.99995	1.00000
1.0	5.0	5.0	0.43929	0.52155	0.70505	0.87116	0.96102	0.99200	0.99890	0.99990	0.99999

Table.3.1A

ANALYSIS OF VARIANCE --- TWO-WAY LAYOUT

FOR BETWEEN-COLUMNS COMPARISON

WITH VA = 0.0 AND U* = 1.00 1.00 -2.00

ROW = 5 CCL = 3 DF1 = 2 DF2 = 8

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.07734	0.16816	0.33068	0.54052	0.74086	0.88309	0.95850	0.98852
1.0	2.0	3.0	0.05376	0.11446	0.28404	0.51623	0.73681	0.88821	0.96370	0.99111	0.99837
1.0	3.0	5.0	0.05673	0.14315	0.36402	0.62357	0.82732	0.94008	0.98456	0.99708	0.99960
1.0	2.0	4.0	0.05649	0.13753	0.34865	0.60472	0.81323	0.93308	0.98215	0.99650	0.99950
1.0	3.0	9.0	0.06557	0.19224	0.48095	0.75538	0.91687	0.97995	0.99662	0.99961	0.99997
1.0	1.0	3.0	0.05728	0.13997	0.35466	0.61292	0.82026	0.93707	0.98369	0.99692	0.99958
1.0	1.0	5.0	0.06722	0.18441	0.45853	0.73171	0.90285	0.97478	0.99539	0.99942	0.99995
1.0	3.0	3.0	0.05368	0.10350	0.24755	0.45802	0.67708	0.84572	0.94216	0.98322	0.99627
1.0	5.0	5.0	0.05600	0.13022	0.32579	0.57030	0.78098	0.91292	0.97348	0.99389	0.99895

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.01744	0.04660	0.11458	0.23648	0.40781	0.59788	0.76557	0.88418
1.0	2.0	3.0	0.01166	0.05334	0.17455	0.35838	0.56778	0.75468	0.88552	0.95718	0.98769
1.0	3.0	5.0	0.01303	0.08500	0.27520	0.51722	0.73541	0.88339	0.95958	0.98928	0.99791
1.0	2.0	4.0	0.01291	0.07717	0.25117	0.48241	0.70277	0.86178	0.94926	0.98577	0.99709
1.0	3.0	9.0	0.01806	0.13697	0.41627	0.69933	0.88388	0.96701	0.99327	0.99904	0.99991
1.0	1.0	3.0	0.01329	0.07830	0.25439	0.48802	0.70934	0.86725	0.95261	0.98728	0.99756
1.0	1.0	5.0	0.01928	0.12555	0.38333	0.66095	0.85773	0.95565	0.99006	0.99846	0.99984
1.0	3.0	3.0	0.01162	0.04395	0.14047	0.29497	0.48583	0.67541	0.82668	0.92340	0.97291
1.0	5.0	5.0	0.01268	0.07427	0.24054	0.46207	0.67721	0.83925	0.93483	0.97891	0.99471

Table 3.1A

ANALYSIS OF VARIANCE --- TWO-WAY LAYOUT

FOR BETWEEN-COLUMNS COMPARISON

WITH VA = 0.0 AND U* = -2.00 1.00 1.00

ROW = 5 CCL = 3 DF1 = 2 DF2 = 8

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.07734	0.16816	0.33068	0.54052	0.74086	0.88309	0.95850	0.98852
1.0	2.0	3.0	0.05376	0.10436	0.24666	0.44889	0.65896	0.82617	0.92854	0.97664	0.99398
1.0	3.0	5.0	0.05673	0.13680	0.34146	0.58632	0.78966	0.91499	0.97311	0.99342	0.99877
1.0	2.0	4.0	0.05649	0.11251	0.26614	0.47573	0.68378	0.84260	0.93653	0.97953	0.99476
1.0	3.0	9.0	0.06557	0.15623	0.38026	0.63225	0.82544	0.93446	0.98074	0.99561	0.99923
1.0	1.0	3.0	0.05728	0.08264	0.16240	0.29943	0.47919	0.66528	0.81777	0.91703	0.96866
1.0	1.0	5.0	0.06722	0.09205	0.16720	0.29084	0.45048	0.62012	0.76945	0.87869	0.94547
1.0	3.0	3.0	0.05368	0.11909	0.29413	0.52175	0.73243	0.87928	0.95692	0.98801	0.99742
1.0	5.0	5.0	0.05600	0.15713	0.40201	0.66599	0.85504	0.95181	0.98790	0.99773	0.99968

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.01744	0.04660	0.11458	0.23648	0.40782	0.59788	0.76557	0.88418
1.0	2.0	3.0	0.01166	0.05269	0.16842	0.33763	0.52829	0.70496	0.84076	0.92694	0.97181
1.0	3.0	5.0	0.01303	0.08900	0.28475	0.52464	0.73472	0.87697	0.95311	0.98547	0.99637
1.0	2.0	4.0	0.01291	0.06152	0.19538	0.38236	0.58042	0.75136	0.87335	0.94525	0.98014
1.0	3.0	9.0	0.01806	0.10820	0.33248	0.58925	0.79309	0.91516	0.97187	0.99251	0.99841
1.0	1.0	3.0	0.01329	0.02671	0.06928	0.14643	0.26167	0.40927	0.57080	0.72155	0.84252
1.0	1.0	5.0	0.01928	0.03639	0.08781	0.17313	0.28939	0.42829	0.57551	0.71435	0.83130
1.0	3.0	3.0	0.01162	0.06971	0.22619	0.43539	0.64294	0.80720	0.91248	0.96704	0.98982
1.0	5.0	5.0	0.01268	0.11207	0.35488	0.62266	0.82334	0.93432	0.98077	0.99561	0.99922

Table 3.1B

ANALYSIS OF VARIANCE --- TWO-WAY LAYOUT

BETWEEN-COLUMNS COMPARISON

FOR EQUAL ERROR VARIANCES AND WITHIN ROW SERIAL CORRELATION

WITH VA = 0.0 AND U* = 1.00 1.00 -2.00

ROW = 5 COL = 3 DF1 = 2 DF2 = 8

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION RHO	NON CENTRALITY PARAMETER 0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.05199	0.07674	0.15841	0.30552	0.50142	0.69919	0.85121	0.94058	0.98100
-0.2	0.05062	0.07604	0.16077	0.31427	0.51712	0.71751	0.86624	0.94957	0.98500
0.0	0.05000	0.07734	0.16816	0.33068	0.54052	0.74086	0.88309	0.95850	0.98852
0.2	0.05106	0.08113	0.17932	0.35031	0.56409	0.76110	0.89572	0.96429	0.99049
0.4	0.05600	0.09028	0.19733	0.37365	0.58425	0.77259	0.89965	0.96478	0.99033

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION RHO	NON CENTRALITY PARAMETER 0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.01087	0.01916	0.04906	0.11333	0.22417	0.37992	0.55798	0.72405	0.85153
-0.2	0.01027	0.01743	0.04493	0.10812	0.22166	0.38380	0.56871	0.73819	0.86410
0.0	0.01000	0.01744	0.04660	0.11458	0.23648	0.40781	0.59788	0.76557	0.88418
0.2	0.01046	0.01956	0.05408	0.13130	0.26416	0.44327	0.63358	0.79434	0.90380
0.4	0.01268	0.02707	0.07604	0.17178	0.31876	0.50040	0.68214	0.83075	0.92907

Table 3.1C

ANALYSIS OF VARIANCE --- TWO-WAY LAYOUT

BETWEEN-ROWS COMPARISON

FOR EQUAL ERROR VARIANCES AND WITHIN ROW SERIAL CORRELATION

WITH VA = 0.0 AND U* = 1.00 1.00 1.00 1.00 -4.00

ROW = 5 COL = 3 DF1 = 4 DF2 = 8

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION RHO	NON CENTRALITY PARAMETER 0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.00311	0.01668	0.05744	0.12545	0.22017	0.33862	0.47298	0.61036	0.73629
-0.2	0.01636	0.02470	0.05345	0.11225	0.21088	0.34991	0.51401	0.67594	0.80982
0.0	0.05000	0.06545	0.11775	0.21852	0.36952	0.55018	0.72298	0.85529	0.93663
0.2	0.11557	0.14604	0.23977	0.39330	0.58045	0.75613	0.88353	0.95498	0.98605
0.4	0.22401	0.27301	0.40846	0.59259	0.76941	0.89538	0.96259	0.98957	0.99774

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION RHO	NON CENTRALITY PARAMETER 0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.00041	0.01294	0.04978	0.10893	0.18739	0.28146	0.38667	0.49760	0.60953
-0.2	0.00264	0.00617	0.01783	0.04103	0.08154	0.14612	0.23912	0.35865	0.49676
0.0	0.01000	0.01394	0.02880	0.06333	0.12930	0.23499	0.37710	0.53792	0.69239
0.2	0.02929	0.04145	0.08269	0.16385	0.29149	0.45612	0.63017	0.78098	0.88835
0.4	0.07433	0.10501	0.19784	0.34788	0.53208	0.71105	0.84933	0.93446	0.97636

Table 3.2A

ANALYSIS OF VARIANCE --- TWO-WAY LAYOUT

FOR BETWEEN-COLUMNS COMPARISON

WITH VA = 0.50 AND U* = 1.00 1.00 -2.00

ROW = 5 COL = 3 DF1 = 2 DF2 = 8

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.33089	0.40693	0.59231	0.78916	0.92065	0.97884	0.99608	0.99950	0.99996
1.0	2.0	3.0	0.20328	0.27568	0.46408	0.68864	0.86318	0.95581	0.98970	0.99829	0.99980
1.0	3.0	5.0	0.15575	0.22841	0.41969	0.65310	0.84106	0.94569	0.98640	0.99753	0.99967
1.0	2.0	4.0	0.18450	0.26002	0.45518	0.68538	0.86247	0.95569	0.98966	0.99827	0.99979
1.0	3.0	9.0	0.13254	0.22206	0.44514	0.69350	0.87260	0.96105	0.99138	0.99863	0.99985
1.0	1.0	3.0	0.23507	0.31474	0.51377	0.73503	0.89265	0.96846	0.99339	0.99902	0.99990
1.0	1.0	5.0	0.19440	0.28086	0.49424	0.72726	0.89046	0.96798	0.99330	0.99901	0.99990
1.0	3.0	3.0	0.18196	0.24748	0.42371	0.64629	0.83275	0.94087	0.98467	0.99712	0.99961
1.0	5.0	5.0	0.13639	0.19788	0.36737	0.59162	0.79242	0.91933	0.97646	0.99490	0.99918

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.14598	0.20132	0.35858	0.57608	0.77953	0.91285	0.97442	0.99450	0.99914
1.0	2.0	3.0	0.07065	0.11384	0.24474	0.44743	0.66768	0.84117	0.94097	0.98314	0.99632
1.0	3.0	5.0	0.04914	0.09389	0.22731	0.43078	0.65162	0.82828	0.93319	0.97971	0.99523
1.0	2.0	4.0	0.06233	0.10972	0.25001	0.46013	0.68110	0.85020	0.94513	0.98450	0.99664
1.0	3.0	9.0	0.04243	0.11072	0.29542	0.53620	0.75386	0.89726	0.96687	0.99188	0.99852
1.0	1.0	3.0	0.08894	0.14297	0.29831	0.51889	0.73468	0.88583	0.96236	0.99059	0.99822
1.0	1.0	5.0	0.07148	0.13491	0.30972	0.54299	0.75729	0.89928	0.96789	0.99224	0.99859
1.0	3.0	3.0	0.06013	0.09554	0.20698	0.39076	0.60715	0.79456	0.91480	0.97233	0.99301
1.0	5.0	5.0	0.04067	0.07448	0.17997	0.35437	0.56516	0.75729	0.89009	0.96012	0.98851

Table 3.2A

ANALYSIS OF VARIANCE --- TWO-WAY LAYOUT

FOR BETWEEN-COLUMNS COMPARISON

WITH VA = 0.50 AND U* = -2.00 1.00 1.00

ROW = 5 COL = 3 DF1 = 2 DF2 = 8

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.33089	0.40693	0.59231	0.78916	0.92065	0.97884	0.99608	0.99950	0.99996
1.0	2.0	3.0	0.20328	0.26513	0.43247	0.64612	0.82862	0.93743	0.98311	0.99666	0.99952
1.0	3.0	5.0	0.15575	0.21325	0.37206	0.58468	0.78040	0.90977	0.97171	0.99330	0.99881
1.0	2.0	4.0	0.18450	0.24297	0.40344	0.61472	0.80354	0.92314	0.97734	0.99501	0.99918
1.0	3.0	9.0	0.13254	0.18698	0.33759	0.54265	0.74006	0.88126	0.95711	0.98788	0.99734
1.0	1.0	3.0	0.23507	0.29888	0.46807	0.67726	0.84895	0.94692	0.98623	0.99739	0.99964
1.0	1.0	5.0	0.19440	0.24796	0.39653	0.59690	0.78334	0.90874	0.97040	0.99271	0.99865
1.0	3.0	3.0	0.18196	0.24214	0.40660	0.62130	0.81051	0.92787	0.97952	0.99571	0.99934
1.0	5.0	5.0	0.13639	0.19688	0.36214	0.58026	0.77882	0.90924	0.97153	0.99325	0.99880

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.14598	0.20132	0.35858	0.57608	0.77953	0.91285	0.97442	0.99450	0.99914
1.0	2.0	3.0	0.07065	0.10557	0.21420	0.39185	0.60179	0.78663	0.90851	0.96901	0.99176
1.0	3.0	5.0	0.04914	0.08463	0.19163	0.36208	0.56436	0.74983	0.88165	0.95444	0.98581
1.0	2.0	4.0	0.06233	0.09542	0.19814	0.36719	0.57139	0.75839	0.88898	0.95888	0.98779
1.0	3.0	9.0	0.04243	0.08147	0.19444	0.36493	0.55981	0.73737	0.86730	0.94381	0.98020
1.0	1.0	3.0	0.08894	0.12607	0.24039	0.42332	0.63254	0.80948	0.92118	0.97424	0.99337
1.0	1.0	5.0	0.07148	0.10084	0.19287	0.34720	0.53937	0.72378	0.86168	0.94279	0.98063
1.0	3.0	3.0	0.06013	0.09456	0.20102	0.37495	0.58275	0.76994	0.89759	0.96368	0.98981
1.0	5.0	5.0	0.04067	0.08256	0.20421	0.38746	0.59324	0.77312	0.89586	0.96118	0.98833

Table 3.2A

ANALYSIS OF VARIANCE --- TWO-WAY LAYOUT

FOR BETWEEN-COLUMNS COMPARISON

WITH VA = 1.00 AND U* = 1.00 1.00 -2.00

ROW = 5 CCL = 3 DF1 = 2 DF2 = 8

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.50579	0.57923	0.74231	0.88846	0.96660	0.99321	0.99908	0.99992	1.00000
1.0	2.0	3.0	0.33370	0.41282	0.60275	0.79923	0.92650	0.98095	0.99656	0.99957	0.99996
1.0	3.0	5.0	0.25300	0.33118	0.52622	0.74251	0.89607	0.96961	0.99367	0.99907	0.99990
1.0	2.0	4.0	0.30205	0.38237	0.57700	0.78193	0.91787	0.97793	0.99583	0.99945	0.99995
1.0	3.0	9.0	0.20262	0.28748	0.49748	0.72783	0.89008	0.96765	0.99317	0.99898	0.99989
1.0	1.0	3.0	0.37909	0.45984	0.64770	0.83158	0.94245	0.98623	0.99773	0.99974	0.99998
1.0	1.0	5.0	0.31090	0.39512	0.59486	0.79772	0.92665	0.98109	0.99659	0.99957	0.99996
1.0	3.0	3.0	0.29983	0.37588	0.56367	0.76799	0.90920	0.97451	0.99495	0.99930	0.99993
1.0	5.0	5.0	0.21846	0.28916	0.47304	0.69238	0.86359	0.95528	0.98935	0.99817	0.99978

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.29198	0.36609	0.55146	0.75742	0.90325	0.97235	0.99444	0.99923	0.99993
1.0	2.0	3.0	0.14956	0.20979	0.37698	0.59958	0.79875	0.92334	0.97829	0.99548	0.99931
1.0	3.0	5.0	0.09895	0.15209	0.30522	0.52330	0.73708	0.88695	0.96280	0.99073	0.99825
1.0	2.0	4.0	0.12924	0.18862	0.35453	0.57836	0.78274	0.91430	0.97458	0.99439	0.99908
1.0	3.0	9.0	0.07494	0.13651	0.30736	0.53781	0.75214	0.89596	0.96639	0.99174	0.99847
1.0	1.0	3.0	0.18457	0.25279	0.43398	0.65811	0.84134	0.94497	0.98598	0.99740	0.99965
1.0	1.0	5.0	0.13965	0.20670	0.38705	0.61622	0.81194	0.92976	0.98035	0.99594	0.99939
1.0	3.0	3.0	0.12659	0.17965	0.33222	0.54786	0.75605	0.89847	0.96805	0.99249	0.99869
1.0	5.0	5.0	0.07938	0.12204	0.25099	0.45025	0.66702	0.83881	0.93886	0.98203	0.99592

Table 3.2A

ANALYSIS OF VARIANCE --- TWO-WAY LAYOUT

FOR BETWEEN-COLUMNS COMPARISON

WITH VA = 1.00 AND U* = -2.00 1.00 1.00

ROW = 5 COL = 3 DF1 = 2 DF2 = 8

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.50579	0.57928	0.74231	0.88846	0.96660	0.99321	0.99908	0.99992	1.00000
1.0	2.0	3.0	0.33370	0.40693	0.58695	0.78143	0.91494	0.97625	0.99532	0.99936	0.99994
1.0	3.0	5.0	0.25300	0.32003	0.49425	0.70252	0.86632	0.95531	0.98907	0.99806	0.99975
1.0	2.0	4.0	0.30205	0.37265	0.55033	0.75075	0.89659	0.96868	0.99319	0.99895	0.99988
1.0	3.0	9.0	0.20262	0.26198	0.42228	0.62892	0.81065	0.92515	0.97747	0.99489	0.99914
1.0	1.0	3.0	0.37909	0.45304	0.63010	0.81280	0.93106	0.98193	0.99668	0.99958	0.99996
1.0	1.0	5.0	0.31090	0.37900	0.55095	0.74672	0.89191	0.96593	0.99221	0.99872	0.99985
1.0	3.0	3.0	0.29983	0.37126	0.55081	0.75264	0.89851	0.96978	0.99359	0.99904	0.99990
1.0	5.0	5.0	0.21846	0.28358	0.45594	0.66894	0.84422	0.94485	0.98557	0.99724	0.99961

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.29198	0.36609	0.55146	0.75742	0.90325	0.97235	0.99444	0.99923	0.99993
1.0	2.0	3.0	0.14956	0.20288	0.35462	0.56614	0.76769	0.90403	0.97002	0.99300	0.99878
1.0	3.0	5.0	0.09895	0.14183	0.26955	0.46376	0.67339	0.83994	0.93810	0.98130	0.99561
1.0	2.0	4.0	0.12924	0.17767	0.31847	0.52271	0.72864	0.87852	0.95797	0.98888	0.99776
1.0	3.0	9.0	0.07494	0.11244	0.22462	0.39971	0.60074	0.77763	0.89805	0.96192	0.98849
1.0	1.0	3.0	0.18457	0.24330	0.40493	0.61787	0.80718	0.92570	0.97852	0.99538	0.99926
1.0	1.0	5.0	0.13965	0.18670	0.32292	0.52020	0.72075	0.87010	0.95257	0.98658	0.99709
1.0	3.0	3.0	0.12659	0.17548	0.31780	0.52430	0.73190	0.88177	0.96005	0.98977	0.99803
1.0	5.0	5.0	0.07938	0.12059	0.24368	0.43327	0.64351	0.81744	0.92543	0.97597	0.99393

Table 3.2A

ANALYSIS OF VARIANCE --- TWO-WAY LAYOUT

FOR BETWEEN-COLUMNS COMPARISON

WITH VA = 3.00 AND U* = 1.00 1.00 -2.00

ROW = 5 COL = 3 DF1 = 2 DF2 = 8

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.76383	0.80872	0.89854	0.96491	0.99214	0.99887	0.99990	0.99999	1.00000
1.0	2.0	3.0	0.61209	0.67711	0.81454	0.92727	0.98079	0.99663	0.99961	0.99997	1.00000
1.0	3.0	5.0	0.50910	0.58330	0.74670	0.89145	0.96780	0.99350	0.99912	0.99992	1.00000
1.0	2.0	4.0	0.57417	0.64311	0.79089	0.91537	0.97669	0.99569	0.99947	0.99996	1.00000
1.0	3.0	9.0	0.42008	0.50026	0.68260	0.85415	0.95253	0.98926	0.99833	0.99982	0.99999
1.0	1.0	3.0	0.65721	0.71708	0.84142	0.94012	0.98492	0.99750	0.99973	0.99998	1.00000
1.0	1.0	5.0	0.57925	0.64779	0.79428	0.91706	0.97723	0.99580	0.99949	0.99996	1.00000
1.0	3.0	3.0	0.57308	0.64166	0.78916	0.91417	0.97620	0.99557	0.99945	0.99996	1.00000
1.0	5.0	5.0	0.45637	0.53257	0.70520	0.86625	0.95730	0.99059	0.99859	0.99986	0.99999

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.60228	0.66803	0.80785	0.92380	0.97961	0.99637	0.99958	0.99997	1.00000
1.0	2.0	3.0	0.40660	0.48421	0.66452	0.84049	0.94598	0.98725	0.99793	0.99977	0.99998
1.0	3.0	5.0	0.29794	0.37420	0.56233	0.76684	0.90831	0.97403	0.99478	0.99926	0.99993
1.0	2.0	4.0	0.36502	0.44310	0.62824	0.81579	0.93409	0.98334	0.99707	0.99964	0.99997
1.0	3.0	9.0	0.22089	0.29418	0.48217	0.70173	0.86942	0.95762	0.98997	0.99829	0.99979
1.0	1.0	3.0	0.46155	0.53769	0.70960	0.86901	0.95848	0.99092	0.99865	0.99986	0.99999
1.0	1.0	5.0	0.37376	0.45204	0.63631	0.82096	0.93626	0.98393	0.99717	0.99966	0.99997
1.0	3.0	3.0	0.36281	0.43990	0.62379	0.81200	0.93211	0.98270	0.99694	0.99963	0.99997
1.0	5.0	5.0	0.24832	0.31964	0.50278	0.71631	0.87801	0.96150	0.99123	0.99857	0.99983

Table 3.2A

ANALYSIS OF VARIANCE --- TWO-WAY LAYOUT

FOR BETWEEN-COLUMNS COMPARISON

WITH VA = 3.00 AND U* = -2.00 1.00 1.00

ROW = 5 COL = 3 DF1 = 2 DF2 = 8

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.76383	0.80872	0.89854	0.96491	0.99214	0.99887	0.99990	0.99999	1.00000
1.0	2.0	3.0	0.61209	0.67611	0.81230	0.92536	0.97992	0.99640	0.99957	0.99997	1.00000
1.0	3.0	5.0	0.50910	0.58044	0.73988	0.88501	0.96448	0.99247	0.99892	0.99990	0.99999
1.0	2.0	4.0	0.57417	0.64131	0.78676	0.91171	0.97494	0.99520	0.99939	0.99995	1.00000
1.0	3.0	9.0	0.42008	0.49239	0.66266	0.83347	0.94041	0.98486	0.99731	0.99967	0.99997
1.0	1.0	3.0	0.65721	0.71621	0.83951	0.93854	0.98424	0.99732	0.99970	0.99998	1.00000
1.0	1.0	5.0	0.57925	0.64519	0.78827	0.91171	0.97467	0.99507	0.99936	0.99994	1.00000
1.0	3.0	3.0	0.57308	0.64058	0.78668	0.91197	0.97515	0.99528	0.99940	0.99995	1.00000
1.0	5.0	5.0	0.45637	0.52978	0.69830	0.85935	0.95347	0.98929	0.99831	0.99982	0.99999

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

COLUMN VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.60228	0.66803	0.80785	0.92380	0.97961	0.99637	0.99958	0.99997	1.00000
1.0	2.0	3.0	0.40660	0.48212	0.65922	0.83498	0.94276	0.98609	0.99767	0.99973	0.99998
1.0	3.0	5.0	0.29794	0.36930	0.54874	0.75067	0.89705	0.96902	0.99332	0.99898	0.99989
1.0	2.0	4.0	0.36502	0.43959	0.61901	0.80570	0.92778	0.98088	0.99645	0.99954	0.99996
1.0	3.0	9.0	0.22089	0.28273	0.44810	0.65643	0.83273	0.93793	0.98275	0.99645	0.99947
1.0	1.0	3.0	0.46155	0.53573	0.70478	0.86426	0.95587	0.99005	0.99846	0.99984	0.99999
1.0	1.0	5.0	0.37376	0.44692	0.62285	0.80622	0.92697	0.98025	0.99623	0.99950	0.99995
1.0	3.0	3.0	0.36281	0.43782	0.61833	0.80600	0.92836	0.98123	0.99657	0.99957	0.99996
1.0	5.0	5.0	0.24832	0.31557	0.49085	0.70094	0.86618	0.95560	0.98926	0.99813	0.99976

Table 4A

ANALYSIS OF COVARIANCE --- ONE-WAY LAYOUT

Case I

WITH U* = 1.00 1.00 -2.00

VZ(1) = 2.500 Z(1,J) = 3.00 4.00 5.00 6.00 7.00
VZ(2) = 2.500 Z(2,J) = 3.00 4.00 5.00 6.00 7.00
VZ(3) = 2.500 Z(3,J) = 3.00 4.00 5.00 6.00 7.00

DF1 = 2 DF2 =11 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.05007	0.08020	0.18141	0.36219	0.58829	0.78977	0.91781	0.97591	0.99477
1.00	2.00	3.00	0.05612	0.12005	0.29856	0.54035	0.76301	0.90727	0.97314	0.99434	0.99914
1.00	3.00	5.00	0.09711	0.18376	0.40414	0.65909	0.85247	0.95322	0.98941	0.99832	0.99982
1.00	2.00	4.00	0.06487	0.14869	0.36626	0.62660	0.83219	0.94424	0.98662	0.99772	0.99973
1.00	3.00	9.00	0.29087	0.39310	0.62222	0.83202	0.94784	0.98894	0.99843	0.99985	0.99999
1.00	1.00	3.00	0.06028	0.14627	0.36858	0.63218	0.83728	0.94692	0.98749	0.99790	0.99975
1.00	1.00	5.00	0.08380	0.20221	0.47737	0.74740	0.91201	0.97837	0.99631	0.99957	0.99997
1.00	3.00	3.00	0.05867	0.11127	0.26364	0.48471	0.70862	0.87182	0.95733	0.98946	0.99810
1.00	5.00	5.00	0.16678	0.23694	0.42089	0.64671	0.83320	0.94121	0.98500	0.99730	0.99966

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.00998	0.01858	0.05370	0.13830	0.28971	0.49291	0.69779	0.85354	0.94325
1.00	2.00	3.00	0.01309	0.05669	0.18482	0.38077	0.60165	0.79071	0.91278	0.97182	0.99312
1.00	3.00	5.00	0.05192	0.12339	0.31265	0.55287	0.76574	0.90412	0.97018	0.99313	0.99886
1.00	2.00	4.00	0.01995	0.08601	0.26553	0.50393	0.72736	0.88186	0.96071	0.99023	0.99824
1.00	3.00	9.00	0.24254	0.33789	0.56041	0.78189	0.92089	0.97951	0.99630	0.99954	0.99996
1.00	1.00	3.00	0.01496	0.08224	0.26515	0.50745	0.73271	0.88625	0.96306	0.99111	0.99847
1.00	1.00	5.00	0.03371	0.14095	0.40034	0.67703	0.86893	0.96096	0.99171	0.99878	0.99988
1.00	3.00	3.00	0.01557	0.04947	0.15200	0.31830	0.52302	0.71964	0.86562	0.94870	0.98477
1.00	5.00	5.00	0.12215	0.17924	0.33395	0.54012	0.73749	0.88001	0.95740	0.98858	0.99775

Table 4A

ANALYSIS OF COVARIANCE --- ONE-WAY LAYOUT

Case I

	WITH U* =	-2.00 1.00	1.00				
VZ(1) =	2.500	Z(1,J) =	3.00	4.00	5.00	6.00	7.00
VZ(2) =	2.500	Z(2,J) =	3.00	4.00	5.00	6.00	7.00
VZ(3) =	2.500	Z(3,J) =	3.00	4.00	5.00	6.00	7.00

DF1 = 2 DF2 =11 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.05007	0.08020	0.18141	0.36219	0.58829	0.78977	0.91781	0.97591	0.99477
1.00	2.00	3.00	0.05612	0.10809	0.25500	0.46446	0.67998	0.84624	0.94214	0.98326	0.99632
1.00	3.00	5.00	0.09711	0.17516	0.37472	0.61295	0.80875	0.92641	0.97845	0.99530	0.99925
1.00	2.00	4.00	0.06487	0.12176	0.27832	0.49222	0.70282	0.85948	0.94758	0.98486	0.99666
1.00	3.00	9.00	0.29087	0.36180	0.53656	0.73145	0.87789	0.95730	0.98877	0.99782	0.99970
1.00	1.00	3.00	0.06028	0.08732	0.17327	0.32195	0.51493	0.70743	0.85481	0.94156	0.98106
1.00	1.00	5.00	0.08380	0.10964	0.18841	0.31885	0.48674	0.66138	0.80836	0.90845	0.96365
1.00	3.00	3.00	0.05867	0.12505	0.30318	0.53497	0.74755	0.89181	0.96430	0.99111	0.99835
1.00	5.00	5.00	0.16678	0.25775	0.47767	0.71337	0.87964	0.96216	0.99128	0.99856	0.99983

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.00998	0.01858	0.05370	0.13829	0.28971	0.49291	0.69779	0.85354	0.94325
1.00	2.00	3.00	0.01309	0.05467	0.17266	0.34686	0.54445	0.72629	0.86180	0.94253	0.98061
1.00	3.00	5.00	0.05192	0.12547	0.31514	0.54781	0.75119	0.88766	0.95907	0.98817	0.99733
1.00	2.00	4.00	0.01995	0.06882	0.20386	0.39354	0.59507	0.76783	0.88803	0.95538	0.98551
1.00	3.00	9.00	0.24254	0.31290	0.48785	0.68771	0.84540	0.93852	0.98062	0.99523	0.99910
1.00	1.00	3.00	0.01496	0.02922	0.07532	0.16125	0.29219	0.45914	0.63489	0.78643	0.89375
1.00	1.00	5.00	0.03371	0.05138	0.10493	0.19509	0.31960	0.46863	0.62343	0.76233	0.86998
1.00	3.00	3.00	0.01557	0.07396	0.23171	0.44355	0.65406	0.81929	0.92240	0.97312	0.99260
1.00	5.00	5.00	0.12215	0.21112	0.42848	0.66798	0.84674	0.94448	0.98445	0.99669	0.99947

Table 4A

ANALYSIS OF COVARIANCE --- ONE-WAY LAYOUT

Case II

WITH U* =		1.00	1.00	-2.00			
VZ(1) =	10.000	Z(1,J) =	1.00	3.00	5.00	7.00	9.00
VZ(2) =	2.500	Z(2,J) =	3.00	4.00	5.00	6.00	7.00
VZ(3) =	2.500	Z(3,J) =	3.00	4.00	5.00	6.00	7.00

DF1 = 2 DF2 =11 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.05007	0.08020	0.18141	0.36219	0.58829	0.78977	0.91781	0.97591	0.99477
1.00	2.00	3.00	0.05342	0.11637	0.29280	0.53344	0.75722	0.90392	0.97181	0.99397	0.99907
1.00	3.00	5.00	0.09920	0.18452	0.40224	0.65575	0.84974	0.95189	0.98900	0.99824	0.99981
1.00	2.00	4.00	0.06274	0.14558	0.36133	0.62115	0.82819	0.94229	0.98598	0.99758	0.99971
1.00	3.00	9.00	0.30844	0.40762	0.63034	0.83501	0.94853	0.98903	0.99843	0.99985	0.99999
1.00	1.00	3.00	0.05839	0.14374	0.36489	0.62820	0.83437	0.94548	0.98701	0.99779	0.99973
1.00	1.00	5.00	0.08333	0.20101	0.47504	0.74504	0.91059	0.97784	0.99619	0.99955	0.99996
1.00	3.00	3.00	0.05595	0.10744	0.25726	0.47640	0.70090	0.86678	0.95503	0.98873	0.99794
1.00	5.00	5.00	0.17720	0.24553	0.42524	0.64725	0.83215	0.94031	0.98463	0.99721	0.99965

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.00998	0.01858	0.05370	0.13830	0.28970	0.49291	0.69779	0.85354	0.94325
1.00	2.00	3.00	0.01234	0.05537	0.18186	0.37576	0.59558	0.78545	0.90951	0.97037	0.99267
1.00	3.00	5.00	0.05665	0.12709	0.31383	0.55153	0.76336	0.90226	0.96927	0.99284	0.99880
1.00	2.00	4.00	0.02001	0.08540	0.26327	0.50009	0.72327	0.87893	0.95927	0.98975	0.99813
1.00	3.00	9.00	0.26307	0.35543	0.57123	0.78656	0.92224	0.97976	0.99632	0.99954	0.99996
1.00	1.00	3.00	0.01440	0.08129	0.26321	0.50458	0.72977	0.88416	0.96204	0.99077	0.99839
1.00	1.00	5.00	0.03507	0.14168	0.39978	0.67565	0.86772	0.96036	0.99152	0.99875	0.99988
1.00	3.00	3.00	0.01515	0.04843	0.14911	0.31277	0.51550	0.71223	0.86030	0.94590	0.98371
1.00	5.00	5.00	0.13556	0.19124	0.34219	0.54386	0.73793	0.87921	0.95671	0.98828	0.99766

Table 4A

Case II

ANALYSIS OF COVARIANCE --- ONE-WAY LAYOUT

WITH U* = -2.00 1.00 1.00

VZ(1) = 10.000 Z(1,J) = 1.00 3.00 5.00 7.00 9.00
VZ(2) = 2.500 Z(2,J) = 3.00 4.00 5.00 6.00 7.00
VZ(3) = 2.500 Z(3,J) = 3.00 4.00 5.00 6.00 7.00

DF1 = 2 DF2 =11 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.05007	0.08020	0.18141	0.36219	0.58829	0.78977	0.91781	0.97591	0.99477
1.00	2.00	3.00	0.05342	0.10481	0.25026	0.45838	0.67392	0.84177	0.93974	0.98233	0.99606
1.00	3.00	5.00	0.09920	0.17646	0.37424	0.61099	0.80654	0.92493	0.97780	0.99510	0.99921
1.00	2.00	4.00	0.06274	0.11903	0.27427	0.48694	0.69756	0.85560	0.94550	0.98405	0.99643
1.00	3.00	9.00	0.30844	0.37731	0.54715	0.73688	0.87988	0.95779	0.98883	0.99782	0.99969
1.00	1.00	3.00	0.05839	0.08493	0.16942	0.31610	0.50766	0.70039	0.84960	0.93861	0.97979
1.00	1.00	5.00	0.08333	0.10869	0.18602	0.31434	0.48026	0.65419	0.80218	0.90430	0.96150
1.00	3.00	3.00	0.05595	0.12177	0.29865	0.52957	0.74268	0.88862	0.96281	0.99061	0.99823
1.00	5.00	5.00	0.17720	0.26654	0.48279	0.71513	0.87974	0.96193	0.99116	0.99853	0.99983

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.00998	0.01858	0.05370	0.13830	0.28971	0.49291	0.69779	0.85354	0.94325
1.00	2.00	3.00	0.01234	0.05368	0.17090	0.34390	0.54041	0.72204	0.85838	0.94045	0.97964
1.00	3.00	5.00	0.05665	0.12959	0.31772	0.54860	0.75075	0.88685	0.95847	0.98789	0.99724
1.00	2.00	4.00	0.02001	0.06861	0.20286	0.39143	0.59204	0.76464	0.88553	0.95389	0.98485
1.00	3.00	9.00	0.26307	0.33139	0.50130	0.69550	0.84891	0.93971	0.98091	0.99527	0.99910
1.00	1.00	3.00	0.01440	0.02845	0.07384	0.15838	0.28736	0.45249	0.62753	0.77993	0.88921
1.00	1.00	5.00	0.03507	0.05252	0.10534	0.19415	0.31680	0.46392	0.61753	0.75655	0.86554
1.00	3.00	3.00	0.01515	0.07328	0.23030	0.44119	0.65111	0.81655	0.92051	0.97216	0.99224
1.00	5.00	5.00	0.13556	0.22298	0.43659	0.67211	0.84819	0.94476	0.98444	0.99666	0.99946

Table 4A

ANALYSIS OF COVARIANCE --- ONE-WAY LAYOUT

Case III

WITH U* = 1.00 1.00 -2.00

VZ(1) = 2.500 Z(1,J) = 3.00 4.00 5.00 6.00 7.00
VZ(2) = 2.500 Z(2,J) = 3.00 4.00 5.00 6.00 7.00
VZ(3) = 10.000 Z(3,J) = 1.00 3.00 5.00 7.00 9.00

DF1 = 2 DF2 =11 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.05007	0.08020	0.18141	0.36219	0.58829	0.78977	0.91781	0.97591	0.99477
1.00	2.00	3.00	0.05888	0.12380	0.30440	0.54731	0.76882	0.91062	0.97447	0.99470	0.99921
1.00	3.00	5.00	0.09530	0.18328	0.40627	0.66259	0.85527	0.95458	0.98983	0.99841	0.99983
1.00	2.00	4.00	0.06782	0.15287	0.37271	0.63363	0.83730	0.94672	0.98742	0.99789	0.99975
1.00	3.00	9.00	0.26651	0.37303	0.61112	0.82803	0.94697	0.98884	0.99843	0.99985	0.99999
1.00	1.00	3.00	0.06478	0.15212	0.37682	0.64074	0.84334	0.94979	0.98841	0.99809	0.99978
1.00	1.00	5.00	0.08785	0.20758	0.48444	0.75356	0.91540	0.97956	0.99658	0.99961	0.99997
1.00	3.00	3.00	0.06037	0.11356	0.26726	0.48921	0.71264	0.87434	0.95844	0.98980	0.99817
1.00	5.00	5.00	0.16333	0.23436	0.42022	0.64754	0.83432	0.94189	0.98524	0.99735	0.99967

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.00998	0.01858	0.05370	0.13829	0.28970	0.49291	0.69779	0.85354	0.94325
1.00	2.00	3.00	0.01386	0.05805	0.18784	0.38586	0.60779	0.79600	0.91605	0.97326	0.99357
1.00	3.00	5.00	0.04741	0.11991	0.31169	0.55440	0.76823	0.90605	0.97110	0.99342	0.99892
1.00	2.00	4.00	0.02012	0.08701	0.26862	0.50898	0.73265	0.88562	0.96254	0.99084	0.99838
1.00	3.00	9.00	0.21382	0.31341	0.54542	0.77551	0.91910	0.97921	0.99628	0.99954	0.99996
1.00	1.00	3.00	0.01641	0.08459	0.26972	0.51399	0.73919	0.89068	0.96515	0.99177	0.99861
1.00	1.00	5.00	0.03340	0.14189	0.40368	0.68139	0.87219	0.96248	0.99216	0.99887	0.99989
1.00	3.00	3.00	0.01599	0.05024	0.15380	0.32150	0.52717	0.72355	0.86833	0.95007	0.98528
1.00	5.00	5.00	0.11695	0.17475	0.33126	0.53947	0.73812	0.88087	0.95793	0.98878	0.99780

Table 4A

ANALYSIS OF COVARIANCE --- ONE-WAY LAYOUT

Case III

	WITH U* =	-2.00 1.00 1.00					
VZ(1) =	2.500	Z(1,J) =	3.00	4.00	5.00	6.00	7.00
VZ(2) =	2.500	Z(2,J) =	3.00	4.00	5.00	6.00	7.00
VZ(3) =	10.000	Z(3,J) =	1.00	3.00	5.00	7.00	9.00

DF1 = 2 DF2 =11 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.05007	0.08020	0.18141	0.36219	0.58829	0.78977	0.91781	0.97591	0.99477
1.00	2.00	3.00	0.05888	0.11144	0.25982	0.47061	0.68609	0.85073	0.94454	0.98419	0.99658
1.00	3.00	5.00	0.09530	0.17412	0.37544	0.61509	0.81105	0.92792	0.97911	0.99549	0.99929
1.00	2.00	4.00	0.06782	0.12542	0.28368	0.49910	0.70962	0.86445	0.95023	0.98588	0.99694
1.00	3.00	9.00	0.26651	0.34032	0.52200	0.72408	0.87526	0.95672	0.98872	0.99784	0.99970
1.00	1.00	3.00	0.06478	0.09295	0.18212	0.33500	0.53060	0.72197	0.86508	0.94707	0.98331
1.00	1.00	5.00	0.08785	0.11482	0.19686	0.33190	0.50354	0.67862	0.82227	0.91721	0.96795
1.00	3.00	3.00	0.06037	0.12705	0.30584	0.53800	0.75019	0.89348	0.96505	0.99135	0.99840
1.00	5.00	5.00	0.16333	0.25498	0.47639	0.71329	0.87998	0.96241	0.99138	0.99858	0.99984

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.00998	0.01858	0.05370	0.13829	0.28970	0.49291	0.69779	0.85354	0.94325
1.00	2.00	3.00	0.01386	0.05570	0.17449	0.34989	0.54855	0.73060	0.86525	0.94462	0.98157
1.00	3.00	5.00	0.04741	0.12156	0.31275	0.54717	0.75174	0.88853	0.95970	0.98846	0.99742
1.00	2.00	4.00	0.02012	0.06933	0.20535	0.39641	0.59907	0.77197	0.89126	0.95728	0.98636
1.00	3.00	9.00	0.21382	0.28705	0.46910	0.67688	0.84055	0.93691	0.98024	0.99517	0.99909
1.00	1.00	3.00	0.01641	0.03116	0.07895	0.16810	0.30336	0.47400	0.65070	0.79979	0.90264
1.00	1.00	5.00	0.03340	0.05161	0.10690	0.20020	0.32893	0.48195	0.63864	0.77628	0.88011
1.00	3.00	3.00	0.01599	0.07452	0.23268	0.44502	0.65580	0.82084	0.92342	0.97362	0.99279
1.00	5.00	5.00	0.11695	0.20659	0.42553	0.66665	0.84641	0.94452	0.98452	0.99672	0.99948

Table 4B

ANALYSIS OF COVARIANCE --- ONE-WAY LAYOUT

Case I

WITH WITHIN TREATMENT SERIAL CORRELATION AND U* = 1.00 1.00 -2.00

VZ(1) = 2.500 Z(1,J) = 3.00 4.00 5.00 6.00 7.00
VZ(2) = 2.500 Z(2,J) = 3.00 4.00 5.00 6.00 7.00
VZ(3) = 2.500 Z(3,J) = 3.00 4.00 5.00 6.00 7.00

DF1 = 2 DF2 =11 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.00169	0.02805	0.10495	0.22626	0.38120	0.55173	0.71280	0.84084	0.92504
-0.2	0.01439	0.02910	0.08289	0.19621	0.37489	0.58719	0.77646	0.90309	0.96684
0.0	0.05007	0.08020	0.18141	0.36219	0.58829	0.78977	0.91781	0.97591	0.99477
0.2	0.11217	0.16406	0.31683	0.53868	0.75562	0.90247	0.97145	0.99397	0.99909
0.4	0.21029	0.28047	0.46509	0.66839	0.86375	0.95681	0.99032	0.99849	0.99984

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.00045	0.02569	0.09791	0.20768	0.34199	0.48662	0.62753	0.75200	0.85080
-0.2	0.00199	0.00746	0.02719	0.07164	0.15644	0.29180	0.46763	0.65116	0.80472
0.0	0.00998	0.01858	0.05370	0.13830	0.28971	0.49291	0.69779	0.85354	0.94325
0.2	0.03088	0.05359	0.13309	0.28608	0.49779	0.71153	0.86904	0.95398	0.98763
0.4	0.08445	0.12841	0.26186	0.46805	0.68938	0.85888	0.95157	0.98772	0.99774

Table 5.1A

ANALYSIS OF VARIANCE --- SPLIT-PLOT DESIGN

FOR MAIN-PLOT TREATMENTS COMPARISON

WITH SUBPLOT ERROR VARIANCES = 0.50 0.50 AND U* = 1.00 1.00 -2.00

REP = 3 T = 3 S = 2 DF1 = 2 DF2 = 4

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

M-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.06978	0.13257	0.24222	0.39118	0.55691	0.71089	0.83191	0.91328
1.0	2.0	3.0	0.05248	0.09829	0.22780	0.41401	0.61261	0.77989	0.89357	0.95688	0.98596
1.0	3.0	5.0	0.05488	0.12472	0.30820	0.53898	0.74450	0.88361	0.95690	0.98730	0.99715
1.0	2.0	4.0	0.05448	0.11874	0.29045	0.51315	0.71959	0.86613	0.94769	0.98368	0.99614
1.0	3.0	9.0	0.06144	0.17300	0.43587	0.70432	0.88211	0.96467	0.99218	0.99876	0.99986
1.0	1.0	3.0	0.05466	0.11863	0.28991	0.51258	0.71937	0.86625	0.94798	0.98398	0.99631
1.0	1.0	5.0	0.06102	0.16009	0.40116	0.66294	0.85210	0.95020	0.98745	0.99772	0.99971
1.0	3.0	3.0	0.05251	0.08962	0.19728	0.35984	0.54571	0.71682	0.84634	0.92821	0.97205
1.0	5.0	5.0	0.05446	0.11329	0.27203	0.48261	0.68574	0.83863	0.93053	0.97523	0.99291

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

M-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30112	0.41779	0.54105
1.0	2.0	3.0	0.01078	0.04143	0.13001	0.26538	0.42780	0.59266	0.73897	0.85582	0.93748
1.0	3.0	5.0	0.01157	0.06910	0.22402	0.43070	0.63522	0.79806	0.90556	0.96451	0.99011
1.0	2.0	4.0	0.01144	0.06180	0.19993	0.39085	0.58946	0.75807	0.87866	0.95120	0.98562
1.0	3.0	9.0	0.01392	0.11813	0.37029	0.64286	0.84077	0.94526	0.98597	0.99744	0.99968
1.0	1.0	3.0	0.01150	0.06082	0.19660	0.38541	0.58346	0.75343	0.87660	0.95119	0.98612
1.0	1.0	5.0	0.01375	0.10252	0.32518	0.58364	0.79211	0.91828	0.97583	0.99493	0.99929
1.0	3.0	3.0	0.01079	0.03369	0.10130	0.20898	0.34617	0.49654	0.64269	0.77315	0.88092
1.0	5.0	5.0	0.01143	0.05923	0.19065	0.37352	0.56646	0.73376	0.85668	0.93442	0.97610

Table 5.1A

ANALYSIS OF VARIANCE --- SPLIT-PLOT DESIGN

FOR MAIN-PLOT TREATMENTS COMPARISON

WITH SUBPLOT ERROR VARIANCES = 0.50 0.50 AND U* = -2.00 1.00 1.00

REP = 3 T = 3 S = 2 DF1 = 2 DF2 = 4

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

M-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.06978	0.13257	0.24222	0.39117	0.55691	0.71089	0.83191	0.91328
1.0	2.0	3.0	0.05248	0.09254	0.20592	0.37133	0.55497	0.72124	0.84663	0.92622	0.96906
1.0	3.0	5.0	0.05488	0.12186	0.29732	0.51873	0.72006	0.86273	0.94356	0.98062	0.99445
1.0	2.0	4.0	0.05448	0.09998	0.22624	0.40412	0.59302	0.75565	0.87184	0.94150	0.97685
1.0	3.0	9.0	0.06144	0.14008	0.33954	0.57637	0.77417	0.90042	0.96380	0.98918	0.99735
1.0	1.0	3.0	0.05466	0.07591	0.14058	0.24775	0.38799	0.54195	0.68674	0.80528	0.89166
1.0	1.0	5.0	0.06102	0.08371	0.15101	0.25856	0.39487	0.54177	0.67984	0.79531	0.88318
1.0	3.0	3.0	0.05251	0.10530	0.24914	0.44465	0.64174	0.80031	0.90450	0.96099	0.98642
1.0	5.0	5.0	0.05446	0.14150	0.35859	0.60755	0.80458	0.92130	0.97449	0.99337	0.99862

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

M-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30112	0.41778	0.54105
1.0	2.0	3.0	0.01078	0.04228	0.13194	0.26589	0.42342	0.58150	0.72055	0.82900	0.90476
1.0	3.0	5.0	0.01157	0.07422	0.23990	0.45405	0.65796	0.81369	0.91204	0.96411	0.98739
1.0	2.0	4.0	0.01144	0.04986	0.15724	0.31210	0.48528	0.64843	0.78166	0.87720	0.93803
1.0	3.0	9.0	0.01392	0.09112	0.28865	0.52782	0.73468	0.87407	0.94963	0.98308	0.99525
1.0	1.0	3.0	0.01150	0.02217	0.05486	0.11082	0.19004	0.28954	0.40320	0.52497	0.65496
1.0	1.0	5.0	0.01375	0.02865	0.07290	0.14479	0.24043	0.35345	0.47626	0.60286	0.73010
1.0	3.0	3.0	0.01079	0.05677	0.18312	0.35924	0.54657	0.71178	0.83609	0.91689	0.96255
1.0	5.0	5.0	0.01143	0.09629	0.30998	0.56062	0.76720	0.89763	0.96273	0.98880	0.99722

Table 5.1A

ANALYSIS OF VARIANCE --- SPLIT-PLOT DESIGN

FOR MAIN-PLOT TREATMENTS COMPARISON

WITH SUBPLOT ERROR VARIANCES = 1.50 1.50 AND U* = 1.00 1.00 -2.00

REP = 3 T = 3 S = 2 DF1 = 2 DF2 = 4

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

M-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.06978	0.13257	0.24222	0.39117	0.55691	0.71089	0.83191	0.91328
1.0	2.0	3.0	0.05164	0.08938	0.19925	0.36562	0.55530	0.72806	0.85634	0.93519	0.97589
1.0	3.0	5.0	0.05361	0.11056	0.26586	0.47521	0.68010	0.83580	0.92978	0.97546	0.99330
1.0	2.0	4.0	0.05310	0.10547	0.25055	0.45149	0.65511	0.81615	0.91782	0.96981	0.99132
1.0	3.0	9.0	0.05904	0.15506	0.39053	0.65021	0.84210	0.94463	0.98520	0.99707	0.99959
1.0	1.0	3.0	0.05288	0.10348	0.24460	0.44228	0.64535	0.80840	0.91304	0.96752	0.99051
1.0	1.0	5.0	0.05743	0.13856	0.34562	0.59172	0.79362	0.91665	0.97364	0.99370	0.99893
1.0	3.0	3.0	0.05175	0.08266	0.17479	0.32033	0.49637	0.66878	0.80845	0.90349	0.95880
1.0	5.0	5.0	0.05347	0.10012	0.23083	0.41656	0.61299	0.77818	0.89110	0.95476	0.98463

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

M-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30112	0.41779	0.54105
1.0	2.0	3.0	0.01052	0.03245	0.09776	0.20316	0.33932	0.49026	0.63819	0.77148	0.88243
1.0	3.0	5.0	0.01115	0.05412	0.17409	0.34582	0.53379	0.70403	0.83592	0.92441	0.97356
1.0	2.0	4.0	0.01098	0.04824	0.15401	0.31010	0.48834	0.65846	0.79897	0.90111	0.96313
1.0	3.0	9.0	0.01301	0.09906	0.31607	0.57065	0.77932	0.90892	0.97090	0.99319	0.99890
1.0	1.0	3.0	0.01091	0.04582	0.14565	0.29500	0.46870	0.63820	0.78205	0.89020	0.95822
1.0	1.0	5.0	0.01244	0.08078	0.26046	0.48907	0.70013	0.85360	0.94304	0.98350	0.99670
1.0	3.0	3.0	0.01055	0.02645	0.07487	0.15628	0.26751	0.39954	0.53945	0.67741	0.80852
1.0	5.0	5.0	0.01110	0.04490	0.14129	0.28520	0.45304	0.61826	0.75992	0.86829	0.94153

Table 5.1A

ANALYSIS OF VARIANCE --- SPLIT-PLOT DESIGN

FOR MAIN-PLOT TREATMENTS COMPARISON

WITH SUBPLOT ERROR VARIANCES = 1.50 1.50 AND U* = -2.00 1.00 1.00

REP = 3 T = 3 S = 2 DF1 = 2 DF2 = 4

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

M-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.06978	0.13257	0.24222	0.39117	0.55691	0.71088	0.83191	0.91328
1.0	2.0	3.0	0.05164	0.08351	0.17659	0.32003	0.49080	0.65821	0.79603	0.89233	0.94990
1.0	3.0	5.0	0.05361	0.10585	0.24821	0.44197	0.63789	0.79639	0.90144	0.95909	0.98548
1.0	2.0	4.0	0.05310	0.08912	0.19235	0.34646	0.52305	0.68930	0.82062	0.90862	0.95909
1.0	3.0	9.0	0.05904	0.12207	0.28836	0.50145	0.70010	0.84603	0.93283	0.97518	0.99226
1.0	1.0	3.0	0.05288	0.07345	0.13681	0.24354	0.38513	0.54185	0.68944	0.80946	0.89539
1.0	1.0	5.0	0.05743	0.07944	0.14557	0.25310	0.39152	0.54201	0.68337	0.80024	0.88729
1.0	3.0	3.0	0.05175	0.09254	0.20789	0.37572	0.56115	0.72781	0.85220	0.93009	0.97127
1.0	5.0	5.0	0.05347	0.12256	0.30277	0.52815	0.73028	0.87079	0.94843	0.98292	0.99532

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

M-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30111	0.41779	0.54105
1.0	2.0	3.0	0.01052	0.03219	0.09572	0.19607	0.32363	0.46452	0.60308	0.72575	0.82482
1.0	3.0	5.0	0.01115	0.05688	0.18255	0.35784	0.54450	0.70944	0.83397	0.91530	0.96161
1.0	2.0	4.0	0.01098	0.03810	0.11619	0.23546	0.38026	0.53161	0.67141	0.78701	0.87384
1.0	3.0	9.0	0.01301	0.07239	0.23044	0.43741	0.63849	0.79640	0.89980	0.95707	0.98414
1.0	1.0	3.0	0.01091	0.01980	0.04756	0.09660	0.16848	0.26183	0.37145	0.49093	0.62014
1.0	1.0	5.0	0.01244	0.02525	0.06382	0.12793	0.21560	0.32207	0.44036	0.56477	0.69426
1.0	3.0	3.0	0.01055	0.04259	0.13373	0.26961	0.42888	0.58796	0.72698	0.83451	0.90866
1.0	5.0	5.0	0.01110	0.07571	0.24586	0.46402	0.66918	0.82328	0.91856	0.96771	0.98902

Table 5.1B

ANALYSIS OF VARIANCE --- SPLIT-PLOT DESIGN

FOR MAIN-PLOT TREATMENTS COMPARISON

WITH EQUAL MAINPLOT ERROR VARIANCES = 0.50

AND SUBPLOTS SERIAL CORRELATION WITHIN MAIN-PLOT

REP = 3 T = 3 S = 2 DF1 = 2 DF2 = 4

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.05000	0.06978	0.13257	0.24222	0.39118	0.55691	0.71089	0.83191	0.91328
-0.2	0.05000	0.06979	0.13257	0.24222	0.39118	0.55691	0.71089	0.83191	0.91328
0.0	0.05000	0.06979	0.13257	0.24222	0.39118	0.55691	0.71089	0.83191	0.91328
0.2	0.05000	0.06979	0.13257	0.24222	0.39118	0.55691	0.71089	0.83191	0.91328
0.4	0.05000	0.06979	0.13257	0.24222	0.39118	0.55691	0.71089	0.83191	0.91328

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30112	0.41779	0.54105
-0.2	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30112	0.41779	0.54105
0.0	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30112	0.41779	0.54105
0.2	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30112	0.41779	0.54105
0.4	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30112	0.41779	0.54105

Table 5.1B

ANALYSIS OF VARIANCE --- SPLIT-PLOT DESIGN

FOR MAIN-PLOT TREATMENTS COMPARISON

WITH EQUAL MAINPLOT ERROR VARIANCES = 0.50

AND SUBPLOTS SERIAL CORRELATION WITHIN MAIN-PLOT

REP = 3 T = 3 S = 3 DF1 = 2 DF2 = 4

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.05000	0.07105	0.13721	0.25115	0.40363	0.57075	0.72358	0.84176	0.91979
-0.2	0.05000	0.07009	0.13369	0.24438	0.39420	0.56029	0.71398	0.83433	0.91490
0.0	0.05000	0.06979	0.13257	0.24222	0.39118	0.55691	0.71089	0.83191	0.91328
0.2	0.05000	0.07009	0.13369	0.24438	0.39420	0.56029	0.71399	0.83433	0.91490
0.4	0.05000	0.07105	0.13721	0.25115	0.40363	0.57075	0.72359	0.84176	0.91979

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.01000	0.01613	0.03653	0.07602	0.13916	0.22708	0.33567	0.45639	0.58001
-0.2	0.01000	0.01504	0.03227	0.06687	0.12406	0.20596	0.30956	0.42729	0.55074
0.0	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30111	0.41779	0.54105
0.2	0.01000	0.01504	0.03227	0.06687	0.12406	0.20596	0.30957	0.42731	0.55075
0.4	0.01000	0.01613	0.03653	0.07602	0.13916	0.22708	0.33569	0.45639	0.58002

STOP 0
*END
*JOB CPU TIME=03M:20S

Table 5.2A

ANALYSIS OF VARIANCE --- SPLIT-PLOT DESIGN

FOR SUB-PLOT TREATMENTS COMPARISON

WITH U* = 1.000 1.000 -2.000

REP = 2 T = 3 S = 3 DF1 = 2 DF2 = 6

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

S-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.07442	0.15434	0.29682	0.48578	0.67866	0.83180	0.92716	0.97408
1.0	2.0	3.0	0.05361	0.11117	0.27141	0.49193	0.70727	0.86386	0.94970	0.98541	0.99673
1.0	3.0	5.0	0.05652	0.14032	0.35460	0.60826	0.81195	0.92994	0.98002	0.99570	0.99931
1.0	2.0	4.0	0.05627	0.13435	0.33778	0.58653	0.79441	0.92023	0.97621	0.99462	0.99910
1.0	3.0	9.0	0.06459	0.16942	0.47469	0.74806	0.91177	0.97774	0.99601	0.99950	0.99996
1.0	1.0	3.0	0.05706	0.13661	0.34328	0.59419	0.80131	0.92449	0.97808	0.99523	0.99924
1.0	1.0	5.0	0.06583	0.18081	0.45052	0.72187	0.89555	0.97140	0.99440	0.99923	0.99993
1.0	3.0	3.0	0.05353	0.10064	0.23598	0.43375	0.64399	0.81452	0.92119	0.97297	0.99262
1.0	5.0	5.0	0.05579	0.12789	0.31756	0.55548	0.76401	0.89977	0.96640	0.99120	0.99822

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

S-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.01630	0.03987	0.09243	0.18545	0.32004	0.48133	0.64317	0.78084
1.0	2.0	3.0	0.01140	0.05153	0.16685	0.33947	0.53628	0.71730	0.85333	0.93731	0.97926
1.0	3.0	5.0	0.01259	0.08316	0.26904	0.50512	0.71975	0.86949	0.95106	0.98572	0.99693
1.0	2.0	4.0	0.01249	0.07515	0.24395	0.46747	0.68240	0.84273	0.93698	0.98042	0.99557
1.0	3.0	9.0	0.01644	0.13430	0.41132	0.69319	0.87900	0.96454	0.99247	0.99888	0.99989
1.0	1.0	3.0	0.01281	0.07609	0.24656	0.47204	0.68802	0.84796	0.94080	0.98250	0.99633
1.0	1.0	5.0	0.01720	0.12216	0.37686	0.65240	0.85045	0.95172	0.98873	0.99818	0.99980
1.0	3.0	3.0	0.01137	0.04242	0.13385	0.27753	0.45379	0.63234	0.78339	0.89093	0.95538
1.0	5.0	5.0	0.01229	0.07282	0.23559	0.45155	0.66192	0.82346	0.92306	0.97261	0.99234

Table 5.2A

ANALYSIS OF VARIANCE --- SPLIT-PLOT DESIGN

FOR SUB-PLOT TREATMENTS COMPARISON

WITH U* = -2.000 1.000 1.000

REP = 2 T = 3 S = 3 DF1 = 2 DF2 = 6

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

S-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.05000	0.07442	0.15434	0.29682	0.48578	0.67866	0.83180	0.92716	0.97408
1.0	2.0	3.0	0.05361	0.10297	0.24082	0.43543	0.63853	0.80452	0.91201	0.96735	0.99006
1.0	3.0	5.0	0.05652	0.13592	0.33853	0.53064	0.78257	0.90897	0.96956	0.99193	0.99831
1.0	2.0	4.0	0.05627	0.11138	0.26174	0.46583	0.66899	0.82714	0.92488	0.97305	0.99206
1.0	3.0	9.0	0.06459	0.15506	0.37843	0.62956	0.82243	0.93208	0.97941	0.99508	0.99908
1.0	1.0	3.0	0.05706	0.08111	0.15556	0.28120	0.44556	0.61991	0.77154	0.88062	0.94627
1.0	1.0	5.0	0.06583	0.09009	0.16274	0.28033	0.43034	0.59026	0.73497	0.84732	0.92305
1.0	3.0	3.0	0.05353	0.11790	0.28950	0.51196	0.71904	0.86672	0.94861	0.98405	0.99603
1.0	5.0	5.0	0.05579	0.15640	0.39986	0.66239	0.85126	0.94920	0.98668	0.99734	0.99960

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

S-PLOT VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.0	1.0	1.0	0.01000	0.01630	0.03987	0.09243	0.18544	0.32004	0.48133	0.64317	0.78084
1.0	2.0	3.0	0.01140	0.05201	0.16592	0.33092	0.51535	0.68656	0.82097	0.91052	0.96118
1.0	3.0	5.0	0.01259	0.08835	0.28335	0.52196	0.73088	0.87298	0.95008	0.98377	0.99566
1.0	2.0	4.0	0.01249	0.06076	0.19328	0.37739	0.57153	0.73947	0.86130	0.93587	0.97447
1.0	3.0	9.0	0.01644	0.10658	0.33080	0.58744	0.79129	0.91369	0.97094	0.99208	0.99826
1.0	1.0	3.0	0.01281	0.02568	0.06573	0.13606	0.23801	0.36688	0.51031	0.65222	0.77994
1.0	1.0	5.0	0.01720	0.03400	0.08413	0.16613	0.27599	0.40567	0.54365	0.67781	0.79832
1.0	3.0	3.0	0.01137	0.06913	0.22428	0.43081	0.63513	0.79759	0.90375	0.96109	0.98672
1.0	5.0	5.0	0.01229	0.11154	0.35390	0.62107	0.82148	0.93278	0.97988	0.99524	0.99911

Table 5.2B ANALYSIS OF VARIANCE --- SPLIT-PLOT DESIGN

FOR SUB-PLOT TREATMENTS COMPARISON

WITH SUBPLOTS SERIAL CORRELATION WITHIN MAIN-PLOT

REP = 2 T = 3 S = 3 DF1 = 2 DF2 = 6

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.05190	0.07447	0.14759	0.27770	0.45329	0.63967	0.79684	0.90305	0.96108
-0.2	0.05059	0.07344	0.14836	0.28296	0.46458	0.65503	0.81187	0.91418	0.96747
0.0	0.05000	0.07442	0.15434	0.29682	0.48578	0.67866	0.83180	0.92716	0.97408
0.2	0.05101	0.07794	0.16477	0.31584	0.51031	0.70221	0.84901	0.93688	0.97843
0.4	0.05579	0.08718	0.18421	0.34367	0.53846	0.72289	0.86020	0.94165	0.98048

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

SERIAL CORRELATION	NON CENTRALITY PARAMETER								
RHO	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
-0.4	0.01073	0.01820	0.04402	0.09682	0.18515	0.30995	0.45976	0.61383	0.75260
-0.2	0.01022	0.01642	0.03911	0.08877	0.17610	0.30318	0.45781	0.61682	0.75740
0.0	0.01000	0.01630	0.03987	0.09243	0.18545	0.32004	0.48133	0.64317	0.78084
0.2	0.01038	0.01814	0.04637	0.10701	0.21036	0.35442	0.52058	0.68190	0.81797
0.4	0.01229	0.02521	0.06789	0.14865	0.27134	0.42741	0.59726	0.75818	0.88610

Table 6.1 COST IN RELATION TO POWER IN THE DESIGN OF EXPERIMENTS

GROUP= 3 MIN. GROUP SIZE= 3 MAX. SAMPLE SIZE= 12 MAX. COST= 19.0 SIZE OF TEST= .050

CCST(I)= 2.00 1.20 1.00 V(I)= 1.00 1.00 1.00 MUSTAR'(I)= 1.00 1.00 -2.00

TOTAL	N1	N2	N3	AV. COST PER UNIT	TYPE I ERROR	LAMBDA	POWER	PI	CI
9	3	3	3	1.400	0.05000	3.000	0.83180	15.636	11.169
10	3	3	4	1.360	0.05000	3.286	0.91762	17.352	12.759
10	3	4	3	1.380	0.05000	3.074	0.87854	16.571	12.008
10	4	3	3	1.460	0.05000	3.074	0.87854	16.571	11.350
11	3	3	5	1.327	0.05000	3.503	0.95881	18.177	13.695
11	3	4	4	1.345	0.05000	3.384	0.94611	17.923	13.321
11	3	5	3	1.364	0.05000	3.133	0.90916	17.184	12.601
11	4	3	4	1.418	0.05000	3.384	0.94611	17.923	12.638
11	4	4	3	1.436	0.05000	3.133	0.90916	17.184	11.963
11	5	3	3	1.509	0.05000	3.133	0.90916	17.184	11.387
12	3	3	6	1.300	0.05000	3.674	0.97859	18.572	14.286
12	3	4	5	1.317	0.05000	3.623	0.97546	18.509	14.058
12	3	5	4	1.333	0.05000	3.464	0.96331	18.266	13.700
12	3	6	3	1.350	0.05000	3.182	0.92983	17.597	13.035
12	4	3	5	1.383	0.05000	3.623	0.97546	18.509	13.380
12	4	4	4	1.400	0.05000	3.464	0.96331	18.266	13.047
12	4	5	3	1.417	0.05000	3.182	0.92983	17.597	12.421
12	5	3	4	1.467	0.05000	3.464	0.96331	18.266	12.454
12	5	4	3	1.483	0.05000	3.182	0.92983	17.597	11.863
12	6	3	3	1.550	0.05000	3.182	0.92983	17.597	11.353

Table 6.1 COST IN RELATION TO POWER IN THE DESIGN OF EXPERIMENTS

GROUP= 3 MIN. GROUP SIZE= 3 MAX. SAMPLE SIZE= 15 MAX. COST= 19.0 SIZE OF TEST= .050

COST(I)= 2.00 1.20 1.00 V(I)= 1.00 1.00 1.00 MUSTAR'(I)= 1.00 1.00 -2.00

TOTAL	N1	N2	N3	AV. COST PER UNIT	TYPE I ERROR	LAMBDA	POWER	PI	CI
13	3	3	7	1.277	0.05000	3.813	0.98834	18.767	14.697
13	3	4	6	1.292	0.05000	3.813	0.98834	18.767	14.522
13	3	5	5	1.308	0.05000	3.721	0.98473	18.694	14.296
13	3	6	4	1.323	0.05000	3.530	0.97405	18.481	13.968
13	3	7	3	1.338	0.05000	3.223	0.94421	17.884	13.362
13	4	3	6	1.354	0.05000	3.813	0.98834	18.767	13.862
13	4	4	5	1.369	0.05000	3.721	0.98473	18.694	13.653
13	4	5	4	1.385	0.05000	3.530	0.97405	18.481	13.347
13	4	6	3	1.400	0.05000	3.223	0.94421	17.884	12.774
13	5	3	5	1.431	0.05000	3.721	0.98473	18.694	13.066
13	5	4	4	1.446	0.05000	3.530	0.97405	18.481	12.779
13	5	5	3	1.462	0.05000	3.223	0.94421	17.884	12.236
14	3	3	8	1.257	0.05007	3.928	0.99336	18.841	14.987
14	3	4	7	1.271	0.05007	3.969	0.99419	18.858	14.832
14	3	5	6	1.286	0.05007	3.928	0.99336	18.841	14.654
14	3	6	5	1.300	0.05007	3.803	0.99010	18.776	14.443
14	3	7	4	1.314	0.05007	3.586	0.98105	18.595	14.148
14	3	8	3	1.329	0.05007	3.257	0.95460	18.067	13.599
14	4	3	7	1.329	0.05007	3.969	0.99419	18.857	14.194
14	4	4	6	1.343	0.05007	3.928	0.99336	18.841	14.030
14	4	5	5	1.357	0.05007	3.803	0.99010	18.776	13.835
15	3	3	9	1.240	0.05000	4.025	0.99602	18.921	15.259
15	3	4	8	1.253	0.05000	4.099	0.99694	18.939	15.111
15	3	5	7	1.267	0.05000	4.099	0.99694	18.939	14.952

Table 6.2 COST IN RELATION TO POWER IN THE DESIGN OF EXPERIMENTS

GROUP= 3 MIN. GROUP SIZE= 3 MAX. SAMPLE SIZE= 12 MAX. COST= 19.0 SIZE OF TEST= .050

COST(I)= 2.00 1.20 1.00 V(I)= 1.00 2.00 3.00 MUSTAR'(I)= 1.00 1.00 -2.00

TOTAL	N1	N2	N3	AV. COST PER UNIT	TYPE I ERROR	LAMBDA	POWER	PI	CI
9	3	3	3	1.400	0.05653	1.919	0.52779	8.336	5.954
10	3	3	4	1.360	0.04696	2.151	0.60408	11.864	8.724
10	3	4	3	1.380	0.05596	1.936	0.57334	9.245	6.699
10	4	3	3	1.460	0.06851	1.951	0.60965	7.899	5.411
11	3	3	5	1.327	0.04015	2.339	0.66556	15.579	11.737
11	3	4	4	1.345	0.04733	2.176	0.65446	12.828	9.534
11	3	5	3	1.364	0.05565	1.951	0.60948	9.952	7.298
11	4	3	4	1.418	0.05691	2.198	0.68433	11.025	7.774
11	4	4	3	1.436	0.06674	1.964	0.64049	8.597	5.985
11	5	3	3	1.509	0.08002	1.975	0.67209	7.399	4.903
12	3	3	6	1.300	0.03538	2.496	0.71559	19.224	14.787
12	3	4	5	1.317	0.04111	2.372	0.71750	16.455	12.498
12	3	5	4	1.333	0.04780	2.198	0.69400	13.519	10.139
12	3	6	3	1.350	0.05551	1.964	0.63848	10.503	7.780
12	4	3	5	1.383	0.04856	2.399	0.74225	14.286	10.327
12	4	4	4	1.400	0.05644	2.216	0.71925	11.743	8.388
12	4	5	3	1.417	0.06543	1.975	0.66530	9.168	6.472
12	5	3	4	1.467	0.06672	2.231	0.74448	10.159	6.926
12	5	4	3	1.483	0.07715	1.984	0.69242	7.975	5.377
12	6	3	3	1.550	0.09091	1.993	0.71969	6.916	4.462

Table 6.2 COST IN RELATION TO POWER IN THE DESIGN OF EXPERIMENTS

GROUP= 3 MIN. GROUP SIZE= 3 MAX. SAMPLE SIZE= 15 MAX. COST= 19.0 SIZE OF TEST= .050

COST(I)= 2.00 1.20 1.00 V(I)= 1.00 2.00 3.00 MUSTAR'(I)= 1.00 1.00 -2.00

TOTAL	N1	N2	N3	AV. COST PER UNIT	TYPE I ERROR	LAMBDA	POWER	PI	CI
13	3	3	7	1.277	0.03233	2.630	0.75669	22.406	17.547
13	3	4	6	1.292	0.03677	2.535	0.76716	19.862	15.369
13	3	5	5	1.308	0.04210	2.399	0.75761	16.994	12.995
13	3	6	4	1.323	0.04333	2.216	0.72536	14.007	10.587
13	3	7	3	1.338	0.05548	1.975	0.66206	10.932	8.168
13	4	3	6	1.354	0.04259	2.569	0.78789	17.500	12.926
13	4	4	5	1.369	0.04891	2.423	0.77819	14.910	10.889
13	4	5	4	1.385	0.05619	2.231	0.74693	12.294	8.879
13	4	6	3	1.400	0.06445	1.984	0.68554	9.637	6.883
13	5	3	5	1.431	0.05599	2.443	0.79847	13.010	9.093
13	5	4	4	1.446	0.06542	2.245	0.76836	10.745	7.430
13	5	5	3	1.462	0.07491	1.995	0.70915	8.466	5.793
14	3	3	8	1.257	0.03094	2.745	0.79103	24.568	19.543
14	3	4	7	1.271	0.03416	2.676	0.80770	22.621	17.792
14	3	5	6	1.286	0.03825	2.569	0.80645	20.083	15.620
14	3	6	5	1.300	0.04319	2.423	0.78913	17.272	13.286
14	3	7	4	1.314	0.04898	2.231	0.75079	14.330	10.903
14	3	8	3	1.329	0.05562	1.984	0.68174	11.257	8.473
14	4	3	7	1.329	0.03862	2.715	0.82452	20.349	15.317
14	4	4	6	1.343	0.04359	2.598	0.82331	17.837	13.320
14	4	5	5	1.357	0.04944	2.443	0.80639	15.312	11.282
15	3	3	9	1.240	0.03120	2.846	0.81962	25.270	20.379
15	3	4	8	1.253	0.03316	2.797	0.83885	24.298	19.387
15	3	5	7	1.267	0.03599	2.715	0.84398	22.449	17.723

Table 7.1 TANG'S METHOD OF CALCULATING POWER-VALUES AT 5% LEVEL

F1 = 2   F2 = 2   IX = .950000

NON CENTRALITY PARAMETER	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
TANG'S METHOD	0.05000	0.06180	0.09633	0.15108	0.22221	0.30497	0.39425	0.48511	0.57314
LIU'S METHOD	0.05000	0.06180	0.09633	0.15108	0.22221	0.30497	0.39426	0.48521	0.57623

F1 = 2   F2 = 4   IX = .776390

NON CENTRALITY PARAMETER	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
TANG'S METHOD	0.05000	0.06979	0.13258	0.24222	0.39118	0.55692	0.71089	0.83191	0.91321
LIU'S METHOD	0.05000	0.06978	0.13257	0.24222	0.39117	0.55691	0.71088	0.83191	0.91328

F1 = 2   F2 = 6   IX = .631600

NON CENTRALITY PARAMETER	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
TANG'S METHOD	0.05000	0.07441	0.15433	0.29682	0.48578	0.67866	0.83180	0.92716	0.97407
LIU'S METHOD	0.05000	0.07442	0.15434	0.29682	0.48578	0.67866	0.83180	0.92716	0.97408

F1 = 2   F2 = 12   IX = .393040

NON CENTRALITY PARAMETER	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
TANG'S METHOD	0.05000	0.08077	0.18439	0.36931	0.59879	0.79990	0.92437	0.97881	0.99566
LIU'S METHOD	0.05000	0.08077	0.18439	0.36931	0.59880	0.79990	0.92438	0.97881	0.99566

F1 = 4   F2 = 8   IX = .657410

NON CENTRALITY PARAMETER	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
TANG'S METHOD	0.05000	0.06545	0.11775	0.21851	0.36951	0.55017	0.72297	0.85528	0.93661
LIU'S METHOD	0.05000	0.06545	0.11775	0.21852	0.36952	0.55018	0.72298	0.85529	0.93663

Table 7.1 TANG'S METHOD OF CALCULATING POWER VALUES AT 1% LEVEL

F1 = 2 F2 = 2 IX = .990000

	NON CENTRALITY PARAMETER								
	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
TANG'S METHOD	0.01000	0.01247	0.01985	0.03203	0.04882	0.06998	0.09521	0.12414	0.15638
LIU'S METHOD	0.01000	0.01247	0.01985	0.03203	0.04882	0.06998	0.09521	0.12446	0.16626

F1 = 2 F2 = 4 IX = .900000

	NON CENTRALITY PARAMETER								
	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
TANG'S METHOD	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30111	0.41770	0.53847
LIU'S METHOD	0.01000	0.01469	0.03092	0.06394	0.11920	0.19912	0.30111	0.41778	0.54105

F1 = 2 F2 = 6 IX = .784560

	NON CENTRALITY PARAMETER								
	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
TANG'S METHOD	0.01000	0.01630	0.03987	0.09243	0.18544	0.32004	0.48133	0.64316	0.78046
LIU'S METHOD	0.01000	0.01630	0.03987	0.09243	0.18544	0.32004	0.48133	0.64317	0.78084

F1 = 2 F2 = 12 IX = .535840

	NON CENTRALITY PARAMETER								
	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
TANG'S METHOD	0.01000	0.01891	0.05563	0.14462	0.30344	0.51361	0.71997	0.87073	0.95300
LIU'S METHOD	0.01000	0.01891	0.05563	0.14462	0.30344	0.51360	0.71997	0.87073	0.95300

F1 = 4 F2 = 8 IX = .777930

	NON CENTRALITY PARAMETER								
	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
TANG'S METHOD	0.01000	0.01394	0.02880	0.06332	0.12929	0.23498	0.37708	0.53788	0.69167
LIU'S METHOD	0.01000	0.01394	0.02880	0.06333	0.12930	0.23499	0.37710	0.53792	0.69239

Table 7.2

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH G = SMALLEST OF A(I) VA = 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.05000	0.08077	0.18439	0.36931	0.59880	0.79990	0.92438	0.97881	0.99566
1.00	1.20	1.40	0.05064	0.08742	0.20657	0.40733	0.64075	0.83134	0.94062	0.98464	0.99712
1.00	1.40	1.80	0.05188	0.09605	0.23260	0.44792	0.68126	0.85870	0.95333	0.98874	0.99803
1.00	1.00	1.80	0.05296	0.10609	0.26321	0.49442	0.72580	0.88726	0.96582	0.99249	0.99882
1.00	1.80	1.80	0.05216	0.09048	0.21234	0.41356	0.64450	0.83223	0.94024	0.98425	0.99696

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.01000	0.01891	0.05563	0.14462	0.30344	0.51360	0.71997	0.87073	0.95300
1.00	1.20	1.40	0.01030	0.02390	0.07494	0.18590	0.36546	0.58223	0.77634	0.90518	0.96871
1.00	1.40	1.80	0.01088	0.03188	0.10346	0.24090	0.43895	0.65413	0.82842	0.93318	0.97994
1.00	1.00	1.80	0.01138	0.04121	0.13656	0.30260	0.51739	0.72611	0.87677	0.95706	0.98864
1.00	1.80	1.80	0.01101	0.02722	0.08480	0.20245	0.38425	0.59728	0.78479	0.90838	0.96947

Table 7.2

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH G = HARMONIC MEAN VA = 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.05000	0.08077	0.18439	0.36931	0.59880	0.79990	0.92438	0.97881	0.99566
1.00	1.20	1.40	0.05063	0.08741	0.20656	0.40733	0.64075	0.83134	0.94062	0.98464	0.99712
1.00	1.40	1.80	0.05188	0.09604	0.23260	0.44791	0.68125	0.85869	0.95333	0.98873	0.99803
1.00	1.00	1.80	0.05295	0.10608	0.26320	0.49441	0.72580	0.88725	0.96582	0.99249	0.99882
1.00	1.80	1.80	0.05215	0.09047	0.21233	0.41356	0.64450	0.83223	0.94024	0.98425	0.99696

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.01000	0.01891	0.05563	0.14462	0.30344	0.51360	0.71997	0.87073	0.95300
1.00	1.20	1.40	0.01029	0.02389	0.07493	0.18589	0.36545	0.58223	0.77634	0.90517	0.96868
1.00	1.40	1.80	0.01087	0.03188	0.10345	0.24089	0.43895	0.65412	0.82841	0.93315	0.97985
1.00	1.00	1.80	0.01137	0.04121	0.13655	0.30260	0.51738	0.72610	0.87675	0.95699	0.98852
1.00	1.80	1.80	0.01101	0.02722	0.08479	0.20244	0.38424	0.59728	0.78478	0.90834	0.96937

Table 7.2

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH G = GEOMETRIC MEAN VA = 0.0 AND U* = 1.00 1.00 -2.00

DF1 = 2 DF2 =12 GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.05000	0.08077	0.18439	0.36931	0.59880	0.79990	0.92438	0.97881	0.99566
1.00	1.20	1.40	0.05063	0.08741	0.20656	0.40733	0.64075	0.83134	0.94062	0.98464	0.99712
1.00	1.40	1.80	0.05188	0.09604	0.23260	0.44791	0.68125	0.85869	0.95333	0.98874	0.99803
1.00	1.00	1.80	0.05295	0.10608	0.26320	0.49441	0.72580	0.88725	0.96582	0.99249	0.99882
1.00	1.80	1.80	0.05215	0.09047	0.21233	0.41356	0.64450	0.83223	0.94024	0.98425	0.99696

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.01000	0.01891	0.05563	0.14462	0.30344	0.51361	0.71997	0.87073	0.95300
1.00	1.20	1.40	0.01029	0.02390	0.07493	0.18589	0.36545	0.58223	0.77634	0.90517	0.96868
1.00	1.40	1.80	0.01087	0.03188	0.10345	0.24089	0.43895	0.65412	0.82841	0.93315	0.97985
1.00	1.00	1.80	0.01138	0.04121	0.13655	0.30260	0.51738	0.72610	0.87675	0.95699	0.98852
1.00	1.80	1.80	0.01101	0.02722	0.08479	0.20244	0.38424	0.59728	0.78479	0.90835	0.96937

Table 7.2

ANALYSIS OF VARIANCE --- ONE-WAY LAYOUT

WITH G = LARGEST OF A(I)   VA = 0.0   AND   U* = 1.00 1.00 -2.00

DF1 = 2   DF2 =12   GROUP SIZES GS(I) = 5 5 5

POWER VALUES AT 5% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.05000	0.08077	0.18439	0.36931	0.59880	0.79990	0.92438	0.97881	0.99566
1.00	1.20	1.40	0.05065	0.08742	0.20656	0.40733	0.64075	0.83135	0.94062	0.98464	0.99712
1.00	1.40	1.80	0.60550	0.64402	0.76411	0.95302	1.15146	1.28671	1.33154	1.30626	1.24075
1.00	1.00	1.80	*******	*******	*******	*******	*******	*******	*******	*******	*******
1.00	1.80	1.80	0.19661	0.23404	0.35325	0.55017	0.77525	0.95546	1.05359	1.08342	1.07580

POWER VALUES AT 1% LEVEL OF SIGNIFICANCE

GROUP VARIANCES			NON CENTRALITY PARAMETER								
V1	V2	V3	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1.00	1.00	1.00	0.01000	0.01891	0.05563	0.14462	0.30344	0.51360	0.71997	0.87073	0.95300
1.00	1.20	1.40	0.01031	0.02390	0.07494	0.18590	0.36546	0.58223	0.77634	0.90518	0.96867
1.00	1.40	1.80	0.56448	0.57988	0.63497	0.74602	0.90934	1.08332	1.21213	1.26911	1.26622
1.00	1.00	1.80	*******	*******	*******	*******	*******	*******	*******	*******	*******
1.00	1.80	1.80	0.15547	0.17079	0.22572	0.33906	0.51507	0.72101	0.90036	1.01489	1.06596