AN APPROXIMATION OF STOCKOUT PROBABILITIES IN INVENTORY ROUTING PROBLEM

by

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Submitted to the Institute for Graduate Studies in Science and Engineering in partial fulfillment of the requirements for the degree of
Master of Science
in
Industrial Engineering

Boğaziçi University
1985

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DATE OF APPROVAL

ACKNOWLEDGEMENTS

I wish to express my deepest gratitude to Doç. Dr. İlhan Or for introducing me this topic, and for his invaluable guidance and supervision throughout this thesis.

I also thank Doç. Dr. Ali Rıza Kaylan and Doç. Dr. Bülent Sankur for their interest and evaluation as members of the thesis committee.

At last I want to thank Alper Oysal for the painstaking typing.

ABSTRACT

One of the most important variant of the well-known Vehicle Routing Problem is Inventory Routing Problem. We are concerned with the stochastic aspects of this problem. Though a closed form for the stockout probability expression is not available for even simplest form of demand distributions, problem is tried to be solved by using a simplified approximated expression. We test the validity and reliability of the expression with simulation methods, then we deal with the causes of the error resulting from the approximation. Finally by regression methods we estimate a multiplier which minimizes our error.

Ö Z E T

Taşıt Yol Atama probleminin en önemli kollarından biri Sayımcalı Yol Atama Problemidir. Bu çalışmada problemin rassal yönüyle ilgilenilmiştir. En yalın istem dağılımları için bile stok kopma olasılığının kapalı tanımı olmadığından problem bir yaklaşıklama tanımı kullanılarak çözülmeye çalışılmıştır. Benzetim yöntemiyle bu tanımın geçerlilik ve güvenilirliği sınanılmış, yaklaşıklamadan kaynaklanan yanılgının nedenleriyle ilgilenilmiştir. Sonunda, yanılgıyı enküçükleyen bir katsayı regresyon yöntemi yardımıyla kestirilmiştir.

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I. INTRODUCTION

Inventory Routing Problem is an important variant of the well-known Vehicle Routing Problem, where additional consideration is given to vehicle time constraints as well as to inventory fluctuations and stockouts.

There are N demand nodes and a single supply node. The storage capacity SC_i is given for all demand nodes $i = 1,\ldots,N$. The daily requirements ξ_q^i of demand node i in day q are independent and identically distributed random variables with known expected values $R_i = E[\xi_q^i]$ and variances $\sigma_i^2 = Var[\xi_q^i]$ for all $i = 1,\ldots,N$.

Let the planning horizon be Q delivery periods, and let $I_{i,q}$ be the amount of goods left in inventory from day q to day q+1 at node i, for $q = 0,1,\ldots, Q-1$. Assume that deliveries to demand nodes replenish inventories up to their capacities and that deliveries made to node i in day q may be used to meet requirements of day q. Then, $I_{i,q}$ is a random variable dependent not only on daily demands, but also on the date of last delivery, which we call t_i. Since last delivery must have occured before the start of the planning horizons, t_i must be less than zero.

A stockout is said to occur on day q if the amount of goods available at node i on day q is not enough to satisfy daily requirement ξ_q^i. A stockout implies certain penalties and an immediate emergency shipment to replenish the inventory up to its capacity.

Suppose the decision policy is to make deliveries to node i on day q of the planning horizon. Then a stockout may occur on days 1,2,...,q-1 and only if the event :

$\{ \sum_{r=t_i}^{q-1} \xi_r^i > SC_i \}$ occurs.

Furthermode the way parameter t_i is defined implies that event:

$\{ \sum_{r=t_i}^{0} \xi_r^i \leq SC_i \}$ has occured. Otherwise, the logic of the model would imply an emergency shipment to node i at same time $\bar{t}$ $(t_i, 0)$. However, that contradicts the assumption that t_i is the date of last replenishment to node i. Then stockout probability is:

$$P_{iq} = P \{ \sum_{r=t_i}^{q-1} \xi_r^i > SC_i \ / \ \sum_{r=t_i}^{0} \xi_r^i \leq SC_i \} \qquad (1)$$

There are two types of costs in the system:

a) Operating Costs: These are the cost associated with making deliveries to demand nodes.
b) Stockout Costs: These are the costs associated with not making deliveries to demand nodes. A stock cost is incurred if a stockout occurs anytime during the planning horizon.

The objective is to minimize total stockout and delivery costs of all nodes over a fixed planning horizon of Q delivery periods (days), while satisfying routing constraints. It will also be assumed that the date of the last delivery to node i, t_i, is known for all nodes $i = 1,\ldots,N$.

In this research we will analyze the stochastic aspect of the problem, especially the stockout probabilities that were mentioned.

Unfortunately, a closed form or simple and accurate approximations for the probability expression in (1) is not available for most probability distributions for ξ_r^i.

On the other hand, if we compute expected stock level at the beginning of the planning horizon, e_i.

$$e_i = E[I_{i,o} / \sum_{r=t_i}^{0} \xi_r^i \leq SC_i] \tag{2}$$

$$\text{where } I_{i,o} = SC_i - \sum_{r=t_i}^{0} \xi_r^i$$

and redefine the probability of a stockout at node i before day q as;

$$P_{iq} = P\{ \sum_{r=1}^{q-1} \xi_r^i > e_i \}$$

$$\phi_i^m(b) = P\{ \sum_{r=1}^{m} \xi_r^i \leq b \}$$

Then it leads to

$$e_i = E[SC_i - \sum_{r=t_i}^{0} \xi_r^i / \sum_{r=t_i}^{0} \xi_r^i \leq SC_i]$$

$$= SC_i - \left[\frac{1}{P\{\sum_{r=t_i}^{0} \xi_r^i \le SC_i\}}\right]\left[\sum_{u=0}^{SC_i-1} P\{u < \sum_{r=t_i}^{0} \xi_r^i \le SC_i\}\right]$$

$$= SC_i - \frac{(SC_i)\,\phi^{1-t_i}(SC_i) - \sum_{u=0}^{SC_i-1} \phi_i^{1-t_i}(u)}{\phi_i^{1-t_i}(SC_i)}$$

$$e_i = \frac{\sum_{u=0}^{SC_i-1} \phi_i^{1-t_i}(u)}{\phi_i^{1-t_i}(SC_i)}$$

which means that e_i can easily be estimated in terms of R_i, σ_i, t_i and SC_i.

Furthermore;

$P_{iq} = 1 - \phi_i^{q-1}(e_i)$ which can also be estimated in terms of R_i, σ_i, q and e_i.

Examples: (ξ_r^i normally distributed)

1.i) $R_i = 2$ $\sigma_i^2 = 2$ $t_i = -5$ $q = 5$ $SC_i = 18$

$$e_i = \frac{\sum_{u=0}^{17} \phi_i^6(u)}{\phi_i^6(18)} = 7 \qquad P_i = 1 - \phi_i^4(7) = .9099$$

1.ii) $R_i = 2$ $\sigma_i^2 = 2$ $t_i = -5$ $q = 5$ $SC_i = 24$

$$e_i = \frac{\sum_{u=0}^{23} \phi_i^6(u)}{\phi_i^6(24)} = 13 \qquad P_i = 1 - \phi_i^4(13) = .0901$$

Unfortunately, P_{iq} estimation (from now on we will call it table estimation) may lead us to wrong conclusions especially in low stockout probability regions. The following figure shows us the relation between the real and table probabilities.

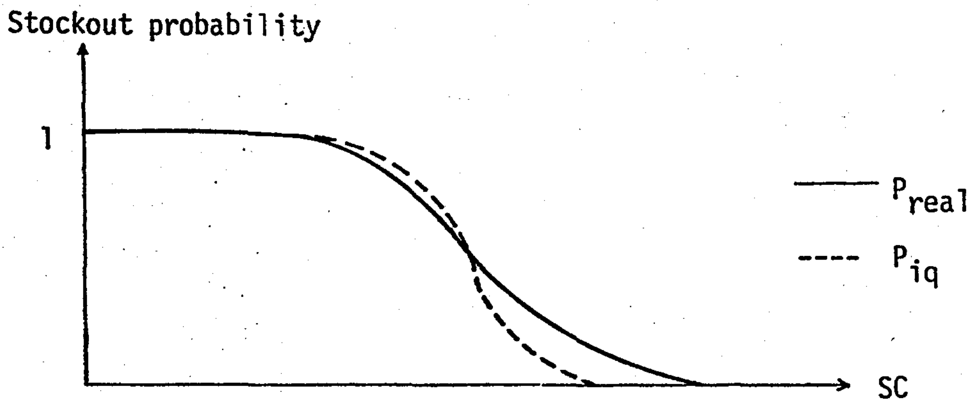


Figure 1.1 Constant R_i, σ_i, t_i, q_i values

As it is seen from Figure 1.1 overestimation occurs at high stockout probability regions and underestimation occurs at low stockout probability regions. Fixing random variable $I_{i,o}$ into one specific point (e_i) results in such errors.

Figures 1.2a and 1.2b shows how overestimation and underestimation occurs.

We want to find the stockout probability (P_{iq}) for known values i and q at time zero. We don't have any information about our stock level at time zero, we only know the replenisment time (t_i), and that any stockout has not occured till that time. $I_{i,o}$ is a random variable which shows us the stock level of node i at the end of time zero.

$$I_{i,o} = SC_i - \sum_{r=t_i}^{0} \xi_r^i \geq 0$$

Underestimation:

Suppose the relation between random variable ξ_r^i, $r = 1,\ldots,q$ and e_i are such that $P\{\sum_{r=1}^{q} \xi_r^i > e_i\} \simeq 0$ whereas $P\{\sum_{r=1}^{q} \xi_r^i > \bar{I}_{i,o}\} > 0$ for at least some possible outcomes $\bar{I}_{i,o}$ of random variable $I_{i,o}$. Then the real stockout probability will be larger than the table estimator.

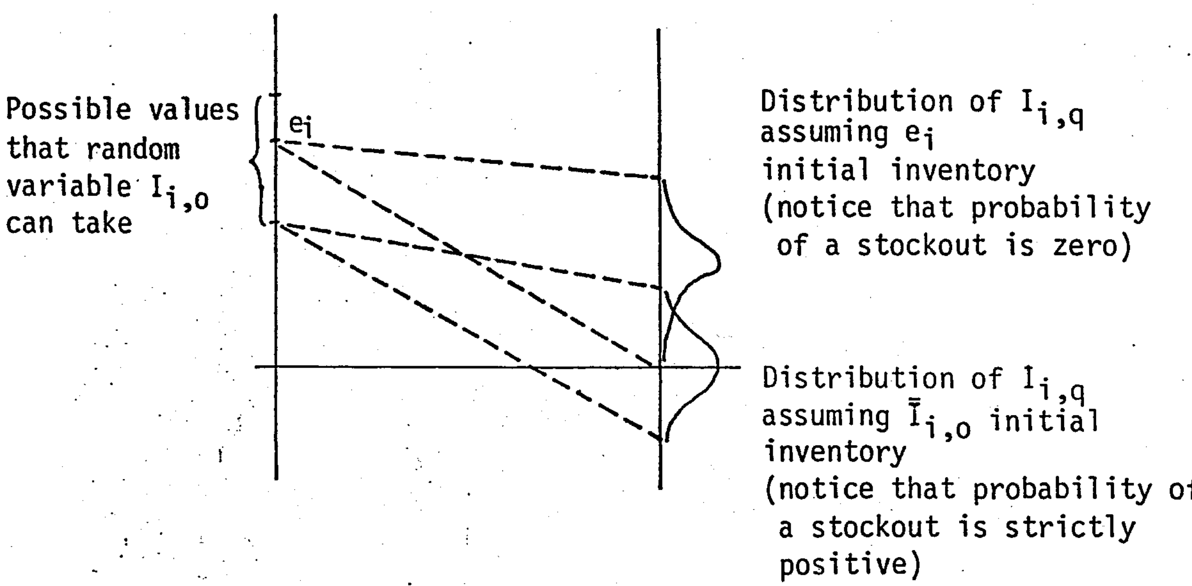


Figure 1.2a

Overestimation:

Suppose the relation between random variable $\xi_{i,j}$ $j = 1,\ldots,q$ and e_i are such that $P\{\sum_{r=1}^{q} \xi_r^i > e_i\} \sim 1$. Whereas $P\{\sum_{r=1}^{q} \xi_r^i > \bar{I}_{i,o}\} < 1$ for at least some possible outcomes $\bar{I}_{i,o}$ of random variable $I_{i,o}$. Then the real stockout probability will be smaller than the table estimator.

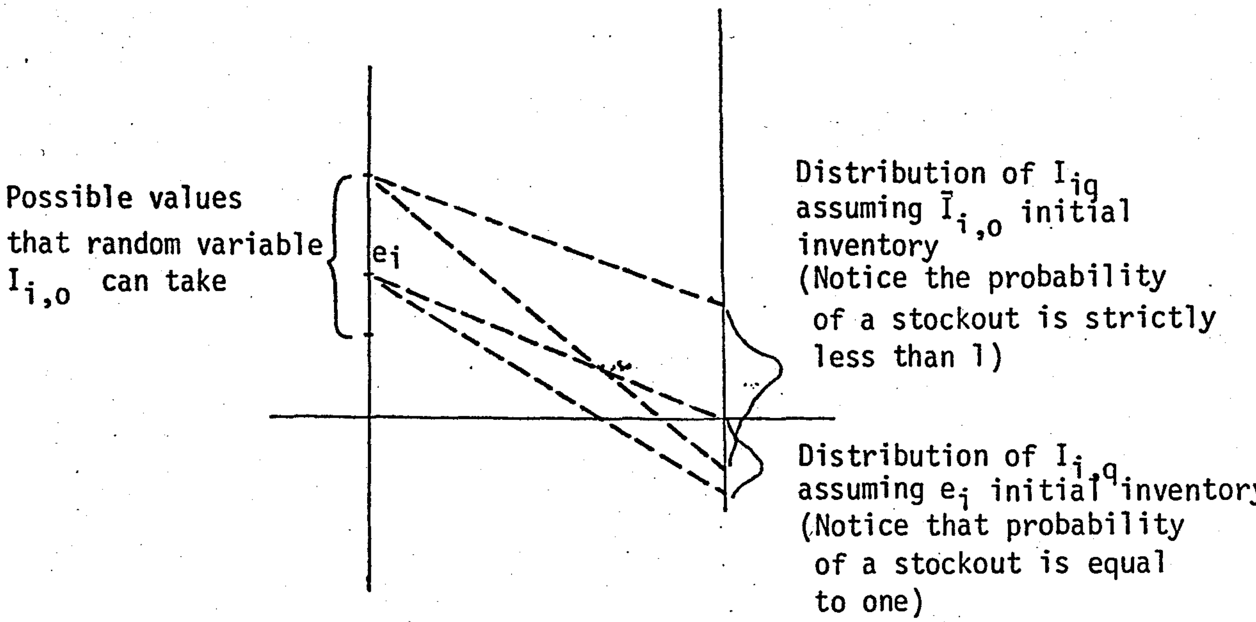


Figure 1.2b

We try to rearrange the stockout probability by the help of relationships between our variables (t_i, q_i, R_i, σ_i, and SC_i) and error deviation. We will analyze these relationships at the following chapters.

II. PROBLEM DEFINITION

2.1 Statement of the Problem and Variance Approach

In the previous section, we saw that, it is possible to estimate the stockout probability but the approximated estimation led us to overestimation or underestimation depending on values of parameters. We firstly deal with the error percentage of the estimation. By a simulation model we check if the magnitude of the error is negligible. Results of the simulation shows us that, especially for low stockout probabilities and high t_i values the error percentage is not negligible. We will explain the simulation model we use, in the next chapter. Appendix 1 includes the results of this simulation study.

In this chapter first we try to solve the problem only by dealing with periodic variances.

Variance Approach

We briefly mentioned the causes of the error in the introduction part. Now we shall look at our problem from a different point ow view (Variance Approach). Let us examine the structure of 2 normal distributions which have the same mean but different variances.

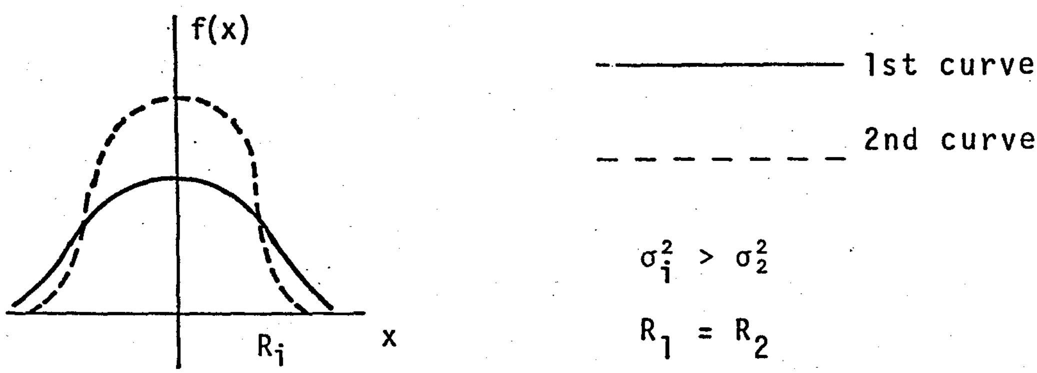


Figure 2.1

Assume F(x) the cumulative of f(x). Then $F(x_1) = \int_{-\infty}^{x_1} f(x)dx$.

Plotting (1-F(x)) versus x we get the following figure for both distributions.

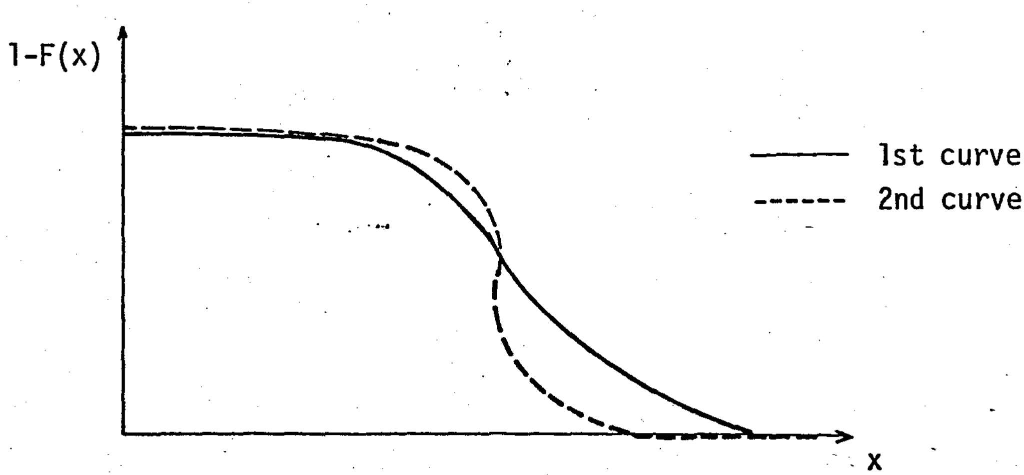


Figure 2.2

The behavior of the 2nd curve with respect to the 1st one looks like the behavior of the table probability with respect to the real probability. So we can say that using table, affect our results in the direction of reducing the variance.

In our study we will first assume that demand is normally distributed with expected values $R_i = E[\xi^i]$ and variances $\sigma_i^2 = Var[\xi^i]$ for all nodes $i = 1,\ldots,N$. We will assume that planning horizon starts at time $t = 0$ and that the date of last replenishment date of node i, the following statement is true for all nodes $i = 1,\ldots,n$ $\{ \sum_{r=t_i}^{0} \xi_r^i \leq SC_i \}$. We will call the time interval $[t,0]$ the first period and $0,q-1$ the second period.

If we use notations x and y for the demand distributions of first period $[t_i,0]$ and second period $[1, q-1]$ respectively we will see that $(\sigma_{x+y}^2 = \sigma_x^2 + \sigma_y^2)$ variance of the demand over the whole period t_i, $q-1$ is equal to the sum of the variances of the first and second periods.

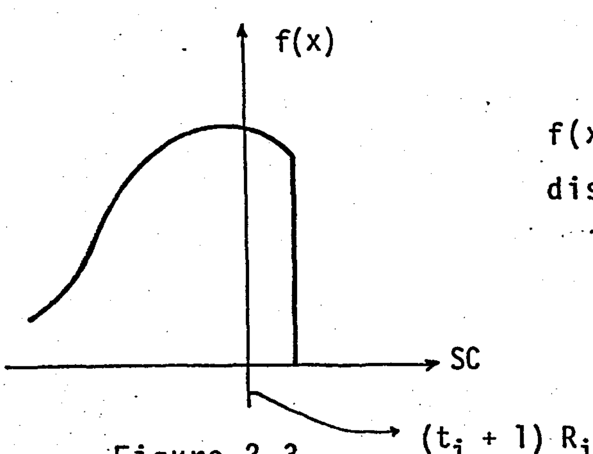


Figure 2.3

f(x) shows the demand distribution of first period

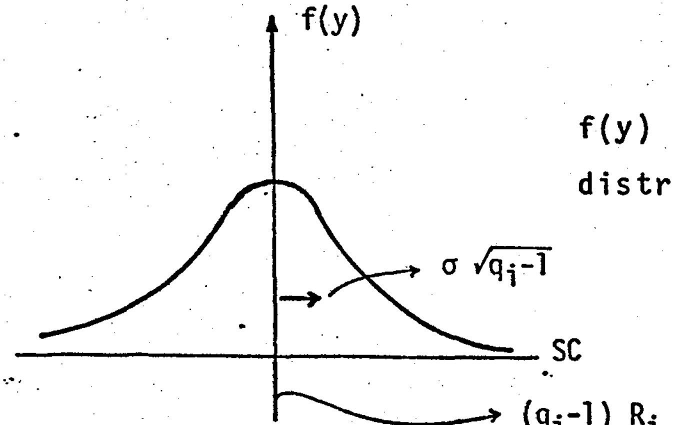


Figure 2.4

f(y) shows the demand distribution of second period

$E(x) \leq (t_i + 1) R_i$ $\qquad E(y) = (q_i - 1) R_i$

$\sigma^2(x) > 0$ $\qquad \sigma^2(y) = (q_i - 1) \sigma^2$

$\sigma^2_{x+y} = \sigma^2(x) + \sigma^2(y)$ $\qquad$ because

$P(xy) = P(x) \cdot P(y)$

(x and y are independent variables)

Instead of f(x), using the expected value of x, which is equal to a constant ($SC_i - e_i$) decreases the whole period variance.

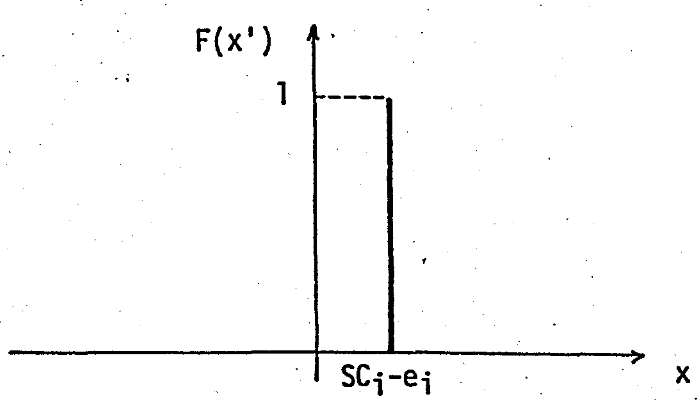


Figure 2.5

$\sigma^2(x') = \sigma^2(\text{constant}) = \sigma^2(SC - e_i) = 0$

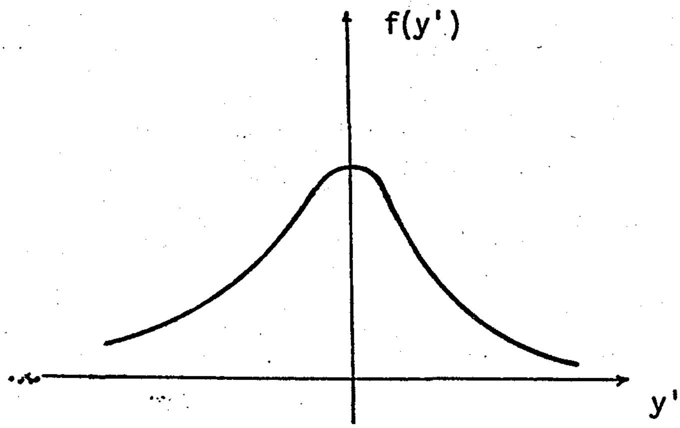


Figure 2.6

$$\sigma^2(y') = \sigma^2(y) = (q_i - 1)\,\sigma^2$$

$$\sigma^2_{x'+y'} = \sigma^2_{x'} + \sigma^2_{y'} \qquad \text{where} \qquad \sigma^2_{x'} = 0$$

$$\text{and} \qquad \sigma^2_{y'} = \sigma^2_{y}$$

then

$$\sigma^2_{x'+y'} = \sigma^2_{y'} = \sigma^2(y)$$

$$\sigma^2_{x+y} = \sigma^2(x) + \sigma^2(y) \geq \sigma^2(y)$$

because $\sigma^2(x) \geq 0$

So $\sigma^2_{x'+y'} \leq \sigma^2_{x+y}$

Relation between table and real values does not possess the characteristics of the relation between two normal curves with same means and different variances. First we take two normal curves with same means and different variances. We can easily say that both of them are symmetric and therefore the difference of the two symmetric curves around mean is also symmetric. The difference of the two symmetric curves around mean will be symmetric (Figure 2.2). Then we take our real distribution curve, which is the summation of the conditional first part with the normally distributed second part. Conditional first part is non-symmetric but normally distributed second part is symmetric. Summation of one symmetric and one non-symmetric distribution will give us a non-symmetric distribution. So our real values graphs a non-symmetric curve. But when we look at our table values we see that they are normally distributed with $E(x+y) = E(x) + E(y)$ and $\sigma^2_{x+y} = \sigma^2_y$ in other words it is a symmetric curve. Then the difference of the non-symmetric real values and symmetric table values around mean will also be non-symmetric. The difference of the symmetric and non-symmetric curves will be non-symmetric (Figure 1.2a).

The practical conclusion is that; using table values will be underestimating the real variance, unfortunately, we can not solve the problem only by increasing the variance. Increasing the variance will change its shape symmetrically but symmetric changes won't yield acceptable solution to our problem.

2.2 Elimination of Parameters

So far we deal with 5 parameters t_i, q_i, σ_i^2, R_i and SC_i. From now on we will use $PER1_i$ instead of t_{i+1}, $PER2_i$ instead of q_{i-1}. $PER1_i$ defines the number of days of the planning horizon which we are trying to find the stockout probability. Dividing the other three terms (σ_i, R_i, SC_i) by R_i we get $\sigma_i'^2 = \sigma_i^2/R_i^2$, $R_i' = R_i/R_i = 1$ and $SC_i' = SC_i/R_i$ and this helps us to eliminate R_i parameter from our analysis.

We know that probability of stockout for given n days at a given SC_i is equal to 1 - F(Z), where Z can be found from the following equation.

$$Z = \frac{X - E(X)}{\sigma_X} \qquad E(X) = n\,R_i$$

$$\sigma_X = \sqrt{n}\,\sigma$$

Therefore

$$Z = \frac{X - n\,R_i}{\sigma\sqrt{n}} = \frac{R_i\left(\frac{X}{R_i} - n\right)}{R_i\left(\frac{\sqrt{n}\,\sigma}{R_i}\right)} = \frac{\frac{X}{R_i} - n}{\frac{\sigma\sqrt{n}}{R_i}}$$

This is equivalent to using random variable Y to measure demand in units of expected daily demand for given n days.

$$Y_i = \frac{X_i}{R_i} \qquad E[Y_i] = \frac{E[X_i]}{R_i} = n$$

$$\sigma|Y_i| = \frac{\sigma\,[X_i]}{R_i} = \frac{\sqrt{n}\,\sigma}{R_i}$$

By the help of this analyses we eliminate the variable R_i, and assume that daily demand for each day is distributed normally for each node with a mean 1.

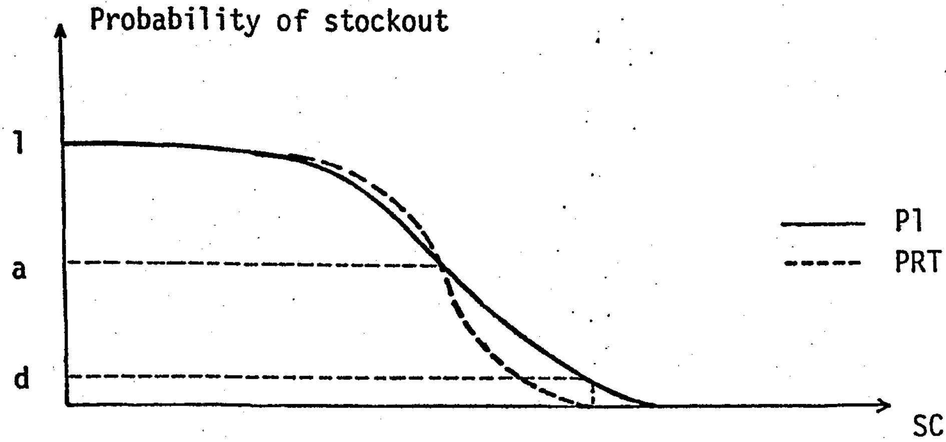
2.3 P1P2T

Now we define a new parameter P1P2T which will be used to measure the error percentage.

$$\underset{\varepsilon \to 0}{P1P2T} = \left[\frac{P1 - PRT \pm \varepsilon}{P1 \pm \varepsilon}\right]$$

P1 is the real probability and PRT is the table approximation probability.

In the light of the previous figure (Figure 1.1)



we will get the following scheme

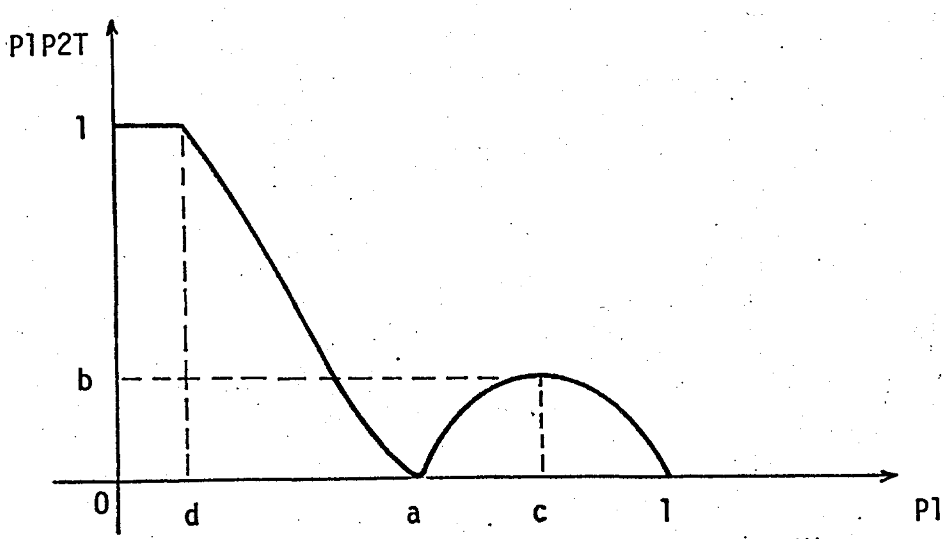


Figure 2.7

$$P1P2T = \left[\frac{P1 - PRT \pm \varepsilon}{P1 \pm \varepsilon}\right]$$ where ε is a very small number.

We can divide Figure 2.7 into 3 regions.

1) $0 \leq P1 \leq d$

When P1 is equal to zero, PRT must be zero also. PRT value starts to increase after P1 reaches a considerable value. So when PRT is equal to zero, then

$$P1P2T = \left[\frac{P1 \pm \varepsilon}{P1 \pm \varepsilon}\right] = 1$$
$$PRT=0$$

2) $d \leq P1 \leq a$

When PRT value starts to increase, P1P2T value decreases, the reasons for this decrease are: i. Since PRT value increases faster than P1 value (P1 - PRT) value decreases. (PRT curve has a smaller variance than P1 curve.) This decreases the numerator part of P1P2T.

ii. P1 value increase and this increases the denomanator part. Increase in denominator together with decrease in the numerator continues to the point where P1 curve intercepts with the PRT curve. This is the point where P1 equals to "a" and P1P2T equals to zero

$$\underset{\substack{\varepsilon \to 0 \\ PRT \to P1}}{P1P2T} = \left[\frac{P1 - P1 \pm \varepsilon}{P1 \pm \varepsilon}\right] = 0$$

3) $a \leq P1 \leq 1$

After this interception point P1P2T curve shows the characteristics of 2nd degree polynomial. First, it increases and after reaching maximum point (let us define coordinates of this point by P1 = c and P1P2T = b) it begins to decrease until P1 = 1 where P1P2T reaches to value zero.

$$P1P2T = \left[\frac{P1 - 1 \pm \varepsilon}{P1 \pm \varepsilon}\right] = 0$$

Note: PRT curve reaches one before P1 curve.

We can see from Figure 2.7 that especially for small stockout probability values the error percentage is very high. Increase in PER1 value will have a direct effect on the variance of our P1 curve and this will increase the difference between our curves, in other words an increase of error will be observed. These statements are correct when PER2 is constant. Increase in PER2 will lead to variance increases for both curves and probably this will decrease the difference between them. As we can conclude from here PER1/PER2 value is more effective on the system as compared to PER1 and PER2 values individually.

Error percentage will increase if we increase $\frac{PER1}{PER2}$ value. We can also say that $\frac{PER1}{PER2}$ value is one of the most important factors of P1P2T function.

Variance of daily demand is important for our system. Comparing extreme cases for variance will show us the effect of variance on the P1P2T curve. If daily demand variance is very small, then 1st part variance is equal to a very small number also, and this means that P1 curve has a very small variance like PRT curve. (The difference between two small varianced curves (P1 and PRT) is very small so P1P2T $\rightarrow$ 0.) But if we increase the daily demand variance P1P2T value increases or in another words P1P2T curve shifts upwards (increasing error).

Variance is an effective factor of our P1P2T curve, but it is more meaningful to take PER1/σ^2 as a factor as a factor and not σ^2 by itself. Because instead of dealing with effect of variables alone it is more realistic to analyze the effect of ratios. So we take PER1/σ^2 as one of our parameters. When we think of the effect of this ratio, it will be observed that increasing this ratio will decrease our P1P2T value. Taking PER1 constant and decreasing variance, or taking variance constant and increasing PER1 value forces our (1-F(x)) curve to have a narrower shape.

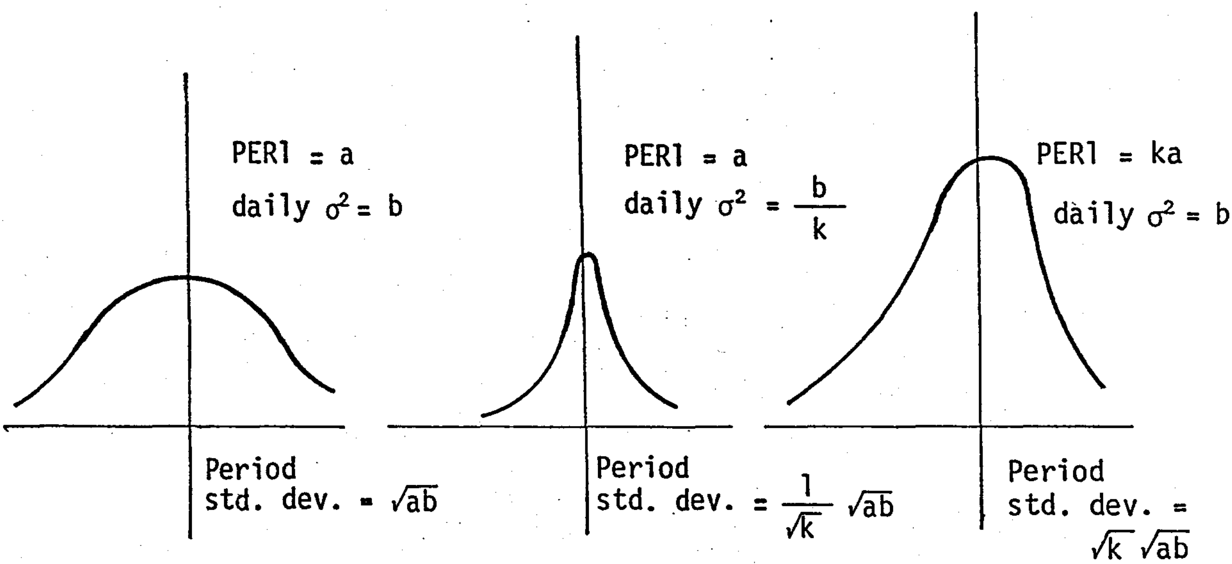


Figure 2.8a Figure 2.8b Figure 2.8c

$$Z_1 = \frac{X - a}{\sqrt{ab}} \qquad Z_2 = \frac{X - a}{\frac{1}{\sqrt{k}}\sqrt{ab}} \qquad Z_3 = \frac{kX - ka}{\sqrt{k}\sqrt{ab}}$$

$$Z_3 = \frac{\sqrt{k}\,(X - a)}{\sqrt{ab}}$$

$$Z_2 = Z_3$$

Z_2 and Z_3 values are greater than Z_1, and since Z_i value ($i = 1,\ldots,n$) is the only factor which determines the shape of the curve (Figure 10a,b,c) (increase in Z_i makes the (1-F(x)) curve narrower) or P1P2T curve (Scheme 9) will shift downwards.

A question may come to our mind such that eventhough we increase PER1 value how does the curve (1 - F(x), Figure 1) becomes narrower. Since we know that increase in PER1 will lead us to an increase at the variance of 1st part of the curve. We can easily answer that we are not dealing with PER1 value only by itself but we are concerned with the PER1/σ^2 ratio effect. PER1 increase will lead us to an increase in P1P2T value but we take it into consideration by making one of the variables equal to $\frac{PER1}{PER2}$ value. Effect of the increase in PER1 value can be shown at this part of the equation.

We will now define the most important parameter EII which shows us the percentage expected stockout. Equation for that is:

$$EII = \frac{PER2 - EI}{EI}$$

If we subtract the expected inventory at the beginning of period 2 from expected demand over period 2, we will get an expected negative inventory at the end of the period.

$$E(I_q^-) = E\left(\sum_{r=1}^{q-1} \xi_r\right) - EI$$

$$= PER2 - EI$$

$E(I_q^-)$ = Expected negative inventory at the end of period

EI = Expected inventory at the beginning of period

If negative inventory value is greater than zero, we expect a stockout over that period with a probability approximately greater than %50, and otherwise we expect a probability approximately less than %50.

So increase in negative inventory comes together with an increase in stockout probability. Division of I_q^- by the EI gives us the expected negative inventory percentage.

$$EII = \frac{I_q^-}{EI}$$ and this ratio is more meaningful than I_q^- when we deal to find a variable in order to express the characteristics of P1P2T curve.

Example 2: Let us compare 2 situations:

2.i) $EI_1 = 3$

$PER2_1 = 4$ $\quad EII_1 = \frac{4 - 3}{3} = \frac{1}{3}$

2.ii) $EI_2 = 103$

$PER2_2 = 104$ $\quad EII_2 = \frac{104 - 103}{103} = \frac{1}{103}$

If EII is positive, although I_q^-'s are equal, first point will tell us a very high stockout probability when it is compared with the second one. Second one (if denominator is very large) will give us nearly %50 probability.

If EII < 0, second point will give us higher stockout probability than the first one. We can think EII as Z value in normality table and EI as σ^2 value. Increasing EI is similar to increasing variance.

What we have said for I_q^- is true also for an increase in stockout probability.

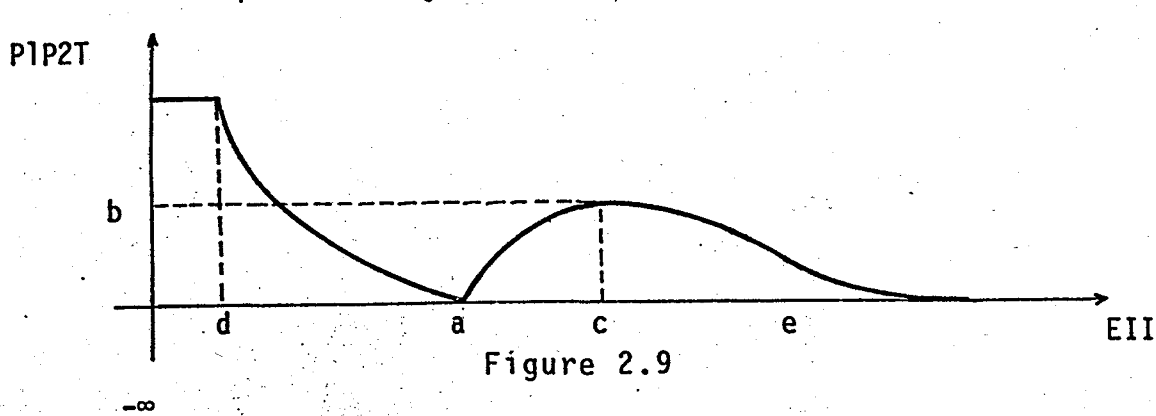


Figure 2.9

$$P1P2T = \left[\frac{P1 - PRT \pm \varepsilon}{P1 \pm \varepsilon}\right] \qquad EII = \frac{PER2 - EI}{EI}$$

There exists 4 regions.

i) When EII is between $-\infty$ and "d" value PRT equals zero.

$$-\infty < \frac{PER2 - EI}{EI} < d \qquad \begin{matrix} P1P2T = \left[\frac{P1 - 0 \pm \varepsilon}{P1 \pm \varepsilon}\right] = 1 \\ PRT = 0 \end{matrix}$$

ii) When EII is between d and a P1P2T shows a decreasing characteristic.

$$d \leq \frac{PER2 - EI}{EI} \leq a \qquad \frac{\partial P1P2T}{\partial EII} \leq 0$$

When EII is equal to "a", P1P2T equals to zero (P1 equals to PRT at that point)b

$$EII = a \ , \ P1 = PRT \ , \ \begin{matrix} P1P2T = \left[\frac{P1 - P1 \pm \varepsilon}{P1 \pm \varepsilon}\right] = 0 \\ PRT \to P1 \end{matrix}$$

iii) When EII is between "a" and "e" P1P2T shows the characteristics of second degree polynomial.

$$a \leq \frac{PER2 - EI}{EI} \leq c \qquad \frac{\partial P1P2T}{\partial EII} > 0$$

$$\frac{PER2 - EI}{EI} = c \qquad \frac{\partial P1P2T}{\partial EII} = 0 \text{ and also } P1P2T = b$$

$$c < \frac{PER2 - EI}{EI} < e \qquad \frac{\partial P1P2T}{\partial EII} < 0$$

iv) When EII is greater or equal to e, P1P2T is equal to zero.

$$\frac{PER2 - EI}{EI} \geq e \qquad \frac{\partial P1P2T}{\partial EII} = 0 \qquad \lim_{\substack{P2 \to 1 \\ PRT \to 1}} P1P2T = \left[\frac{1 - 1 \pm \varepsilon}{1 \pm \varepsilon}\right] = 0$$

P1DP2T

Now we define P1DP2T which is an other form of function P1P2T.

$$P1DP2T = \frac{P1 \pm \varepsilon}{PRT \pm \varepsilon} \qquad P1P2T = \left[\frac{P1 - PRT \pm \varepsilon}{P1 \pm \varepsilon}\right]$$

$$P1P2T = \begin{cases} 1 - \dfrac{PRT}{P1 \pm \varepsilon} & P1 \geq PRT \\ \dfrac{PRT}{P1 \pm \varepsilon} - 1 & P1 < PRT \end{cases}$$

2.4 P1DP2T

We interprete P1P2T as an error measuring function and it helps us to observe the high percentage error regions but because of its absolute character, we prefer to use P1DP2T function from now on.

If $P1 \geq PRT$ $\quad P1P2T = \dfrac{P1 - PRT}{P1} \quad P1DP2T = \dfrac{P1}{PRT} = \dfrac{1}{1 - P1P2T}$

If $P1 < PRT$ $\quad P1P2T = \dfrac{PRT - P1}{P1} \quad P1DP2T = \dfrac{P1}{PRT} = \dfrac{1}{P1P2T + 1}$

$$P1DP2T = \begin{cases} \dfrac{1}{1 - P1P2T} & P1 \geq PRT \\ \dfrac{1}{1 + P1P2T} & P1 < PRT \end{cases}$$

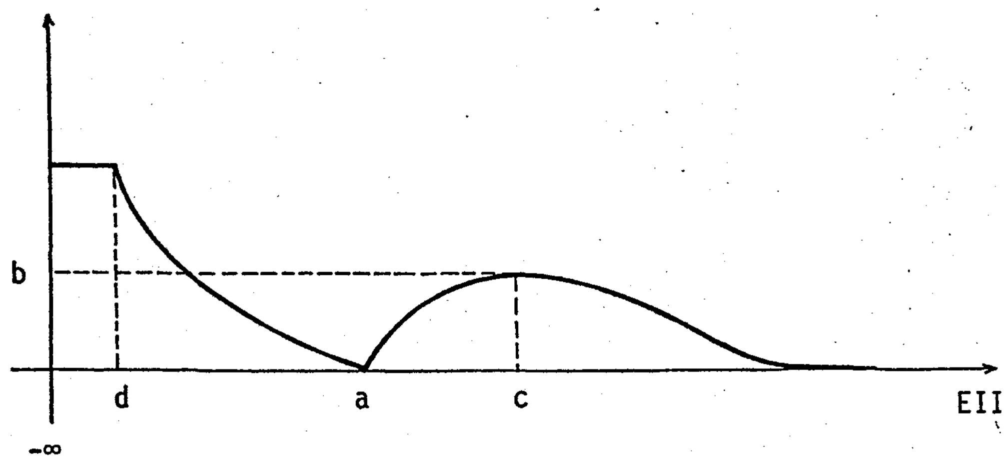


Figure 2.9

We try to plot P1DP2T versus EII.

i) $-\infty \leq EII \leq d$ $\qquad P1DP2T = \frac{1}{1 - P1P2T} = \frac{1}{1-1} = \infty$

ii) $d \leq EII \leq a$ $\qquad \frac{\partial P1DP2T}{\partial EII} \leq 0$

because P1P2T is a decreasing function between these EII limits, then 1 - P1P2T must be increasing and $\frac{1}{1 - P1P2T}$ must be decreasing function.

iii) $a \leq EII \leq c$ $\quad \frac{\partial P1DP2T}{\partial EII} \leq 0$ $\qquad$ at EII = a $\qquad$ P1 = PRT

Because P1P2T is an increasing function, 1 + P1P2T must also be an increasing function and $\frac{1}{1 + P1P2T}$ must be decreasing function.

iv) $c \leq EII \qquad \frac{\partial P1DP2T}{\partial EII} \geq 0$

Because P1P2T must be decreasing function, $1 \pm P1P2T$ must be decreasing and $\frac{1}{1 + P1P2T}$ must be increasing function.

v) $\lim_{EII \to \infty} P1DP2T \to 1$

When we plot P1DP2T versus EII a curve with special characteristics can be seen.

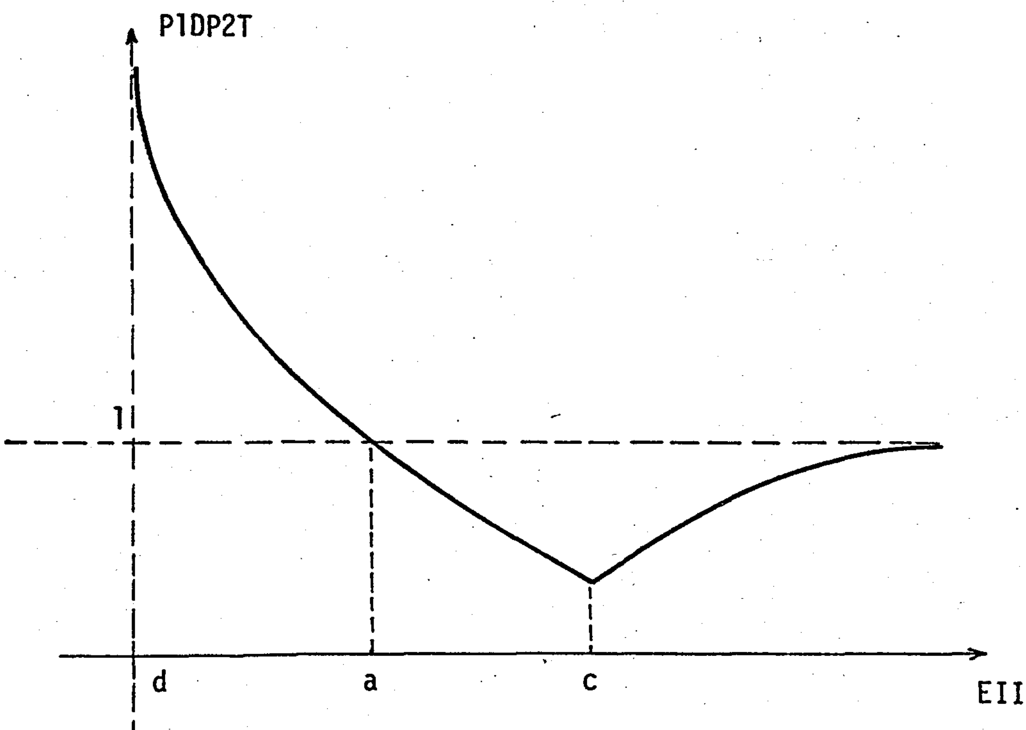


Figure 2.10

From now on we will focus our attention only on this figure. First we will collect data by a simulation program and then using regression methods we will estimate critical points, in terms of the parameters which we mentioned before. Then by using table values and P1DP2T function, which we obtained from regression analysis, we will make another estimation for stockout probabilities (we call it P1EST).

P1EST = (PRT) × (P1DP2T)

Instead of PRT values, P1EST values will be used in Inventory Routing Problem. It will affect our results especially for problems with given high stockout costs or high daily variances.

III. SIMULATION

In previous chapters, we mentioned the characteristics of the system. Next, through a simulation model we will generate some quantitative results.

3.1 Real Probability Value

We defined in introduction part the stockout probability as;

$$P_{iq} = P\{ \sum_{r=t_i}^{q-1} \xi_r^i > SC_i \,/\, \sum_{r=t_i}^{0} \xi_r^i \leq SC_i \}$$

Then we changed it into

$$P_{i,PER2} = P\{ \sum_{r=-(PER1+1)}^{PER2} \xi_r^i > SC_i \,/\, \sum_{r=-(PER1+1)}^{0} \xi_r^i \leq SC_i \}$$

The daily requirements ξ_q^i of demand node i in day q are independent and identically distributed random variables with expected values equaling to one {mean = 1 = $E[\xi_q^i]$} and variances $\sigma^2_{iq} = q\sigma_i^2$. Therefore instead of dealing with daily demands we prefer to deal with the periodic demands. Next, we use simulation technique and generate demand random variables for the first and second periods.

Library random number generator of CDC which generates normally distributed random numbers with zero mean and unit variance, is used for this purpose. This is a generator which gives us the deviation from mean value. So we will adjust the outcomes by multiplying them with the standard deviation of our periodic demand to obtain normally distributed random variables with our desired mean and variance.

If Y is a normally distributed random variable with mean and standard deviation .

Then $$X = \frac{Y - \mu}{\sigma}$$

where X is normally distributed random variable with mean 0 and standard deviation 1.

$$\rightarrow \quad Y = \mu + \sigma X$$

In our case $$Y = PERi + \sigma\sqrt{PERi} \quad X$$

$$(\mu = PERi\ ,\ \sigma_{period} = \sigma_{day}\sqrt{PERi})$$

So we can generate periodic demands by a random number generator through normally distributed random variables with unit variance and zero mean. At this point a new problem arises; some generated quantities may be negative. This will happen when

$$Y = PERi + X\sigma\sqrt{PERi} \leq 0$$

$$\rightarrow \quad X \leq - \frac{\sqrt{PERi}}{\sigma}$$

All we can say is that increase in PERi or decrease in daily variance, increases the probability of Y to be greater than zero.

$$P\{Y < 0\} = \phi(\frac{-\sqrt{PERi}}{\sigma})$$

What can we do, when we generate negative values? It is meaningless to accept negative value of demand over some period. We have 2 alternatives. First one is not taking it into account and generating a new one. The second alternative is assuming negative value as a zero demand. Following figures compare two alternatives.

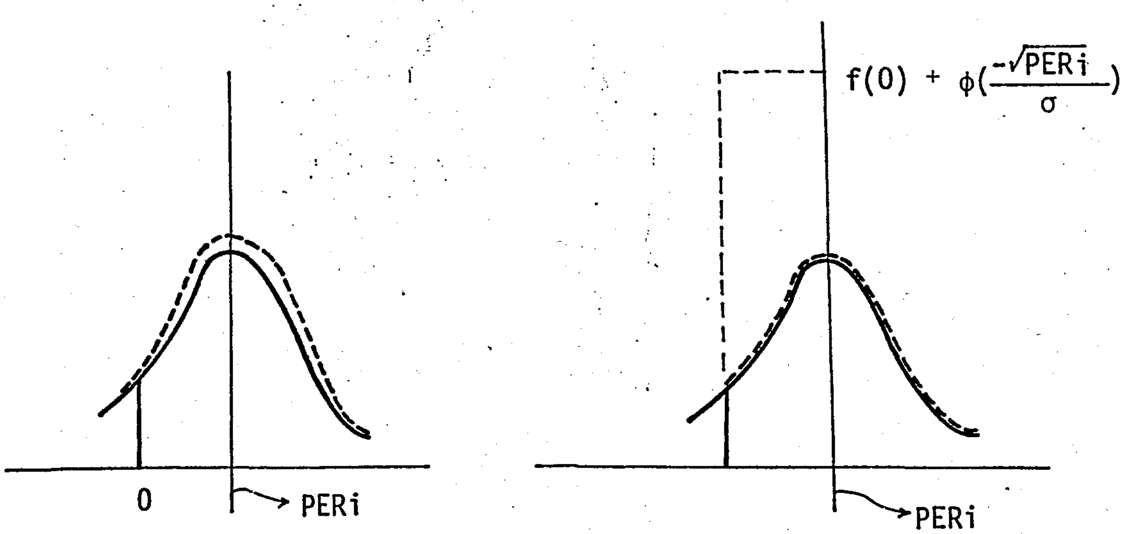


Figure 3.1a

Figure 3.1b

First decision rule shifts the curve upwards by putting a conditional part. There is no such shift for the second one. Expected values increases for both of the situations but increase in the first one must be greater than the other. Our conclusion is, since second one increases our mean value less than the first one, it is more appropriate to use second decision rule in our analyses. So, when we generate a negative value, we assume zero demand occuring over that period.

The shape of our normal curve deteriorates for small values of PERi and large values of variance and we can say that dealing with periodic demand instead of daily demand decreases the deterioration of the normal curve.

We generate two numbers which we will use as periodic demand for PER1 and PER2. But for the first period demand we know it will be less or equal than storage capacity, which means that we won't use the generated Y value if it is greater than SC value. We generate a second one if first value is less than or equal to storage capacity, and then by adding the two values and comparing with storage capacity we decide if stockout occured at that trial. We repeat this many times and dividing the number of trials in which stockout occured, to the total number of trials we get stockout probability for given PER1, PER2, σ^2 and SC values.

$$P\{\text{Stockout}\} = \frac{\text{No of trials in which stockout occured}}{\text{Total no of trials}}$$

Increasing the total number of trials will give us a better estimation for stockout probability, but it also requires a larger computer time. We can determine the appropriate trial number which will give us a good estimation together with an economic usage of computer time by experimenting. We repeat this procedure for different values of PER1, PER2, σ^2 and SC.

By taking PER1, PER2 and σ^2 constant and by changing SC value we develop a system which uses the same random number with different SC values. Let us say that we try to estimate P1 for given PER1, PER2 and σ^2 values and SC from SCMIN to SCMAX in k increments.

First we generate two random numbers X_1 and X_2. Then we convert them to Y_1 and Y_2 where $Y_1 = PER1 + X_1 \sigma\sqrt{PER1}$ and $Y_2 = PER1 + X_1\sigma\sqrt{PER2}$. We compare Y_1 value with SC_j, if Y_1 is greater; then we don't use this pair of random numbers in the estimation of P1 for that given SC_j, but if Y_1 is smaller we then add Y_1 and Y_2 up, and use it in our estimation, by comparing the sum with SC_j. Instead of comparing Y_1 and $Y_1 + Y_2$ with all SC_j $(j = 1,\ldots,k)$ values, we use a boundary approach. We rank SC_j values in an increasing order such that $SC_1 \leq SC_2 \leq \ldots\ldots \leq SC_k$. First we define II_j, $j = 1,2,\ldots,k$ which gives us the total number of trials that we use in simulation for given storage capacity SC_j. Define $I1_j$, $j = 1,2,\ldots,k$ number of trials in which stockout occurs for given storage capacity SC_j. Then we try to find "t" value which satisfies the following condition:

$$SC_{t-1} \leq Y_1 \text{ (or } Y_1 + Y_2) \leq SC_t$$

where $SC_0 = 0$ and $SC_{k+1} = L$ (very large number)

First, we find boundary t for random number Y_1, and increment II_j by one where j goes from "t" to "k". $(j = t, t+1,\ldots, k)$. This means that we increase total trial number by one, where Y_1 is less than our storage capacity. And store this "t" value as tt. Then we find boundary "t" for random number $Y_1 + Y_2$ and increment Il_j by one where j goes from tt to t-1, (j = tt,...,t-1).

These are the cases where the storage capacities are greater than Y but also less than $Y_1 + Y_2$ (In our problem this is the region where we satisfy demand till time zero but we don't satisfy demand between time zero and PER2, in other words, stockout region.)

3.2 Table Probability Value

Probability of a stockout during the planning horizon PER2, can be expressed as following.

$$P\{ \sum_{r=t_i}^{q-1} \xi_r^i > SC_i \ / \ \sum_{r=t_i}^{0} \xi_r^i \le SC_i \} \qquad \text{or}$$

$$P\{ \sum_{r=-PER1+1}^{PER2} \xi_r^i > SC_i \ / \ \sum_{r=-PER1+1}^{0} \xi_r^i \le SC_i \}$$

And by using the derivations in the introduction part we get;

$$P_{i,PER2} = 1 - \phi_i^{PER2}[e_i] \quad \text{and} \quad e_i = \frac{\sum^{SC_i-1} \phi_i^{PER1}(u)}{\phi_i^{PER1}(SC_i)}$$

where P_i is the stockout probability over PER2 days (includes the day PER2), and it is very easy to calculate $P_{i,PER2}$ by using z table.

3.3 P1DP2T

We have PRT and P1 values in our hand. Dividing P1 values to PRT values, we can obtain P1DP2T values, we can obtain P1DP2T values. Plotting the simulation result gives us the following figure (Figure 3.2).

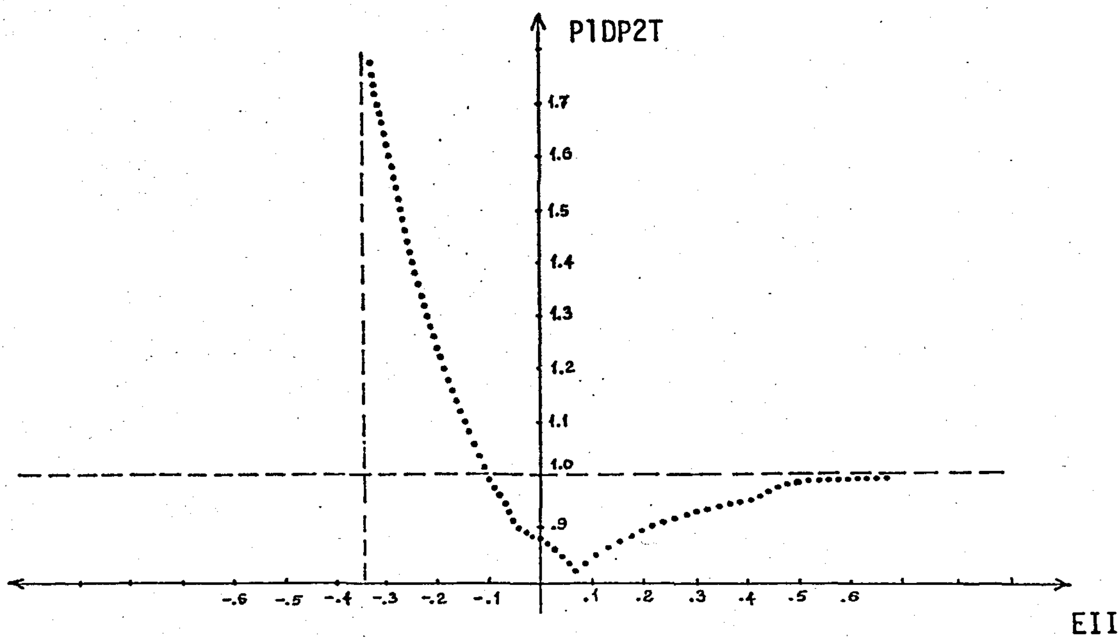


Figure 3.2

Since EII is the most effective variable,we focus our attention on the curve where P1DP2T versus EII is plotted. Drawing this curve for different values of other variables $(\frac{PER1}{PER2}, \frac{PER1}{\sigma^2})$ we observe that there exists a point at which the shape of the curve changes. Curve shows different characteristics before and after this critical point.

The critical point moves when we change PER1, PER2 and σ^2 values. So we try to express the coordinates of the critical point in terms of the variables $\frac{PER1}{PER2}$ and $\frac{PER1}{\sigma^2}$.

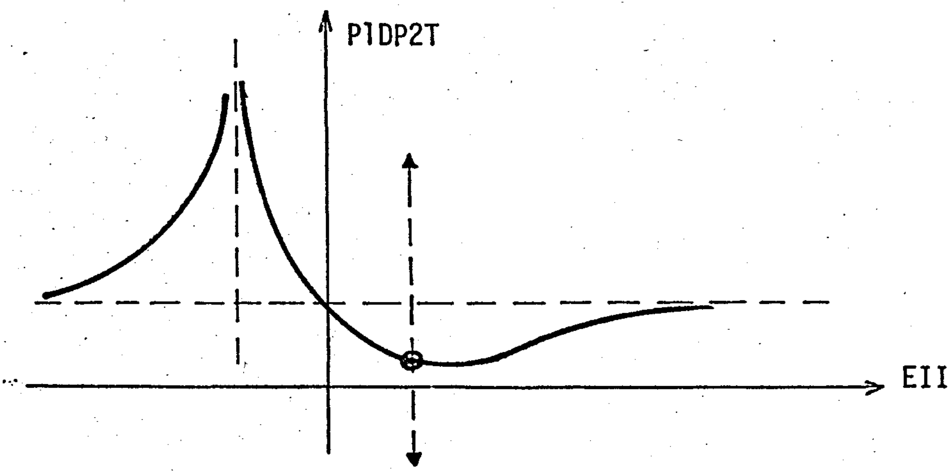


Figure 3.3

$$EII_{cr} = f(PER1/PER2,\ PER1/\sigma^2)$$

$$P1DP2T_{cr} = f(PER1/PER2,\ PER1/\sigma^2)$$

First we assume a simple linear relationship

$$EII_{cr_1} = a\ (\frac{PER1}{PER2}) + b\ (\frac{PER1}{\sigma^2}) + c$$

$$P1D_{cr} = d\ (\frac{PER1}{PER2}) + e\ (\frac{PER1}{\sigma^2}) + f$$

We deal with the experimentation part as follows:

We take PER1, PER2 and σ^2 constant and change SC values, this will give us different EII values (EII is a function of EI and EI is a function of SC).

We can find P1DP2T values which corresponds directly to our EII values. (We know that $P1DP2T(EII) = \frac{P1(EII)}{PRT(EII)}$.) We can easily observe where P1DP2T value reaches minimum point and note the coordinates of this point as P1DCR and $EIICR_1$.

The following data points can be seen at the Appendix 1.

Example 3 : PER1 = 12 PER2 = 12 $\sigma^2 = 1$

SC	EII	EI	P1	P1P2T	P1DP2T	PRT
⋮						
21.5	.3285	9.0328	.6955	.1536	.8667	.8023
21.75	.2934	9.2776	.6771	.1554	.8654	.7823
22.0	.2602	9.5221	.6558	.1606	.8615	.7611
22.25	.2286	9.7672	.6359	.1619	.8605	.7389
22.5	.1984	10.0137	.6197	.1549	.8657	.7157
22.75	.1693	10.2622	.6025	.1477	.8712	.6915

We take P1DCR = .8605 $EIICR_1$ = .2286 when PER1 = 12, PER2 = 12 and σ^2 = 1. We make this analyses for different values of σ^2 , PER1, PER2. We put limits on the range of our variables for the purpose of a specific problem.

Limits are chosen such as

i) PER1 $\leq$ 20

ii) PER2 $\leq$ 20

iii) $.3 \leq \sigma^2 \leq 2$

Choosing a large range for parameters, results in lack of fit. We will make suggestions for further research on this topic in the last chapter.

We use a least square approximation technique to estimate a,b,c,d,e and f values. Defining X to $\frac{PER1}{PER2}$, Y to $\frac{PER1}{\sigma^2}$, Z_1 to $EIICR_1$ and Z_2 to P1DP2T, we get following equations.

$$Z_1 = \hat{a}X + \hat{b}Y + \hat{c}$$

$$Z_2 = \hat{d}X + \hat{e}Y + \hat{f}$$

SSE (Sum of square of error) $= \sum_{i=1}^{n} (Z_1 - \hat{a}X_i - \hat{b}Y_i - \hat{c})^2$

$$\frac{\partial SSE}{\partial \hat{a}} = -2 \sum_{i=1}^{n} (Z_{1i} - \hat{a}X_i - \hat{b}Y_i - \hat{c})(X_i) = 0$$

$$\frac{\partial SSE}{\partial \hat{b}} = -2 \sum_{i=1}^{n} (Z_{1i} - \hat{a}X_i - \hat{b}Y_i - \hat{c})(Y_i) = 0$$

$$\frac{\partial SSE}{\partial \hat{c}} = -2 \sum_{i=1}^{n} (Z_{1i} - aX_i - bY_i - c) = 0$$

We get the following equations

$$\sum_{i=1}^{n} Z_1 X_i = \hat{a} \sum_{i=1}^{n} X_i^2 + \hat{b} \sum_{i=1}^{n} X_i Y_i + \hat{c} \ \Sigma \ X_i$$

$$\sum_{i=1}^{n} Z_1 Y_i = \hat{a} \sum_{i=1}^{n} X_i Y_i + \hat{b} \sum_{i=1}^{n} Y_i^2 + \hat{c} \ \Sigma \ Y_i$$

$$\sum_{i=1}^{n} Z_1 = \hat{a} \sum_{i=1}^{n} X_i + \hat{b} \sum_{i=1}^{n} Y_i + n\,\hat{c}$$

Applying what we mention above, we first estimate a,b,c, d,e and f values,then we understand that we come to face with a lack of fit. This means that $Z_1 = \hat{a}X + \hat{b}Y + \hat{c}$ equation is inadequate for our data points. By trial and error we find an equation which fits with our data points. (Appendix 2 includes linear regression result.)

$$Z_1 = aX + \frac{b}{X} + cY + d\,\frac{Y}{X} + e$$

$$TSE = \sum_{i=1}^{n} (Z_{1i} - \hat{a}X_i - \frac{\hat{b}}{X_i} - \hat{c}Y_i - \hat{d}\,\frac{Y_i}{X_i} - \hat{e})^2$$

$$\frac{\partial TSE}{\partial \hat{a}} = -2 \sum_{i=1}^{n} (Z_{1i} - \hat{a}X_i - \frac{\hat{b}}{X_i} - \hat{c}Y_i - \hat{d}\,\frac{Y_i}{X_i} - e)(X_i) = 0$$

$$\frac{\partial TSE}{\partial \hat{b}} = -2 \sum_{i=1}^{n} (Z_{1i} - \hat{a}X_i - \frac{\hat{b}}{X_i} - \hat{c}Y_i - \hat{d}\,\frac{Y_i}{X_i} - e)(\frac{1}{X_i}) = 0$$

$$\frac{\partial TSE}{\partial \hat{c}} = -2 \sum_{i=1}^{n} (Z_{1i} - \hat{a}X_i - \frac{\hat{b}}{X_i} - \hat{c}Y_i - d\,\frac{Y_i}{X_i} - e)(Y_i) = 0$$

$$\frac{\partial TSE}{\partial \hat{d}} = -2 \sum_{i=1}^{n} (Z_{1i} - \hat{a}X_i - \frac{\hat{b}}{X_i} - \hat{c}Y_i - \hat{d}\,\frac{Y_i}{X_i} - \hat{e})(\frac{Y_i}{X_i}) = 0$$

$$\frac{\partial TSE}{\partial \hat{e}} = -2 \sum_{i=1}^{n} (Z_{1i} - \hat{a}X_i - \frac{\hat{b}}{X_i} - \hat{c}Y_i - \hat{d}\,\frac{Y_i}{X_i} - \hat{e}) = 0$$

And we get following equations.

$$\sum_{i=1}^{n} Z_{1i}X_i = \hat{a} \sum_{i=1}^{n} X_i^2 + \hat{b}\cdot n + \hat{c} \sum_{i=1}^{n} Y_iX_i + \hat{d} \sum_{i=1}^{n} Y_i + \hat{e} \sum_{i=1}^{n} X_i$$

$$\sum_{i=1}^{n} \frac{Z_{1i}}{X_i} = \hat{a}\cdot n + \hat{b} \sum_{i=1}^{n} \frac{1}{X_i^2} + \hat{c} \sum_{i=1}^{n} \frac{Y_i}{X_i} + \hat{d} \sum_{i=1}^{n} \frac{Y_i}{X_i^2} + \hat{e} \sum_{i=1}^{n} \frac{1}{X_i}$$

$$\sum_{i=1}^{n} Z_{1i}Y_i = \hat{a} \sum_{i=1}^{n} X_iY_i + \hat{b} \sum_{i=1}^{n} \frac{Y_i}{X_i} + \hat{c} \sum_{i=1}^{n} Y_i^2 + \hat{d} \sum_{i=1}^{n} \frac{Y_i^2}{X_i}$$

$$+ \hat{e} \sum_{i=1}^{n} Y_i$$

$$\sum_{i=1}^{n} Z_{1i}\frac{Y_i}{X_i} = \hat{a}\sum_{i=1}^{n} Y_i + \hat{b}\sum_{i=1}^{n}\frac{Y_i}{X_i^2} + \hat{c}\sum_{i=1}^{n}\frac{Y_i^2}{X_i} + \hat{d}\sum_{i=1}^{n}\frac{Y_i^2}{X_i^2} + \hat{e}\sum_{i=1}^{n}\frac{Y_i}{X_i}$$

$$\sum_{i=1}^{n} Z_{1i} = \hat{a}\sum_{i=1}^{n} X_i + \hat{b}\sum_{i=1}^{n}\frac{1}{X_i} + \hat{c}\sum_{i=1}^{n} Y_i + \hat{d}\sum_{i=1}^{n}\frac{Y_i}{X_i} + e\cdot n$$

And by solving the linear equations above, we can estimate the P1D and EII coordinates of the critical point in terms of PER1, PER2 and σ^2.

The result is as follows:

$$Z_1 = 0.0221X - \frac{0.04073}{X} - 0.00045Y - 0.00135\frac{Y}{X} + 0.3148$$

$$Z_2 = 0.00099X - \frac{0.0003}{X} - 0.0021Y + 0.00076\frac{Y}{X} + 0.85167$$

Change it in terms of PER1, PER2, σ^2, $EIICR_1$ and $P1D_{cr}$.

$$EIICR_1 = 0.221\frac{PER1}{PER2} - \frac{0.04073}{PER1/PER2} - 0.00045\frac{PER1}{\sigma^2} - 0.00135\frac{PER1/}{PER1/PER2} + 0.3148$$

$$EIICR_1 = 0.0221\frac{PER1}{PER2} - 0.04073\frac{PER2}{PER1} - 0.00045\frac{PER1}{\sigma^2} - 0.00135\frac{PER2}{\sigma^2} + 0.3148$$

$$P1DCR = 0.00099\frac{PER1}{PER2} - 0.0003\frac{PER2}{PER1} - 0.0021\frac{PER1}{\sigma^2} + 0.00076\frac{PER2}{\sigma^2} \quad 0.85167$$

We obtain these results in five iterations (Appendix 2 includes these results). We collect data for different values of PER1, PER2 and σ^2, then we made estimations and checked them for different PER1, PER2 and σ^2 values; if results are unsatisfactory then we give more weight to these regions by collecting more data points from these and we make estimations again, we repeat this kind of work until we get satisfactory results.

As mentioned earlier the error curve (P1DP2T versus EII) shows different characteristics before and after the critical point determined above. Now we will analyze these two regions seperately.

3.4 Approximation of the Error Curve in the Interval (EII_{cr1}, ∞)

Results obtained about the error curve in this region and the general behavior are presented in Figure 3.4.

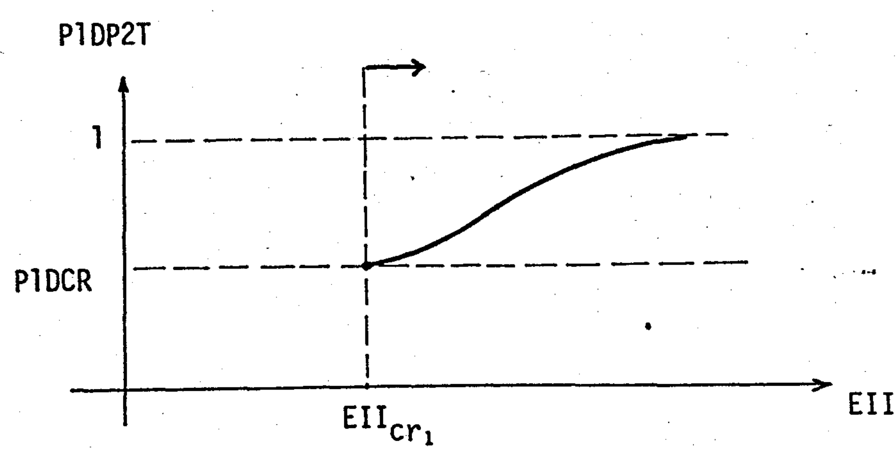


Figure 3.4

That general behavior suggests fitting a curve from "S curves" (Gombertz equation) family. (A few other types of curves here also been considered but even early results were not satisfactory.)

An S curve can simply be defined as

$$y = a \cdot b^{c^{x}} \qquad \text{where} \qquad b\ ,\ c < 1$$

S curve lies between two horizontal assymptotes; y goes to a, b when x goes to zero and y goes to a when x goes infinity.

$$\underset{x \to 0}{y} = a \cdot b^{c^{0}} = a \cdot b^{1} = a \cdot b$$

$$\underset{x \to \infty}{y} = a \cdot b^{c^{\infty}} = a \cdot b^{0} = a$$

In our analysis $EII_i - EIICR_i$ corresponds to x variable, P1DP2T corresponds to Y variable, "a" value corresponds to 1 and also P1DCR value corresponds to "a·b".

$$a = 1$$

$$P1DCR = a \cdot b \quad \rightarrow \quad b = P1DCR$$

So we use S function in such a form

$$P1DP2T = P1DCR^{c^{(EII - EIICR)}}$$

$$PIDP2T = PIDCR\,c^{(EII - EIICR_1)}$$

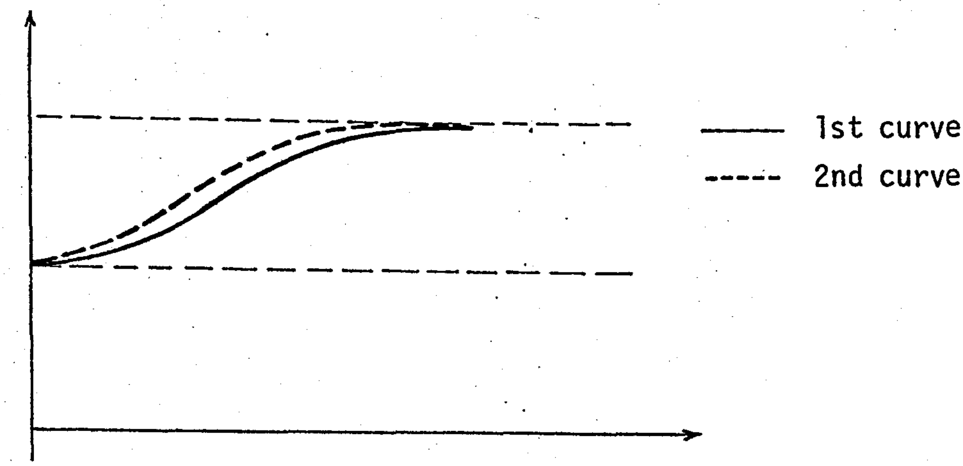


Figure 3.5

Second curve has a larger "c" value than the first one. If "c" value is higher, we can see a faster reach of PIDP2T value to the upper assymptote. We now want to find appropriate c values corresponding to given PER1, PER2 and σ^2 values. We again refer to our simulation results and gather $PIDP2T_i$ and EII_i values. (All data belongs to the rightside of the critic point.) We also note PIDCR and $EIICR_1$ values corresponding to the given parameters. Then we use the sum of square error criteria.

$$SSE = \sum_{i=1}^{n} \left(PIDP2T_i - PIDCR\,c^{(EII_i - EIICR_i)}\right)^2$$

And we find the optimal "c" which makes the SSE value minimum, simply by making a one-dimensional search through the "c" values. At the end of this analyses, we obtain optimum c values corresponding to known PER1, PER2 and σ^2 values.

After obtaining optimal c_i values for given $PER1_i$ and $PER2_i$ and σ_i^2 values, we try to estimate "c" as a function of these parameters. By using a technique which we mention before, to estimate the coordinates of the critical point, we reach to the following result.

$$c = 0.10709 \left(\frac{PER1}{PER2}\right) - 0.02933 \left(\frac{PER2}{PER1}\right) - 0.00078 \left(\frac{PER1}{\sigma^2}\right)$$

$$- 0.00096\left(\frac{PER2}{\sigma^2}\right) + 0.272$$

Note: When we are searching optimal values for "c", we have PER1, PER2 and σ^2 values in our hand and by changing SC values we obtain $P1DP2T_i$ and EII_i values. We use these values in our regression study, but we have two alternatives for the P1DCR and $EIICR_1$ values: we can use either estimation values or simulation data. We call these alternatives "estimation decision rule" and "simulation decision rule". Estimation decision rule takes the estimation errors into account and arranges "c" value. If P1DCR1 estimation value is less than (underestimation) its simulation value, it tries to shift the curve upwards by overestimating the c_i value, but this also causes an overestimation for high EII values. Simulation decision rule does not consider the previous estimation errors, it only tries to find appropriate c_i value which shows the general slope of the data points.

If P1DCR1 estimation is less than its simulation value we come to face with an underestimation for all values of EII. Figure 3.6 compares two rules.

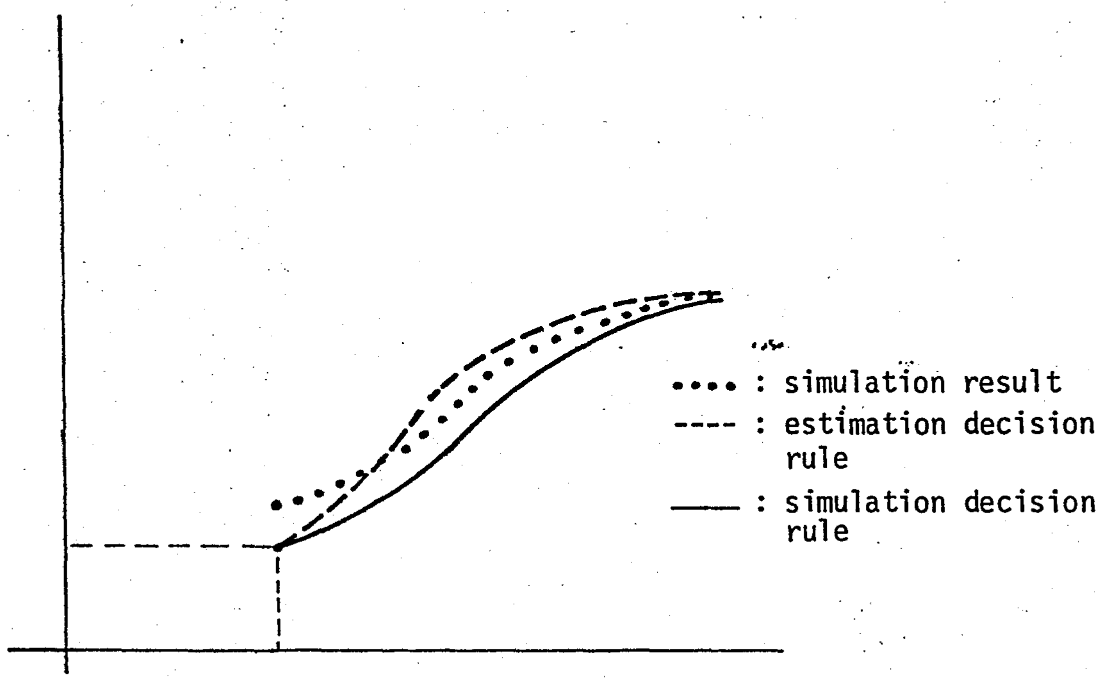


Figure 3.6

We made some tests to compare the performance of the rules, one simulation rule came out to be more successful than the estimation rule. So, we used simulation rule afterwards. (Simulation rule came out to be %78 more successful than estimation rule, estimation rule came out to be %22 more successful than simulation rule.)

We also add that,"c" value is between zero and one. If we estimate "c" less than zero, we change it to zero and if we estimate it larger than one, we change it to one.

3.5 Approximation of the Error Curve in the Interval $(-\infty, EII_{cr1})$

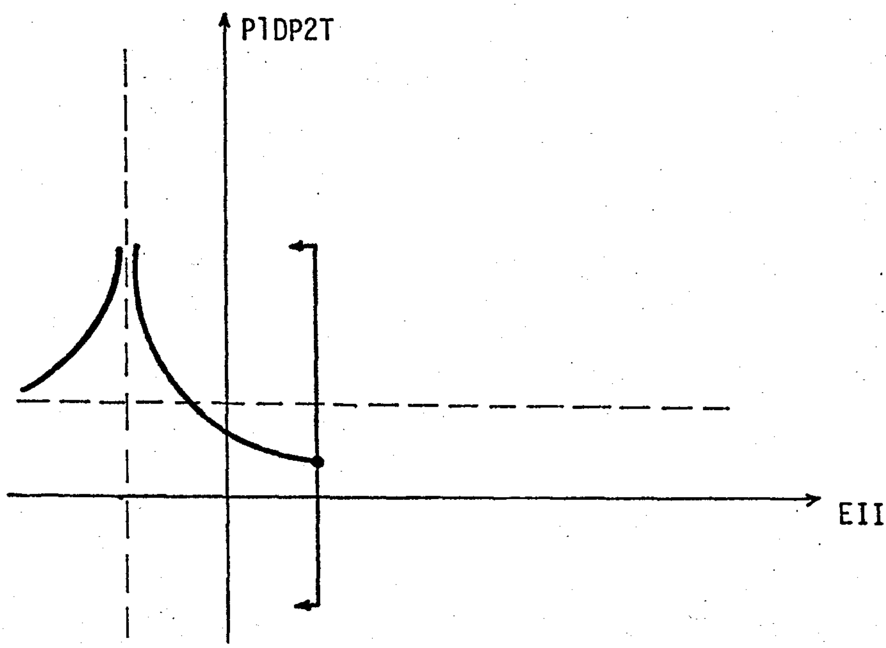


Figure 3.7

By looking to the region before the critical point we observe a vertical assymptote and call it EIICR2. When EII_i value goes to $EIICR_2$, P1DP2T value goes to infinity

$$P1DP2T = \frac{P1 \pm \varepsilon}{PRT \pm \varepsilon}$$

The above equation tells us that when PRT value goes to zero, P1DP2T value goes to infinity and we will assume $EIICR_2$ to be the EII value obtained when PRT is approximately equal to 0.01. So we will now determine the corresponding EII value when PRT equals 0.01.

$$P_r \{ \sum_{r=1}^{PER2} \xi_r^i > EI \} = 0.01$$

$$P_r \{ \sum_{r=1}^{PER2} \xi_r^i \leq EI \} = 0.99$$

$$\frac{EI - PER2}{\sigma \sqrt{PER2}} = 2.326$$

$$EI = 2.326 \sigma \sqrt{PER2} + PER2$$

$$EII = \frac{PER2 - EI}{EI} = \frac{PER2 - (2.326 \sigma \sqrt{PER2} + PER2)}{2.326 \sigma \sqrt{PER2} + PER2}$$

$$EII = \frac{-2.326 \sigma \sqrt{PER2}}{PER2 + 2.326 \sigma \sqrt{PER2}}$$

As mentioned before we will call this value $EIICR_2$. Now we are dealing with the values where EII lies between $EIICR_1$ and $EIICR_2$.

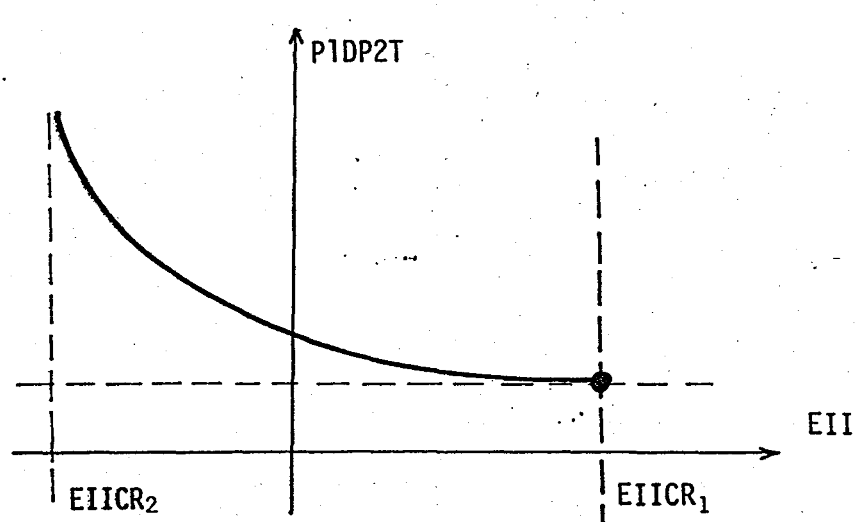
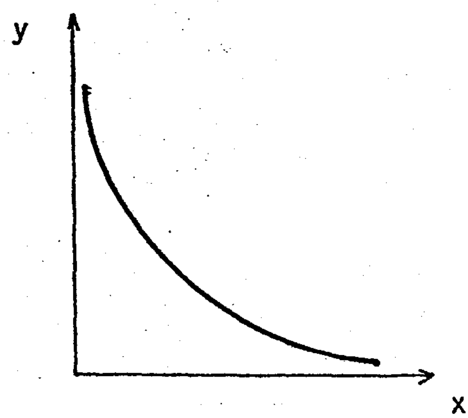


Figure 3.8

If we look the intersection region of the inequalities, $EIICR_2 \leq EII \leq EIICR_1$ and $P1DP2T \geq P1DCR$ we observe a curve which looklikes the shape of $y = \frac{k}{x^{\ell}}$ curve.



$$y = \frac{k}{x^{\ell}}$$

Figure 3.9

Where X_i value can be defined as $EII_i - EIICR_2$ and Y_i value can be defined as $P1DP2T_i - P1DCR$. Now our equation is in the form :

$$P1DP2T - P1DCR = \frac{k}{[EII - EIICR_2]^{\ell}}$$

For the purpose of simplicity we will take one of our decision variables (in this step eitler k or ℓ) as constant and the other as a function of PER1, PER2, σ^2. It is obvious that to assume both of them as a function of PER1, PER2 and σ^2 will give us a better result, but it complicates our work considerably since it tries to define two dependent parameters as a function of common parameters (PER1, PER2 and σ^2). Also even if we find k and ℓ values by making a two-dimensional search over different values of PER1, PER2 and σ^2 still a perfect fit can not be guaranteed since ℓ and k values are not independent from each other (More work must be done to solve this kind of problems.). So we prefer to keep one of the decision variables as a fixed value.

The following analysis will help in deciding which variable to keep fixed

i) k constant

$$P1DP2T - P1DCR = \frac{k}{[EII - EIICR_2]^{\ell}}$$

$$\rightarrow \quad k = (P1DP2T - P1DCR)(EII - EIICR_2)^{\ell}$$

First, we find the $\hat{\ell}$ value which causes least deviations in k value (when we change SC or EII) under given PER1, PER2 and σ^2 values. P1DCR and $EIICR_2$ does not depend on SC, P1DP2T and EII values change according to SC value. Then we note the "$\hat{k}$" value, which corresponds to the $\hat{\ell}$ value. We repeat these steps for different PER1, PER2 and σ^2 values. At the end we compare $\hat{k}$'s and we find SSE (Sum of square of error) for k values.

Example 4: PER1 = 5 PER2 = 7 σ^2 = 1 Say that
P1DCR = 0.87 $EIICR_2$ = -0.31

SC	EII	P1DP2T	ℓ = 1.1 k	ℓ = 1.3 k	ℓ = 1.4 k	ℓ = 1.5 k
.	-0.23	4.2	.207	.125	.096	.090
.	-0.16	2.2	.165	.113	.093	.077
.	-0.11	1.2	.048	.040	.034	.029

Among them we find $\hat{\ell}$ equal to 1.4.

$$\hat{\ell} = 1.4 \quad \hat{k} = \frac{(0.096 + 0.093 + 0.034)}{3} = 0.074$$

$\hat{k} = 0.074$ for PER1 = 5 , PER2 = 7 , $\sigma^2 = 1$

Finding different values for different PER1,PER2, values gives us k_i values for i = 1,...,n. Then we find SSE for $\hat{k}_i$ values.

$$SSE_k = \sum_{i=1}^{n} (\hat{k}_i - \bar{k})^2 \qquad \text{where} \qquad \bar{k} = \frac{1}{n} \sum_{i=1}^{n} \hat{k}_i$$

Define a new criteria (Error percentage) (EP)

$$EP_k = \frac{SSE_k}{n\ \bar{k}^2}$$

ii) ℓ is constant

Apply the same steps for the following model.

$$[EII\text{-}EIICR_2]^{\ell} = \frac{k}{[P1DP2T - P1DCR]}$$

$$\ell \ln[EII\text{-}EIICR_2] = \ln k - \ln[P1DP2T - P1DCR]$$

$$\ell = \frac{\ln k - \ln[P1DP2T - P1DCR]}{\ln[EII\text{-}EIICR_2]}$$

and find

$$EP_{\ell} = \frac{SSE_{\ell}}{n\ \bar{\ell}^2}$$

After comparing EP_ℓ and EP_k values (we get; $EP_\ell < EP_k$). We decide to assume ℓ as a constant and k as a function of PER1, PER2 and σ^2. We obtain value equaling 1.22 from the following analyses.

$$SSE_\ell = \sum_{i=1}^{n} w_i(\ell_i - \hat{\ell})^2$$

$$\frac{\partial SSE}{\partial \hat{\ell}} = -2 \sum_{i=1}^{n} w_i(\ell_i - \hat{\ell}) = 0 \rightarrow \hat{\ell} = \frac{\sum_{i=1}^{n} w_i \ell_i}{\sum_{i=1}^{n} w_i}$$

Now we want to express k in terms of PER1, PER2 and σ^2 values. Firstly we must find optimal k values corresponds to known PER1, PER2 and σ^2 values. For the purpose of our specific IRP we don't use the equal weighted SSE criteria to find optimal k function for given PER1, PER2 and σ^2. Since correct estimation is considerably more important for some specific regions, we give more weight to these regions when we try to estimate optimal k function. (We give more weight to the region where stockout probability is less then %20, because for high probability regions, the deviation from real value won't make a great change on results. Stockout costs are assumed to be very high, which causes a shipment to occur before stockout probability reaches %20.)

Regression analyses gives us the following result

$$k = 0.0136 \frac{PER1}{PER2} - 0.0289 \frac{PER2}{PER1} - 0.0006 \frac{PER1}{}$$

$$+ 0.000177 \frac{PER2}{\sigma^2} + 0.0793$$

And we equate k to 0.00001 when its estimation value is less than zero.

The analysis is now almost complete. There exist one more detail.

Remember the following equation

$$P1DP2T = \frac{k}{[EII - EIICR_2]^{\ell}} + P1DCR$$

When EII goes to $EIICR_2$ we obtain a very small number in the denominator and this leads us to a very large increase in P1DP2T. We solve this problem by equating the denominator part to a constant m when $[EII - EIICR_2]$ value is less than some other constant n. Experimentation led to appropriate choosing m = 0.030 and n = 0.030.

We can summarize the results of our analyses. We obtain better estimates for stockout probabilities by using PER1, PER2 and σ^2 values together with table estimation value.

The full procedure is as follows:

1) Find EII $\quad EII = (\frac{PER2 - EI}{EI})$
2) Compare EII with $EIICR_1$. If EII is greater, then go to 6.
3) $PDEST = [OPTK/[EII - EIICR_2]^{1.22}] + P1DCR$
4) Compare EII with $EIICR_2 + 0.03$, if EII is smaller, then set $PDEST = [OPTK/(0.03)^{1.22}] + P1DCR$
5) Go to 7
6) $PDEST = P1DCR^{C(EII - EIICR_1)}$
7) P1EST = (PRT)(PDEST)

where $EIICR_1$, P1DCR, $EIICR_2$, C, OPTK are the functions of our parameters. (PER1, PER2 and σ^2)

We also know that $0 < P1DCR < 1$

$0 < C < 1$

$OPTK > 0$

Note: Appendix 3 includes a computer program of our study.

IV. DISCUSSION OF THE ALGORITHM

Firstly, we must stress that this analysis is made for the purpose of a specific Inventory Routing Problem, which possess high stockout costs and high variances. It is impossible to maintain exact fit for different values of our parameters. We try to avoid high percentage of error especially at low stockout probability regions, by giving more weight or taking more sample data from there. We also give more weight to high varianced cases, since table probability works fine to a certain extent for low varianced cases. For very small values of PER1 like as 1,2, or 3, it is more appropriate to use table probability if PER2 is greater than 6. (Lack of fit can be seen where $\frac{\text{PER1}}{\text{PER2}} \leq \frac{1}{4}$) (We can see it in the Appendix 4.)

Our aim is to minimize the estimation error in the regions where table estimation shows a great lack of fit. Simplicity of the estimation criteria is also very important, since it directly affects the computer time requirement. For example, we deal basicly with two different regions (not three because the region where $EIICR_2 + EII + EIICR_2 + 0.03$ is a narrow region.) but we can easily say that dealing with five regions will give us a better fit, but this causes more comparisons and more consumption of computer time.

We try to balance, estimation fit criteria with the simplicity of the work. For example; instead of equating ℓ to 1.22, we may find $\ell_{critical}$ in terms of our parameters, then equate the ℓ value differently at the right and left side of this point. This will cost us mach more computer time since a larger number of comparisons is added into our work.

Our study is based on two important assumptions; normality assumption and the limited range of parameters assumption. However another analyses using poisonally distribution demand showed similar characteristics. Here we assumed demand is poisonally distributed for periods and for also days.

Especially the right part of the curve (P1DP2T versus EII) indicated a proper fit with the S curve. The left part can be improved by re-estimating the ℓ value.

In our analysis we considered the range of parameters as follows:

$$\frac{1}{2} \leq \frac{PER1}{\sigma^2} \leq \frac{20}{0.3} \qquad \frac{1}{20} \leq \frac{PER1}{PER2} \leq \frac{20}{1}$$

Throughout our study we collect data from the following regions:

$$1 \leq PER1 \leq 20 \quad 1 \leq PER2 \leq 20 \quad 0.3 \leq \sigma^2 \leq 2.0$$

We can easily use the results of our analysis, out of these restricted regions by making small changes on our parameters.

Example : $PER1 = 40 \quad PER2 = 36 \quad \sigma^2 = 1 \quad SC = SC_1$

$PER1' = 20 \quad PER2' = 18 \quad \sigma'^2 = 1/2 \quad SC' = SC_1/2$

$$P\{\sum_{r=1}^{PER1} \xi_r^i \leq SC_1\} = P\{\sum_{r=1}^{PER1'} \xi_r^i \leq SC_1'\}$$

$$\phi\left(\frac{SC_1 - PER1}{\sqrt{PER1}}\right) = \phi\left(\frac{SC_1' - PER1'}{\sqrt{PER1'}\,\sigma'}\right)$$

$$\frac{SC_1 - 40}{40 \cdot 1} = \frac{(SC_1/2) - 20}{\sqrt{20}\ (1/\sqrt{2})} \rightarrow \frac{SC_1 - 40}{2\sqrt{10}} = \frac{1/2(SC_1 - 40)}{\sqrt{10}}$$

$$\frac{SC_1 - 40}{\sqrt{10}} = \frac{SC_1 - 40}{\sqrt{10}}$$

As it can be seen above our estimations won't change when we make these kind of changes on our parameters, but we observe different real probabilities (where we get from simulation) so this causes the error of our estimation to increase.

V. COMPARISON OF ERRORS

We compare percentage error of estimation and percentage error of table in the Appendix 4.

$$\text{Percentage error of estimation} = \left[\frac{\text{P1EST} - \text{P1}}{\text{P1}}\right]$$

$$\text{Percentage error of table} = \left[\frac{\text{PRT} - \text{P1}}{\text{P1}}\right]$$

$F_1(x) = P\ \{\%\ \text{error of estimation} \leq X\}$

$F_2(x) = P\ \{\%\ \text{error of table} \leq X\}$

We compare $F_1(x)$ and $F_2(x)$ for different regions of real probability value.

$.75 \leq P1 \leq 1.0$

X	$F_1(X)$	$F_2(X)$
.1	.98	.80
.2	1	.94
.3	1	.98
.4	1	1
.5	1	1
.6	1	1
.7	1	1
.8	1	1
.9	1	1
1.0	1	1

$.5 \leq P1 \leq .75$

X	$F_1(X)$	$F_2(X)$
.1	.57	.10
.2	.97	.69
.3	1	.98
.4	1	1
.5	1	1
.6	1	1
.7	1	1
.8	1	1
.9	1	1
1.0	1	1

$.35 \leq P1 \leq .5$		
X	$F_1(X)$	$F_2(X)$
.1	.50	.59
.2	.85	.81
.3	.93	.86
.4	1	.95
.5	1	.98
.6	1	1
.7	1	1
.8	1	1
.9	1	1
1.0	1	1

$.2 \leq P1 \leq .35$		
X	$F_1(X)$	$F_2(X)$
.1	.81	.28
.2	.92	.59
.3	.95	.78
.4	.97	.92
.5	1	.96
.6	1	.98
.7	1	1
.8	1	1
.9	1	1
1.0	1	1

$.1 \leq P1 \leq .2$

X	$F_1(X)$	$F_2(X)$
.1	.69	.07
.2	.83	.16
.3	.89	.31
.4	.98	.45
.5	1	.64
.6	1	.75
.7	1	.82
.8	1	.87
.9	1	.99
1.0	1	1

$0 \leq P1 \leq .1$

X	$F_1(X)$	$F_2(X)$
.1	.27	.07
.2	.51	.12
.3	.63	.22
.4	.78	.27
.5	.83	.37
.6	.92	.46
.7	.95	.55
.8	.98	.75
.9	.99	.93
1.0	1	1

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APPENDIX I

Result of Simulation

PROGRAM NORM2:

E1=10.00 PFR2= 4.00 SIGMA= 1.00

BSC	EII	EI	PI	PIP2T	PIDP2T	PRT
6.000	2.8057	1.0511	.8350	.1128	.8985	.9292
7.930	1.7900	1.4337	.7733	.1634	.8594	.8997
9.860	1.0627	1.9973	.7146	.1773	.8493	.8413
11.790	[.4177]	2.8210	.6093	.1801	[.8473]	.71[illegible]
12.755	.1978	3.3394	.5533	.1374	.8790	.62[illegible]
13.720	.0117	3.9538	.4653	.0917	.9158	.508[illegible]
14.685	-.1387	4.6439	.3811	.0173	1.0174	.374[illegible]
15.650	-.2622	5.4213	.3055	.2181	1.2784	.2389
16.615	-.3611	6.2605	.2356	.4516	1.8219	.1272
17.580	-.4407	7.1524	.1722	.6621	2.9543	.0582
18.545	-.5047	8.0764	.1183	.8207	5.5520	.0212
19.510	-.5567	9.0220	.0342	.9287	13.7752	.006[illegible]
21.440	-.6344	10.940[illegible]	.0243	.9876	60.6296	.00[illegible]
23.370	-.6892	12.8690	.0083	1.0000	82.4774	.00[illegible]
25.300	-.7297	14.7974	.0005	.9998	5.1553	.00[illegible]
27.230	-.7609	16.7298	.0000	.9380	.0005	.00[illegible]

PROGRAM NORM2:

1 10.00 PFR2= 5.00 SIGMA= 1.00

BSC	EII	EI	PI	PIP2T	PIDP2T	PRT
6.000	3.7571	1.0511	.8884	.0815	.9245	.960[illegible]
8.015	2.4493	1.4496	.8629	.0928	.9150	.942[illegible]
10.030	1.3976	2.0854	.7975	.1325	.8829	.903[illegible]
12.045	.6939	2.9517	.6984	.1721	.8531	.81[illegible]
13.053	[.4219]	3.5186	.6331	.1773	[.8493]	.745[illegible]
14.060	.1952	4.1833	.5531	.1582	.8633	.64[illegible]
15.068	.0117	4.9421	.4606	.1030	.9064	.508[illegible]
16.075	-.1347	5.7786	.3592	.0216	.9786	.366[illegible]
17.083	-.2522	6.6867	.2668	.1507	1.0769	.226[illegible]
18.090	-.3452	7.6368	.1878	.3557	1.[illegible]	.12[illegible]
19.098	-.4197	8.6164	.1260	.5738	2.3419	.0537
20.105	-.4797	9.6105	.0887	.7778	4.4775	.0197
22.120	-.5697	11.6192	.0280	.9464	17.4802	.0015
24.135	-.6333	13.6349	.0084	1.0000	84.3044	.00[illegible]
26.150	-.6805	15.6476	.0005	.9998	5.2695	.000[illegible]
28.165	-.7169	17.6623	.0005	.9998	5.[illegible]	.00[illegible]

PROGRAM NORM2:

1=10.00 PFR2= 6.00 SIGMA= 1.00

BSC	EII	EI	PI	PIP2T	PIDP2T	PRT
6.000	4.7085	1.0511	.9688	.0099	.9901	.978[illegible]
5.100	3.0309	1.4885	.9228	.0480	.9541	.967[illegible]
0.200	1.8091	2.1359	.8590	.0963	.9120	.9418
2.300	.9437	3.0869	.7596	.1598	.8622	.881
3.350	[.6167]	3.7113	.6969	.1821	[.8458]	.823[illegible]
4.400	.3546	4.4293	.6281	.1764	.8499	.73[illegible]
5.450	.1426	5.2513	.5378	.1490	.8702	.617[illegible]
6.500	-.0257	6.1595	.4417	.0778	.9270	.476[illegible]
7.550	-.1581	7.1269	.3521	.0831	1.0933	.3[illegible]
8.600	-.2621	8.1311	.2605	.2621	1.3545	.1[illegible]
9.650	-.3451	9.1615	.1790	.4497	1.8153	[illegible]
0.700	-.4121	10.2061	.1141	.6380	2.6[illegible]	[illegible]
2.800	-.5122	12.3016	.0412	.8763	7.9[illegible]	[illegible]
4.900	-.5833	14.3998	.0128	.9767	32.12[illegible]	[illegible]
7.000	-.6363	16.4989	.0043	[illegible]	42.7[illegible]43	.0[illegible]
9.100	-.6774	18.5992	.0011	.9999	10.6965	[illegible]

R1=10.00 PER2= 7.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.000	5.6599	1.0511	.9795	.0082	.9918	.98
8.185	3.6716	1.4955	.9379	.0458	.9561	.98
10.370	2.1708	2.2076	.8978	.0747	.9304	.9649
12.555	1.1667	3.2307	.8268	.1153	.8965	.9222
13.648	.7951	3.8994	.7642	.1592	.8693	.8790
14.740	.4917	4.6926	.6940	.1639	.8591	.8078
15.833	.2556	5.5751	.6000	.1698	.8547	.701
16.925	.0692	6.5472	.5142	.1136	.9059	.5675
18.018	-.0750	7.5674	.4042	.0311	.9696	.4168
19.110	-.1886	8.6273	.3072	.1180	1.1334	.27
20.203	-.2790	9.7087	.2163	.2950	1.4176	.153
21.295	-.3514	10.7932	.1511	.4945	1.9757	.0764
23.480	-.4607	12.9801	.0520	.7712	4.3337	.011
25.665	-.5384	15.1662	.0195	.9487	17.7288	.001
27.850	-.5966	17.3514	.0005	.9998	5.4122	.000
30.035	-.6416	19.5315	.0005	.9998	5.4122	.000

PROGRAM NORM2:

R1=10.00 PER2= 8.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.000	6.6114	1.0511	.9711	.0225	.9779	.992
8.270	4.2678	1.5187	.9669	.0208	.9795	.98
10.540	2.5389	2.2606	.9289	.0532	.9494	.97
12.810	1.3685	3.3776	.8669	.0940	.9140	.948
13.945	.9465	4.1099	.8005	.1427	.8750	.914
15.080	.6149	4.9540	.7448	.1515	.8683	.857
16.215	.3548	5.9051	.6633	.1614	.8607	.77
17.350	.1533	6.9364	.5663	.1377	.8789	.644
18.485	-.0024	8.0195	.4600	.0869	.9199	.5
19.620	-.1239	9.1309	.3602	.0331	1.0340	.34
20.755	-.2203	10.2600	.2622	.1807	1.2200	.21
21.890	-.2977	11.3917	.1835	.3625	1.5674	.11
24.160	-.4143	13.6586	.0753	.6970	3.2863	.02
26.430	-.4977	15.9281	.0282	.9077	10.4273	.0
28.700	-.5605	18.2016	.0070	1.0000	70.3146	[illegible]
30.970	-.6092	20.4714	.0005	.9998	5.4093	.0

PROGRAM NORM2:

R1=10.00 PER2= 9.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.000	7.5628	1.0511	1.0000	.0041	1.0040	.9
8.355	4.7956	1.5529	.9962	.0032	.9967	.9
10.710	2.8557	2.3342	.9618	.0260	.9745	.98
13.065	1.5485	3.5314	.9138	.0566	.9463	.96
14.243	1.0870	4.3125	.8669	.0851	.9215	[illegible]
15.420	.7213	5.2286	.7995	.1186	.8938	[illegible]
16.598	.4405	6.2480	.7169	.1387	.8781	.81
17.775	.2263	7.3390	.6118	.1586	.8630	.7
18.953	.0618	8.4761	.5175	.0966	.9117	.56
20.130	-.0659	9.6347	.4141	.0066	.9932	[illegible]
21.308	-.1671	10.8053	.3162	.1326	1.1525	[illegible]
22.485	-.2490	11.9842	.2301	.2999	1.4274	.1
24.840	-.3724	14.3404	.0992	.6221	2.6393	[illegible]
27.195	-.4609	16.6941	.0354	.8533	6.6871	[illegible]
29.550	-.5276	19.0510	.0087	.9542	17.4483	.00
31.905	-.5795	21.4037	.0033	1.0000	32.6832	[illegible]

[illegible] PFR2=[illegible] SIGMA=1.[illegible]

BSC	EII	EI	P1	P1P2T	P1OP2T	PFT
6.[illegible]	[illegible].5142	1.[illegible]	.9857	[illegible]79	.[illegible]	.9970
8.440	[illegible].3603	1.572[illegible]	.[illegible]	.[illegible]61	.[illegible]	.9961
10.380	3.1455	2.4125	.9631	.0296	.97[illegible]	.9916
13.320	1.7083	3.6926	.9183	.0636	.9461	.9767
14.[illegible]	1.[illegible]	4.[illegible]	.8767	.0919	.9157	.9573
15.760	.8138	5.0134	.8160	.1284	.8962	.9207
16.980	.5164	6.5944	.7528	.1394	.8776	.8577
18.200	.2916	7.7420	.6457	.1787	.8483	.7611
19.420	.1191	8.9357	.5365	.1730	.8524	.6293
20.640	-.0141	10.1476	.4207	.1504	.8591	.4840
21.360	-.1197	11.3598	.3246	.0278	.9726	.3336
23.080	-.2050	12.5792	.2330	.1030	1.1143	.20[illegible]
25.520	-.3342	15.0189	.1113	.4869	1.9457	.0571
27.960	-.4272	17.4594	.0389	.7585	4.0974	.0094
30.400	-.4975	19.9006	.0110	.9379	10.9659	.00[illegible]
32.840	-.5524	22.3404	.0044	1.0000	43.8164	.00[illegible]

PROGRAM NORB2:

P1=10.00 PFR2=11.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1OP2T	PFT
6.000	9.4656	1.0511	1.0000	.0014	1.0013	.9996
8.525	5.9406	1.6649	.9846	.0133	.9867	.9977
11.050	3.4557	2.4688	.9697	.0260	.9746	.9949
13.575	1.8587	3.8478	.9359	.0516	.9504	.9842
14.838	1.3078	4.7664	.8984	.0790	.9267	.9693
16.100	.8945	5.8062	.8502	.1063	.9038	.9460
17.363	.5831	6.9483	.7844	.1330	.8825	.8888
18.625	.3484	8.1580	.6890	.1645	.8586	.8023
19.888	.1705	9.3978	.5986	.1434	.8745	.6344
21.150	.0331	10.6476	.4789	.1271	.8371	.5399
22.413	-.0766	11.9125	.3804	.0347	.9662	.3936
23.675	-.1650	13.1741	.2879	.1046	1.1163	.2578
26.200	-.2993	15.6981	.1292	.3861	1.6269	.0793
28.725	-.3965	18.2256	.0536	.7204	3.5523	.015[illegible]
31.250	-.4699	20.7493	.0153	.8891	8.5143	.0017
33.775	-.5274	23.2757	.0044	1.0000	43.7444	.00[illegible]

PROGRAM NORB2:

P1=1[illegible].00 PFR2=12.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1OP2T	PFT
6.0[illegible]	10.4170	1.0511	.9948	.0044	.9955	.99[illegible]
8.6[illegible]	6.4916	1.6019	.9919	.0069	.9930	.99[illegible]
11.2[illegible]	3.7047	2.5506	.9820	.0150	.9852	.99[illegible]
13.8[illegible]	1.9819	4.0242	.9526	.0385	.9628	.9[illegible]
15.1[illegible]	1.4017	4.9965	.9216	.0615	.9419	.97[illegible]
16.4[illegible]	.9653	6.1058	.8721	.0955	.9127	.955[illegible]
17.745	.6415	7.3103	.8039	.1339	.8818	.9115
19.[illegible]	.4005	8.5683	.7237	.1592	.8626	.83[illegible]
20.3[illegible]	.2173	9.8582	.6331	.1515	.8683	.72[illegible]
21.8[illegible]	.0752	11.1612	.5262	.1303	.8646	.594[illegible]
2[illegible]	-.0375	12.4671	.4152	.0796	.9269	.44[illegible]
24.[illegible]	-.1285	13.7692	.3043	.0025	.9972	.30[illegible]
[illegible]	-.2674	16.[illegible]	.1474	.2959	1.[illegible]	.1[illegible]
2[illegible].4[illegible]	-.3681	18.[illegible]	.0574	.6134	2.[illegible]	.0224
32.[illegible]	-.4444	21.5972	.0188	.8509	6.4739	.00[illegible]
34.7[illegible]	-.5043	24.2099	.0072	1.0000	71.7124	.00[illegible]

1=10.00 PER2=13.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PKT
.000	11.3685	1.0511	1.0000	.0005	1.0004	.9995
8.695	6.9265	1.6491	.9969	.0023	.9976	.9992
1.390	3.9304	2.6367	.9927	.0052	.9947	.9979
4.085	2.0964	4.1984	.9634	.0394	.9704	.9927
5.433	1.4805	5.2498	.9460	.0471	.9549	.9842
6.780	1.0273	6.4124	.9036	.0686	.9357	.9656
8.125	.6940	7.6742	.8489	.0946	.9135	.9292
9.475	.4459	8.9916	.7798	.1103	.9096	.8658
0.823	.2587	10.3282	.6722	.1461	.8724	.7704
2.170	.1143	11.6667	.5695	.1249	.8888	.6406
3.518	-.0012	13.0153	.4449	.1238	.8897	.5000
4.865	-.0956	14.3641	.3365	.0572	.9457	.3557
7.560	-.2379	17.0591	.1743	.2462	1.3256	.1314
0.255	-.3419	19.7537	.0653	.5299	2.1292	.0397
2.950	-.4210	22.4515	.0155	.7160	3.4434	.0044
5.645	-.4830	25.1463	.0033	.8795	6.6410	.0004

PROGRAM NORM2:

1=10.00 PER2=14.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PKT
6.000	12.3199	1.0511	1.0000	.0003	1.0002	.9997
8.780	7.4615	1.6545	.9985	.0010	.9989	.9995
1.560	4.1713	2.7072	.9936	.0051	.9943	.9987
4.340	2.1942	4.3830	.9766	.0187	.9816	.9949
5.730	1.5519	5.4862	.9577	.0320	.9689	.9884
7.120	1.0829	6.7213	.9245	.0533	.9493	.9738
8.510	.7405	8.0435	.8678	.0880	.9391	.9441
9.900	.4879	9.4095	.8010	.1096	.9011	.888[illegible]
1.290	.2976	10.7891	.7175	.1183	.8941	.80[illegible]
2.680	.1424	12.1803	.6061	.1292	.8855	.6844
4.070	.0317	13.5673	.5017	.0840	.9223	[illegible]
5.460	-.0647	14.9605	.3865	.0383	.9629	.40[illegible]
8.240	-.2167	17.7376	.2010	.1985	1.2469	.1[illegible]
1.020	-.3177	20.5191	.0825	.5043	2.0123	.0[illegible]
3.800	-.3992	23.3010	.0249	.7351	3.7190	[illegible]
6.580	-.4632	26.0788	.0072	.9166	10.2833	[illegible]

PROGRAM NORM2:

1=10.00 PER2=15.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PKT
6.000	13.2713	1.0511	1.0000	.0000	.9999	1.0000
8.865	7.9694	1.6724	1.0000	.0003	1.0002	.9997
1.730	4.3651	2.7959	.9976	.0016	.9983	.999[illegible]
4.595	2.2782	4.5757	.9856	.0109	.9891	[illegible]
6.028	1.6125	5.7417	.9682	.0242	.9763	.991[illegible]
7.460	1.1301	7.0418	.9330	.0501	.9522	.97[illegible]
8.893	.7822	8.4164	.8894	.0731	.9317	.954[illegible]
0.325	.5257	9.8314	.8252	.1006	.9085	.908[illegible]
1.758	.3325	11.2573	.7420	.1207	.8922	[illegible]
3.1[illegible]	.1820	12.6903	.6387	.1310	.8841	.72[illegible]
4.623	.0621	14.1225	.5244	.1195	.8931	[illegible]
6.055	-.0355	15.5522	.4156	.0689	.9353	.44[illegible]
8.920	-.1857	18.4198	.2181	.1316	1.[illegible]569	[illegible]
1.785	-.2953	21.2851	.0816	.3552	[illegible]479	[illegible]
4.650	-.3789	24.1499	.0300	.6963	[illegible]273	[illegible]
7.515	-.4447	27.0148	.0059	.7998	4.5405	[illegible]

=10. PFR2=16.00 SIGMA=1.00

BSC	EII	FI	P1	P1P2T	P1DP2T	PET
.000	16.2227	1.0511	1.0000	.0000	.9999	1.0000
.750	8.3449	1.7122	.9985	.0015	.9984	1.0000
.000	4.5751	2.8699	.9977	.0018	.9981	.9995
.550	2.3516	4.77[illegible]	.9840	.0136	.9905	.9974
.325	1.6669	6.0016	.9666	.0279	.9727	.9936
.400	1.1731	7.3627	.9432	.0435	.9582	.9842
.275	.8201	8.7907	.9923	.0679	.9363	.9641
.750	.5605	10.2532	.8441	.0942	.9138	.9235
.225	.3648	11.7234	.7636	.1202	.8926	.8554
.700	.2120	13.2016	.6676	.1308	.8842	.7549
.175	.0904	14.6741	.5610	.1217	.8914	.6293
.650	-.0093	16.1499	.4467	.0924	.9152	.488[illegible]
.600	-.1622	19.0985	.2547	.1339	1.1541	.2266
.550	-.2744	22.0510	.1049	.3755	1.5938	.0655
.500	-.3600	24.9995	.0305	.5905	2.4224	.0125
.450	-.4275	27.9481	.0050	.7197	3.3297	.0014

PROGRAM NORM2:

1=10.00 PFR2=17.00 SIGMA= 1.00

BSC	EII	FI	P1	P1P2T	P1DP2T	PET
0.000	15.1792	1.0511	1.0000	.0000	.9999	1.0000
[illegible].035	8.8315	1.7291	1.0000	.0000	.9999	1.000[illegible]
2.070	4.7472	2.9580	.9970	.0027	.9972	.9997
5.105	2.4198	4.9710	.9877	.0106	.9894	.998[illegible]
6.623	1.7120	6.2684	.9769	.0188	.9814	.9953
8.140	1.2118	7.6861	.9576	.0315	.9693	.9878
9.658	.8539	9.1697	.9206	.0544	.9483	.970[illegible]
1.175	.5926	10.6741	.8717	.0749	.9303	.937[illegible]
2.693	.3942	12.1937	.8079	.0856	.9211	.8776
4.210	.2400	13.7101	.7175	.1620	.9[illegible]73	.7652
5.728	.1162	15.2298	.6043	.0968	.9116	.602[illegible]
7.245	.0154	16.7425	.4772	.0978	.9108	.5239
0.280	-.1404	19.7774	.2636	.0463	1.0481	.251[illegible]
3.315	-.2548	22.8130	.1052	.2533	1.3376	.08[illegible]
6.350	-.3423	25.8492	.0355	.5439	2.1789	.01[illegible]
9.385	-.4115	28.8846	.0100	.7998	4.2566	.002[illegible]

PROGRAM NORM2:

1=10.00 PFR2=18.00 SIGMA= 1.00

BSC	EII	FI	P1	P1P2T	P1DP2T	PET
0.000	16.1256	1.0511	1.0000	.0000	.9999	1.[illegible]
9.120	9.2812	1.7508	1.0000	.0000	.9999	1.[illegible]
2.240	4.8914	3.0553	.9978	.0022	.9977	1.[illegible]
5.360	2.4743	5.1808	.9865	.0123	.9877	.99[illegible]
6.920	1.7524	6.5397	.9763	.0207	.9797	.99[illegible]
8.480	1.2457	8.0154	.9627	.0290	.9717	.99[illegible]
0.040	.8852	9.5479	.9344	.0452	.9566	.97[illegible]
1.600	.6218	11.0985	.8911	.0632	.9405	.947[illegible]
3.160	.4220	12.6586	.8283	.0798	.9261	.8[illegible]
4.720	.2657	14.2216	.7328	.1099	.9099	.81[illegible]
6.280	.1409	15.7774	.6372	.0962	.9121	.6[illegible]
7.840	.0380	17.3404	.5239	.0682	.9360	.55[illegible]
[illegible].960	-.1202	20.4594	.3066	.0541	1.0568	.2[illegible]4
4.080	-.2386	23.5792	.1344	.2926	1.4122	[illegible]
7.200	-.3298	26.6981	.0461	.5619	2.2715	[illegible]
0.320	-.3964	29.8187	.0078	.6529	[illegible].7778	.[illegible]

[illegible]	[illegible]=12.00	SIGMA= 1.[illegible]				
BSC	EII	EI	PI	PIP2T	PIDP2T	PET
.000	17.0770	1.9513	1.0000	.0000	.9999	1.0000
.205	9.6179	1.7894	1.0000	.0000	.9999	1.000[illegible]
.410	5.05[illegible]2	3.1394	.9979	.0021	.9975	1.000[illegible]
.615	2.5242	5.3913	.9962	.0000	.9910	.9991
.218	1.7891	6.3123	.9836	.0156	.9851	.9974
.820	1.2762	8.3471	.9765	.0228	.9776	.9927
.423	.9141	9.9262	.9467	.0365	.9647	.9812
.025	.6488	11.5234	.9001	.0625	.9410	.9564
.628	.4475	13.1262	.8374	.0866	.9202	.9099
.230	.2899	14.7298	.7555	.1033	.9022	.834[illegible]
.833	.1633	16.3327	.6526	.1172	.8953	.7231
.435	.0593	17.9362	.5287	.1247	.8890	.5948
.640	-.1011	21.1381	.2958	.0552	.9474	.3121
.845	-.2195	24.3447	.1404	.2630	1.2615	.1112
.050	-.3103	27.5474	.0472	.4700	1.8793	.0250
.255	-.3822	30.7537	.0094	.6184	2.5497	.0035

PROGRAM NORM2:

=10.00	PER2=20.00	SIGMA= 1.00				
BSC	EII	EI	PI	PIP2T	PIDP2T	PET
.000	14.0284	1.9511	1.0000	.0000	.9999	1.000[illegible]
.290	10.0519	1.3096	.9986	.0014	.9985	1.000[illegible]
.580	5.1715	3.2407	.9972	.0028	.9971	1.000[illegible]
.870	2.5651	5.6099	.9937	.0056	.9943	.999[illegible]
.515	1.8200	7.0927	.9866	.0116	.9834	.998[illegible]
.160	1.3048	8.6777	.9739	.0210	.9794	.9943
.805	.9402	10.3084	.9550	.0310	.9698	.9846
.450	.6739	11.9481	.9211	.0467	.9553	.9641
[illegible]	.4713	13.5953	.8639	.0691	.9352	.9236
.740	.3122	15.2417	.7844	.0905	.9169	.8554
.385	.1845	16.8846	.6944	.0871	.9198	.7549
.030	.0795	18.5272	.5706	.0963	.9120	.6255
.320	-.0834	21.8187	.3439	.0021	.9876	.3446
.610	-.2035	25.1105	.1578	.1944	1.2404	.1271
.900	-.2958	28.3998	.0522	.4171	1.6955	.0307
.190	-.3689	31.6903	.0139	.6760	3.0193	.0045

PROGRAM NORM2:

11.00	PER2= 1.00	SIGMA= 1.00				
BSC	EII	EI	PI	PIP2T	PIDP2T	PET
.500	-.0694	1.0746	.4194	.1258	.8981	.4721
.250	-.2771	1.3833	.3286	.0711	.9234	.3520
.000	-.4594	1.8498	.2755	.2723	1.3735	.2005
.750	-.5972	2.4827	.2096	.6688	3.0153	.0634
.625	-.6510	2.8654	.1639	.8084	5.2039	.0314
.500	-.6975	3.3063	.1549	.9309	14.3398	.0107
.375	-.7388	3.8283	.1194	.9799	47.7778	.0024
.250	-.7728	4.4019	.0774	.9961	193.4[illegible]	.000[illegible]
.125	-.8023	5.0592	.0569	1.0000	568.7[illegible]	.0000
.000	-.8268	5.7738	.0325	1.0000	325.1[illegible]	.0000
.875	-.8470	6.5352	.0238	1.0000	237.97[illegible]	.0000
.750	-.8638	7.3412	.0111	1.0000	111.1617	.0000
.500	-.8892	9.0218	.0029	1.0000	28.8574	.0000
.250	-.9070	10.7512	.0005	.9998	4.3[illegible]	.0000
.000	-.9206	12.5000	.0005	.9998	4.8[illegible]	.0000
.750	-.9298	14.2520	.0000	1.0810	.1005	.0000

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.5[illegible]	.3617	1.[illegible]	.7[illegible]	.0478	.[illegible]	.7472
8.335	.4066	1.4219	.5014	.[illegible]98	.[illegible]74	.65[illegible]
0.170	.0520	1.9011	.4824	.0859	.9207	.5239
2.005	-.2225	2.5723	.3765	.0846	1.[illegible]	.3446
2.923	-.3360	3.0119	.3179	.2485	1.3309	.2389
3.340	-.4295	3.5054	.2675	.4594	1.3484	.1445
4.758	-.5082	4.0671	.2133	.6620	2.[illegible]548	.0721
5.675	-.5764	4.7214	.1681	.8370	6.1115	.0274
6.593	-.6321	5.4358	.1337	.9417	16.9245	.0078
7.510	-.6779	6.2098	.0857	.9825	53.5538	.0015
8.428	-.7159	7.0398	.0599	1.0000	598.2338	.0000
9.345	-.7469	7.9019	.0406	1.0000	405.7842	.0000
21.180	-.7936	9.6906	.0135	1.0000	134.4814	.0000
23.015	-.8263	11.5120	.0058	1.0000	57.4969	.0000
24.850	-.8502	13.3518	.0010	.9999	9.5832	.0000
26.685	-.8683	15.1848	.0000	1.0850	.0005	.0000

PROGRAM NORM2:

I=11.00 PER2= 3.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.500	1.7918	1.0746	.7681	.1272	.8671	.8658
8.420	1.0983	1.4297	.6453	.2644	.7[illegible]	.81[illegible]
10.340	.5500	1.9355	.5990	.2171	.8215	.72[illegible]
12.260	.1127	2.6961	.5039	.1262	.8878	.5675
13.220	-.0511	3.1614	.4563	.0171	.9830	.4645
14.180	-.1992	3.7047	.3812	.0959	1.1058	.344[illegible]
15.140	-.3076	4.3330	.3167	.2939	1.4156	.2236
16.100	-.4051	5.0426	.2574	.5299	2.1255	.121[illegible]
17.060	-.4847	5.8215	.1917	.7256	3.6371	.052[illegible]
18.020	-.5498	6.6639	.1411	.8766	8.0605	.0174
18.980	-.6031	7.5577	.0944	.9544	21.4451	.00[illegible]
19.940	-.6461	8.4781	.0578	.9862	64.2197	.00[illegible]
21.860	-.7106	10.3670	.0178	1.0000	178.1285	.000[illegible]
23.780	-.7557	12.2806	.0074	1.0000	74.0737	.000[illegible]
25.700	-.7887	14.1995	.0015	.9999	14.3151	.000[illegible]
27.620	-.8139	16.1187	.0000	1.0230	.0005	.000[illegible]

PROGRAM NORM2:

I=11.00 PER2= 4.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.500	2.7224	1.0746	.8462	.0966	.9118	.[illegible]
8.505	1.7400	1.4598	.7983	.1249	.8889	.[illegible]
10.510	1.0023	1.9977	.7207	.1674	.8565	.84[illegible]
12.515	.4221	2.8126	.6075	.1892	.8408	.7[illegible]
13.518	.2046	3.3207	.5408	.1637	.8592	.[illegible]
14.520	.0232	3.9092	.4725	.0921	.9155	.[illegible]
15.523	-.1309	4.6022	.3939	.0299	1.0306	.38[illegible]
16.525	-.2562	5.3778	.3139	.2090	1.2638	.24[illegible]
17.528	-.3577	[illegible].2278	.2393	.4392	1.7813	.1[illegible]
[illegible]	-.4391	7.1308	.1656	.6412	2.7827	.059[illegible]
[illegible]	-.5051	[illegible].0817	.1163	.8221	5.5937	.[illegible]
20.535	-.5583	9.0556	.0791	.9254	[illegible].1799	.[illegible]
22.5[illegible]	-.6378	11.0423	.0330	1.0000	329.5061	.[illegible]
24.545	-.6933	13.0440	.0060	1.0000	79.8407	[illegible]
26.5[illegible]	-.7342	15.0496	.0000	1.0020	.0005	[illegible]
28.555	-.7655	17.0550	.0000	1.0020	.0005	.00[illegible]

PROGRAM NORM2:

1=11.00 PER2= 5.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1OP2T	PET
0.500	3.6530	1.0746	.8916	.0766	.9267	.9599
5.590	2.3928	1.4737	.8662	.0948	.9133	.941
0.680	1.4276	2.0597	.8049	.1243	.8894	.9049
2.775	.7066	2.9298	.7266	.1395	.8774	.8212
3.815	.4324	3.4966	.6424	.1654	.8580	.7436
4.860	.2079	4.1393	.5546	.1683	.8558	.648
5.905	.0220	4.8926	.4822	.0700	.9344	.5160
6.950	-.1275	5.7309	.3825	.0208	1.0210	.3745
7.995	-.2479	6.6483	.2864	.1932	1.2390	.2327
9.140	-.3430	7.6164	.2163	.4326	1.7610	.123
0.085	-.4197	8.6164	.1546	.6528	2.3744	.0537
1.130	-.4814	9.6467	.0964	.8609	4.9960	.0192
3.220	-.5733	11.7190	.0362	.9641	25.8666	.0013
5.31	-.6379	13.8101	.0098	1.0000	98.1951	.000
7.40	-.6855	15.9600	.0021	1.0000	20.6731	.000
9.490	-.7221	17.9901	.0000	.9330	.0005	.000

PROGRAM NORM2:

1=11.00 PER2= 6.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1OP2T	PET
6.500	4.5836	1.0746	.9364	.0442	.9576	.9778
8.675	3.0077	1.4971	.8913	.0843	.9222	.9664
0.850	1.8277	2.1219	.8492	.1103	.9005	.942
3.0	.9713	3.0438	.7662	.1519	.8680	.8847
4.113	.6376	3.6639	.7028	.1794	.8478	.8089
5.20	.3716	4.3745	.6207	.2009	.8326	.7454
6.283	.1569	5.1861	.5272	.1936	.8377	.6293
7.375	-.0153	6.0934	.4365	.1179	.8943	.488
8.463	-.1517	7.0691	.3417	.0236	1.0238	.333
9.550	-.2592	8.0991	.2512	.2129	1.2697	.1977
0.638	-.3448	9.1578	.1807	.4449	1.7995	.1093
1.725	-.4137	10.2337	.1149	.6284	2.6846	.0427
3.900	-.5161	12.3995	.0388	.8840	8.4313	.0045
6.075	-.5883	14.5733	.0115	1.0000	115.1393	.000
8.250	-.6417	16.7477	.0037	1.0000	36.6515	.000
0.425	-.6829	18.9236	.0010	.9999	10.4722	.0000

PROGRAM NORM2:

1=11.00 PER2= 7.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1OP2T	PET
0.500	5.5142	1.0746	.9639	.0241	.9764	.9870
3.760	3.6165	1.5163	.9416	.0417	.9599	.9698
1.020	2.1836	2.1988	.9062	.0719	.9329	.9649
3.280	1.1940	3.1965	.8269	.1169	.8952	.92
4.410	.8183	3.8498	.7762	.1465	.8721	.88
5.540	.5156	4.6188	.6960	.1825	.8456	.81
6.670	.2726	5.5004	.6033	.1806	.8467	.712
7.800	.0825	6.4663	.4957	.1687	.8555	.579
8.930	-.0678	7.5083	.4064	.0450	.9567	.4247
0.060	-.1851	8.5898	.3063	.1044	1.1161	.2243
1.190	-.2785	9.7014	.2218	.3060	1.4399	.153
2.320	-.3532	10.8226	.1533	.5115	2.0442	.0249
4.580	-.4649	13.0809	.0610	.8197	5.4952	.0170
6.84	-.5437	15.3421	.0196	.9592	20.3097	.0006
9.100	-.6023	17.6091	.0048	1.0000	47.6982	.000
1.36	-.6476	19.8616	.0000	.8850	.0005	.000

PROGRAM NORM2:

PER1=11.00 PER2= 8.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1OP2T	PET
6.500	6.4443	1.0746	.9873	.0155	.9844	.992
8.945	4.2694	1.5132	.9624	.0276	.9730	.96
11.190	2.5343	2.2635	.9452	.0350	.9660	.97
13.535	1.4952	3.3247	.8719	.0901	.9172	.95
14.708	.9771	4.0464	.8184	.1214	.8616	.937
15.880	.6433	4.8682	.7617	.1347	.8812	.87
17.053	.3758	5.8146	.6722	.1594	.8624	.77
18.225	.1675	6.8525	.5738	.1421	.8754	.65
19.398	.0063	7.9499	.4705	.0713	.9333	.50
20.570	-.1201	9.0920	.3633	.0312	1.0319	.352
21.743	-.2195	10.2494	.2600	.1739	1.2100	.214
22.915	-.2992	11.4156	.1850	.3779	1.6661	.115
25.260	-.4185	13.7572	.0824	.7426	3.8663	.021
27.605	-.5032	16.1046	.0251	.9164	11.4244	.002
29.950	-.5664	18.4518	.0059	1.0000	58.7653	.000
32.295	-.6153	20.7949	.0011	.9999	10.6850	.000

PROGRAM NORM2:

PER1=11.00 PER2= 9.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1OP2T	PET
6.500	7.3754	1.0746	.9838	.0123	.9877	.99
8.930	4.7839	1.5561	.9730	.0210	.9793	.99
11.360	2.8643	2.3290	.9520	.0365	.9647	.98
13.790	1.5977	3.4645	.8854	.0923	.9154	.967
15.005	1.1244	4.2365	.8393	.1234	.8901	.942
16.220	.7535	5.1326	.7737	.1628	.8599	.897
17.435	.4653	6.1421	.7039	.1776	.8491	.82
18.650	.2422	7.2449	.6231	.1539	.8665	.719
19.865	.0709	8.4038	.5231	.0999	.9096	.575
21.080	-.0617	9.5917	.4142	.0254	.9750	.424
22.295	-.1665	10.7984	.3173	.1251	1.1426	.277
23.510	-.2506	12.0093	.2265	.2993	1.4262	.15
25.940	-.3768	14.4421	.1021	.6562	2.9008	.03
28.370	-.4666	16.8714	.0308	.8571	6.8432	.004
30.800	-.5337	19.2999	.0108	.9722	27.0126	.000
33.230	-.5858	21.7286	.0027	1.0000	26.9860	.000

PROGRAM NORM2:

PER1=11.00 PER2=10.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1OP2T	PET
6.500	8.3060	1.0746	.9940	.0036	.9963	.9976
9.015	5.4066	1.5609	.9884	.0078	.9922	.99
11.530	3.1764	2.3944	.9618	.0312	.9697	.991
14.045	1.7599	3.6233	.9135	.0704	.9342	.977
15.303	1.2490	4.4465	.8776	.0938	.9141	.959
16.560	.8436	5.4088	.8251	.1229	.8905	.92
17.818	.5420	6.4851	.7561	.1451	.8732	.86
19.075	.3084	7.6429	.6542	.1776	.8491	.77
20.333	.1289	8.8585	.5407	.1847	[illegible]	[illegible]
21.590	-.0097	10.0930	.4301	.1347	.[illegible]11	.48
22.848	-.1189	11.3423	.3312	.0183	.9818	.37
24.105	-.2067	12.6050	.2486	.1711	1.2058	.27
26.620	-.3386	15.1137	.1183	.5461	2.1993	[illegible]
29.135	-.4329	17.6335	.0387	.7934	4.2794	[illegible]
31.650	-.5037	20.1494	.0062	.9344	10.2236	[illegible]
34.165	-.5587	22.6625	.0005	.9998	5.4477	.000

ER1=11.00 PER2=11.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.500	9.2366	1.0746	.9940	.0047	.9953	.998
9.100	5.8656	1.6022	.9834	.0145	.9856	.997
11.700	3.4984	2.4453	.9718	.0238	.9767	.994
14.300	1.9118	3.7777	.9302	.0589	.9443	.985
15.600	1.3590	4.6631	.8907	.0912	.9164	.971
16.900	.9334	5.6895	.8488	.1135	.8979	.945
18.200	.6110	6.8282	.7883	.1345	.8813	.894
19.500	.3665	8.0500	.6999	.1581	.8634	.810
20.800	.1806	9.3170	.5984	.1557	.8652	.691
22.100	.0373	10.6047	.4913	.1069	.9033	.543
23.400	-.0756	11.9000	.3862	.0193	.9809	.393
24.700	-.1666	13.1995	.2832	.1011	1.1120	.254
27.300	-.3038	15.8002	.1350	.4452	1.8000	.074
29.900	-.4022	18.3995	.0479	.7307	3.6849	.012
32.500	-.4762	20.9997	.0125	.8962	8.9432	.001
35.100	-.5339	23.6001	.0033	1.0000	32.6299	.000

PROGRAM NORM2:

PER1=11.00 PER2=12.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.500	10.1672	1.0746	1.0000	.0008	1.0007	.999
9.185	6.4425	1.6124	.9911	.0076	.9924	.998
11.870	3.7599	2.5211	.9758	.0215	.9789	.996
14.555	2.0503	3.9340	.9495	.0425	.9592	.989
15.898	1.4551	4.8879	.9240	.0604	.9429	.979
17.240	1.0089	5.9735	.8715	.0994	.9095	.958
18.583	.6706	7.1832	.8133	.1283	.8862	.917
19.925	.4181	8.4623	.7272	.1635	.8593	.840
21.268	.2273	9.7777	.6327	.1678	.8562	.738
22.610	.0802	11.1095	.5260	.1383	.8784	.595
23.953	-.0365	12.4546	.3997	.1217	.8913	.448
25.295	-.1301	13.7949	.2963	.0292	.9713	.305
27.980	-.2719	16.4822	.1367	.2794	1.3863	.09
30.665	-.3739	19.1658	.0503	.6084	2.5404	.01
33.350	-.4508	21.8503	.0109	.7897	4.5562	.00
36.035	-.5109	24.5332	.0033	1.0000	32.7726	.00

PROGRAM NORM2:

PER1=11.00 PER2=13.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PR
6.500	11.0978	1.0746	.9937	.0059	.9941	.99
9.270	6.8990	1.6458	.9963	.0029	.9970	.99
12.040	4.0150	2.5922	.9897	.0084	.9916	.99
14.810	2.1637	4.1092	.9696	.0243	.9762	.99
16.195	1.5412	5.1157	.9469	.0406	.9609	.98
17.580	1.0722	6.2736	.9153	.0583	.9448	.96
18.965	.7238	7.5416	.8544	.0937	.9142	.93
20.350	.4646	8.8762	.7705	.1330	.8825	.87
21.735	.2690	10.2443	.6676	.1630	.8597	.77
23.120	.1188	11.6192	.5604	.1563	.8647	.64
24.505	-.0003	13.0045	.4589	.0895	.9176	.50
25.890	-.0966	14.3898	.3425	.0277	.9728	.35
28.660	-.2424	17.1604	.1782	.2978	1.4230	.12
31.430	-.3477	19.9286	.0673	.5928	2.4470	.02
34.200	-.4273	22.6997	.0177	.7960	4.7704	.00
36.970	-.4896	25.4715	.0033	.9094	8.2737	.00

[illegible]	[illegible]	[illegible]	P1	[illegible]	[illegible]	[illegible]
[illegible]	1.[illegible]	1.[illegible]	1.0000	.[illegible]03	1.	.[illegible]
[illegible].355	7.4205	1.[illegible]26	.9982	.[illegible]13	.[illegible]	.99[illegible]
[illegible]	4.2419	2.67[illegible]	.9939	.0[illegible]45	.9[illegible]1	.99[illegible]7
[illegible]	2.734	4.2764	.[illegible]93	.[illegible]61	.9744	.9952
[illegible].493	1.5145	[illegible]	.[illegible]	.[illegible]	.9[illegible]	.[illegible]
7.[illegible]	1.1254	6.[illegible]778	.9171	.[illegible]43	.9[illegible]	.97[illegible]
[illegible].34[illegible]	.7711	7.[illegible]48	.[illegible]07	.0932	.9147	.947[illegible]
[illegible].77[illegible]	.5[illegible]	9.2979	.7936	.1[illegible]70	.8872	.894[illegible]
[illegible]	.3077	10.7[illegible]	.7[illegible]	.1666	.3736	.81[illegible]
3.630	[.1543]	12.128[illegible]	.6[illegible]	.1[illegible]	1.1723	.6[illegible]
[illegible]	.0328	13.5569	.5[illegible]66	.0734	.3314	.543[illegible]
[illegible].435	-.0658	14.9854	.3892	.0211	.7791	.3974
[illegible].342	-.2152	17.3395	.1996	.2288	1.2[illegible]	.153[illegible]
[illegible].125	-.3235	20.0945	.0869	.5667	2.3[illegible]13	.0375
2.[illegible]	-.4055	23.5476	.0237	.7722	4.3[illegible]	.0[illegible]54
7.915	-.4678	26.4048	.0055	.9093	9.1[illegible]77	.[illegible]

PROGRAM NORM2:

[illegible]=11.[illegible] PIR2=15.[illegible] SIGMA= 1.[illegible]

ASC	[illegible]	EI	P1	P1P2T	P1OP2T	P[illegible]
[illegible]	12.[illegible]	1.0746	1.[illegible]	.[illegible]	.9999	1.[illegible]
[illegible].440	7.378[illegible]	1.[illegible]	.9980	.0015	.[illegible]	.[illegible]
12.380	4.4528	2.7559	.9958	.0035	.9965	.999[illegible]
13.329	2.3676	4.4242	.9759	.0213	.9771	.99[illegible]
16.770	1.6803	5.5963	.9548	.0392	.9622	.992[illegible]
[illegible].269	1.1794	6.8326	.9324	.0529	.9496	.98[illegible]
19.736	.3138	8.2746	.8872	.0890	.9258	.95[illegible]
[illegible]	.5445	9.7119	.8246	.1074	.9029	.91[illegible]
[illegible].67	[.3428]	11.1709	.7465	.1205	[.3924]	.8[illegible]
[illegible]	.1367	12.6383	.6491	.1279	.3744	.72[illegible]
[illegible].510	.0631	14.1095	.5329	.1017	.[illegible]76	.5[illegible]
27.[illegible]	-.0373	15.5786	.42[illegible]	.0573	.[illegible]52	.44[illegible]
36.[illegible]	-.1879	18.5173	.2791	.1965	1.2438	.1[illegible]
3[illegible].960	-.3911	21.4614	.0887	.4538	.4447	.04[illegible]
35.900	-.3852	24.3995	.0304	.7437	3.3523	.[illegible]
38.840	-.4514	27.3421	.0077	.9097	7.6846	.[illegible]

PROGRAM NORM2:

[illegible]=11.[illegible] PIR2=16.00 SIGMA= 1.00

ASC	[illegible]	[illegible]	P1	P1P2T	P1OP2T	P[illegible]
[illegible]	13.8896	1.0740	1.[illegible]	.0000	.9997	1.[illegible]
[illegible].525	[illegible].3518	1.7109	.9966	.0034	.9965	1.[illegible]
[illegible].550	4.6072	2.9283	.9944	.0052	.9943	1.[illegible]
15.575	2.4430	4.5471	.9826	.0154	.9840	.[illegible]
17.088	1.7374	5.8449	.9738	.0211	.9792	.[illegible]
[illegible]	1.2231	7.1973	.9439	.0447	.9572	.[illegible]
[illegible].31	.3506	8.6414	.9063	.0665	.9375	.[illegible]
[illegible]	.5773	10.1312	.8466	.0935	.9144	.[illegible]
[illegible].13[illegible]	.3753	11.6342	.75[illegible]	.1346	.8713	.[illegible]
[illegible]	[.2168]	13.1494	.6550	.1620	[.8[illegible]5]	.[illegible]
[illegible].20	.[illegible]	14.[illegible]1	.5474	.1496	.[illegible]	.[illegible]
27.675	-.[illegible]	16.1759	.4359	.1231	.8[illegible]	.[illegible]
[illegible].70	-.1[illegible]	19.1995	.2391	.0623	1.[illegible]	.[illegible]
33.725	-.[illegible]	22.2276	.[illegible]27	.3535	1.5442	.[illegible]
36.75[illegible]	-.[illegible]	25.[illegible]	.[illegible]31	.6[illegible]	2.75[illegible]	.[illegible]
3[illegible].775	-.4341	28.2[illegible]	.[illegible]	.7796	[illegible].[illegible]59	.[illegible]

R1=11.00 PER2=17.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.500	14.8202	1.0746	1.0000	.0000	.9999	1.0000
9.610	8.8997	1.7172	.9983	.0017	.9982	1.0000
12.720	4.8398	2.9111	.9976	.0021	.9978	.9997
15.830	2.5151	4.8363	.9916	.0068	.9931	.9984
17.385	1.7856	6.1028	.9807	.0155	.9846	.9959
18.940	1.2609	7.5192	.9598	.0305	.9703	.9890
20.495	.8853	9.0170	.9256	.0515	.9509	.9732
22.050	.6110	10.5524	.8735	.0768	.9286	.9406
23.605	.4044	12.1046	.7956	.1074	.9029	.8810
25.160	.2447	13.6575	.6964	.1358	.8803	.7910
26.715	.1172	15.2162	.5745	.1599	.8620	.6664
28.270	.0139	16.7673	.4609	.1279	.8864	.5199
31.380	-.1449	19.8810	.2488	.0147	1.0145	.2451
34.490	-.2606	22.9901	.1064	.3090	1.4453	.0735
37.600	-.3487	26.0997	.0388	.6416	2.7701	.0139
40.710	-.4180	29.2102	.0072	.7917	4.5014	.0015

PROGRAM NORM2:

R1=11.00 PER2=18.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.500	15.7508	1.0746	1.0000	.0000	.9999	1.0000
9.695	9.2274	1.7600	1.0000	.0000	.9999	1.0000
12.890	5.0093	2.9954	.9968	.0032	.9967	1.0000
16.085	2.5813	5.0261	.9869	.0122	.9879	.9989
17.683	1.8288	6.3632	.9784	.0189	.9814	.9969
19.280	1.2963	7.8386	.9593	.0336	.9674	.9916
20.878	.9156	9.3964	.9300	.0519	.9505	.9783
22.475	.6394	10.9797	.8868	.0718	.9329	.9505
24.073	.4318	12.5717	.8196	.0956	.9126	.8980
25.670	.2702	14.1709	.7342	.1113	.8997	.8159
27.268	.1417	15.7666	.6321	.1051	.9048	.6985
28.865	.0365	17.3661	.5089	.0920	.9156	.5557
32.060	-.1244	20.5575	.2786	.0154	1.0152	.2743
35.255	-.2422	23.7525	.1127	.2144	1.2715	.0885
38.450	-.3321	26.9498	.0372	.5186	2.0656	.0179
41.645	-.4029	30.1440	.0144	.8545	6.5584	.0021

PROGRAM NORM2:

R1=11.00 PER2=19.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.500	16.6814	1.0746	1.0000	.0000	.9999	1.0000
9.780	9.7183	1.7727	1.0000	.0000	.9999	1.0000
13.060	5.2037	3.0627	.9985	.0015	.9984	1.0000
16.340	2.6364	5.2250	.9906	.0086	.9913	.9992
17.980	1.8648	6.6323	.9831	.0149	.9852	.9977
19.620	1.3269	8.1653	.9655	.0289	.9718	.9934
21.260	.9451	9.7683	.9378	.0478	.9543	.9826
22.900	.6667	11.3995	.8935	.0734	.9315	.9591
24.540	.4572	13.0387	.8286	.1020	.9074	.9131
26.180	.2944	14.6784	.7482	.1212	.8918	.8389
27.820	.1641	16.3212	.6450	.1303	.8846	.7291
29.460	.0579	17.9607	.5280	.1193	.8933	.5910
32.740	-.1056	21.2425	.3128	.0250	1.0253	.3050
36.020	-.2250	24.5173	.1331	.2202	1.2812	.1038
39.300	-.3166	27.8002	.0433	.4868	1.9400	.0222
42.580	-.3887	31.0809	.0133	.7897	4.5901	.0028

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.500	17.6120	1.0746	1.0000	.0000	.9999	1.0000
9.865	10.0529	1.8095	1.0000	.0000	.9999	1.0000
13.230	5.3371	3.1560	.9978	.0022	.9977	1.0000
16.595	2.6786	5.4368	.9936	.0058	.9941	.9994
18.278	1.8987	6.8996	.9882	.0102	.9898	.9982
19.960	1.3539	8.4964	.9771	.0182	.9821	.9949
21.643	.9704	10.1503	.9528	.0350	.9661	.9861
23.325	.6915	11.8238	.9122	.0585	.9446	.9656
25.008	.4809	13.5053	.8578	.0801	.9257	.9265
26.690	.3167	15.1896	.7850	.0926	.9151	.8577
28.373	.1854	16.8717	.6839	.1038	.9058	.7549
30.055	.0780	18.5526	.5600	.1170	.8951	.6255
33.420	-.0875	21.9188	.3267	.0322	.9685	.3372
36.785	-.2090	25.2853	.1517	.2154	1.2734	.1190
40.150	-.3019	28.6478	.0567	.5271	2.1066	.0268
43.515	-.3753	32.0140	.0122	.6973	3.2164	.0037

PROGRAM NORM2:

R1=12.00 PER2= 1.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.200	-.1066	1.1193	.4140	.1020	.9073	.4562
9.035	-.3123	1.4542	.3317	.0161	1.0160	.3264
10.870	-.4778	1.9151	.2850	.3634	1.5701	.1814
12.705	-.6113	2.5726	.2100	.7229	3.6022	.0582
13.623	-.6644	2.9799	.1809	.8651	7.3850	.0244
14.540	-.7086	3.4316	.1526	.9509	20.0823	.0075
15.458	-.7486	3.9779	.1217	.9877	76.0417	.0015
16.375	-.7815	4.5768	.0853	1.0000	851.9826	.0000
17.293	-.8099	5.2613	.0606	1.0000	605.4556	.0000
18.210	-.8333	6.0000	.0430	1.0000	429.7302	.0000
19.128	-.8530	6.8010	.0285	1.0000	284.4810	.0000
20.045	-.8691	7.6394	.0183	1.0000	182.7445	.0000
21.880	-.8937	9.4062	.0056	1.0000	55.7587	.0000
23.715	-.9109	11.2207	.0009	.9999	9.2762	.0000
25.550	-.9234	13.0517	.0000	1.1550	.0005	.0000
27.385	-.9328	14.8835	.0000	1.1550	.0005	.0000

PROGRAM NORM2:

R1=12.00 PER2= 2.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.200	.7868	1.1193	.5562	.3168	.7593	.7324
9.120	.3477	1.4840	.5318	.2047	.8300	.6406
11.040	.0177	1.9652	.4825	.0528	.9497	.5080
12.960	-.2548	2.6837	.3836	.1773	1.2152	.3156
13.920	-.3578	3.1143	.3374	.3548	1.5491	.2177
14.880	-.4481	3.6239	.2810	.5477	2.2092	.1271
15.840	-.5264	4.2228	.2178	.7328	3.7355	.0582
16.800	-.5908	4.8878	.1608	.8712	7.7293	.0207
17.760	-.6448	5.6301	.1194	.9565	22.5317	.0052
18.720	-.6896	6.4433	.0899	.9911	99.9240	.0008
19.680	-.7262	7.3043	.0542	1.0000	541.8315	.0000
20.640	-.7562	8.2045	.0336	1.0000	335.8798	.0000
22.560	-.8015	10.0747	.0096	1.0000	95.4616	.0000
24.480	-.8330	11.9782	.0010	.9999	9.5420	.0000
26.400	-.8561	13.8999	.0000	1.0950	.0005	.0000
28.320	-.8736	15.8188	.0000	1.0950	.0005	.0000

[illegible]=12. PIR2= [illegible] SIGMA= 1.0

OBSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.2?0	4.3003	1.1193	.9?40	.0368	.9644	.976
9.460	2.3622	1.5535	.9234	.0449	.9569	.964
11.720	1.7223	2.2046	.8692	.0794	.9263	.938
13.930	.9998	3.1417	.8062	.0879	.9191	.877
15.110	.5938	3.7645	.7358	.1202	.8926	.818
16.240	.3382	4.4838	.6?14	.1193	.8933	.729
17.370	.1236	5.3163	.5516	.1014	.9073	.606
18.500	-.0400	6.2499	.4494	.0241	.9762	.469
19.630	-.1731	7.2560	.3587	.1497	1.1756	.365
20.760	-.2788	8.3195	.2696	.3560	1.5527	.173
21.8?0	-.3627	9.4147	.1867	.5839	2.2?02	.082
23.020	-.4300	10.5258	.1315	.7497	3.9835	.032
25.2?0	-.5365	12.7794	.0453	.9360	15.1047	.002
27.540	-.6019	15.0389	.0125	1.0000	124.8756	.000
29.8?0	-.6532	17.3006	.0042	1.0000	41.6256	.000
32.0?0	-.6932	19.5564	.0005	.9998	5.2637	.000

PROGRAM NORM2:

PIR1=12.000 PIR2= 7.00 SIGMA= 1.00

OBSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.290	5.2537	1.1193	.9801	.0068	.9931	.98?
9.545	3.4673	1.5669	.9557	.0252	.9753	.97?
11.890	2.1021	2.2566	.9101	.0585	.9447	.963
14.2?0	1.1387	3.2730	.8337	.1026	.9169	.91?
15.4?5	.7770	3.9393	.7743	.1299	.8847	.874
16.5?0	.4814	4.7253	.6989	.1430	.8710	.?7
17.7?5	.2452	5.6217	.6122	.1409	.8764	.693
18.??0	.0570	6.6228	.5100	.0895	.9177	.55?
[illegible]	-.0896	7.6388	.4097	.0299	1.0306	.397
21.270	-.2053	8.8099	.3058	.1879	1.2309	.24?
22.443	-.2970	9.9573	.2152	.3765	1.6027	.134
23.615	-.3706	11.1213	.1480	.5906	2.4337	.06?
25.960	-.4800	13.4603	.0590	.8763	7.9745	.007
28.305	-.5571	15.8040	.0197	.9746	32.7841	.00?
30.650	-.6143	18.1510	.0058	1.0000	58.4216	.00?
32.995	-.6565	20.4951	.0021	1.0000	21.2446	.00?

PROGRAM NORM2:

PIR1=12.00 PIR2= 8.00 SIGMA= 1.00

OBSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.280	6.1471	1.1193	.9763	.0166	.9836	.97?
9.630	4.0365	1.5884	.9734	.0151	.9850	.96?
12.060	2.4335	2.3306	.9191	.0633	.9404	.97?
14.490	1.3394	3.4197	.8540	.1081	.9024	.94?
15.705	.9332	4.1382	.8016	.1391	.8773	.91?
16.920	.6085	4.9734	.7281	.1780	.8488	.85?
18.135	.3472	5.9384	.6433	.1879	.8417	.76?
19.350	.1431	6.9985	.5480	.1621	.8604	.63?
20.565	-.0162	8.1320	.4410	.0976	.9199	.4?
21.780	-.1404	9.3066	.3448	.0637	1.0677	.32?
22.995	-.2384	10.5046	.2532	.2520	1.3362	.1?
24.210	-.3168	11.7092	.1835	.4818	2.2277	.09?
26.640	-.4343	14.1414	.0728	.7939	4.8190	.01?
29.070	-.5172	16.5695	.0251	.9453	17.9623	.00?
[illegible]	-.5789	19.[illegible]	.0020	1.0000	[illegible]	[illegible]
33.930	-.6267	21.4162	.0011	1.0000	[illegible]	[illegible]

ER1=12.00 PER2= 3.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.200	1.6802	1.1193	.7703	.1164	.8957	.859
9.205	1.0136	1.4899	.7347	.0994	.9094	.807
11.210	.4872	2.0172	.6100	.1677	.8563	.712
13.215	.0785	2.7816	.4927	.1118	.8992	.547
14.218	-.0795	3.2590	.4408	.0078	.9920	.444
15.220	-.2175	3.8340	.3667	.1394	1.1616	.315
16.223	-.3302	4.4789	.3111	.3645	1.5729	.197
17.225	-.4241	5.2094	.2301	.5567	2.2538	.102
18.228	-.5014	6.0174	.1606	.7454	3.9176	.040
19.230	-.5647	6.8924	.1202	.8960	9.5416	.012
20.233	-.6161	7.8150	.0829	.9662	28.5904	.002
21.235	-.6581	8.7742	.0512	.9922	102.4097	.000
23.240	-.7208	10.7463	.0180	1.0000	179.9106	.000
25.245	-.7646	12.7439	.0055	1.0000	54.9456	.000
27.250	-.7966	14.7494	.0010	.9999	9.9905	.000
29.255	-.8209	16.7544	.0000	1.0000	.0005	.000

PROGRAM NORM2:

ER1=12.00 PER2= 4.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.200	2.5736	1.1193	.8497	.0887	.9184	.9251
9.290	1.6284	1.5218	.7635	.1667	.8571	.8907
11.380	.9302	2.0724	.6926	.2006	.8328	.831
13.470	.3805	2.8974	.5855	.2105	.8260	.708
14.515	.1689	3.4221	.5449	.1200	.8927	.610
15.560	-.0105	4.0423	.4800	.0250	.9754	.4920
16.605	-.1577	4.7487	.3917	.0918	1.1008	.3557
17.650	-.2781	5.5411	.3228	.3166	1.4626	.2206
18.695	-.3768	6.4180	.2408	.5219	2.0899	.1151
19.740	-.4564	7.3583	.1635	.7094	3.4341	.0475
20.785	-.5205	8.3423	.1106	.8644	7.3251	.0150
21.830	-.5724	9.3556	.0766	.9504	19.6350	.0038
23.920	-.6499	11.4249	.0270	1.0000	269.4613	.0000
26.010	-.7039	13.5089	.0080	1.0000	79.8407	.0000
28.100	-.7436	15.5998	.0010	.9999	9.9805	.0000
30.190	-.7739	17.6896	.0000	1.0020	.0005	.0000

PROGRAM NORM2:

ER1=12.00 PER2= 5.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.200	3.4670	1.1193	.8944	.0713	.9333	.958
9.375	2.2698	1.5291	.8186	.1475	.8713	.939
11.550	1.3496	2.1280	.7867	.1436	.8743	.8997
13.725	.6509	3.0286	.6880	.1782	.8487	.810
14.813	.3952	3.5838	.6237	.1796	.8476	.7357
15.900	.1742	4.2581	.5414	.1623	.8602	.629
16.988	-.0067	5.0337	.4600	.0783	.9272	.4960
18.075	-.1509	5.8883	.3768	.0756	1.0815	.348
19.163	-.2681	6.8313	.2861	.2695	1.3682	.2090
20.250	-.3616	7.8322	.2015	.4847	1.9389	.103
21.338	-.4367	8.8761	.1395	.7003	3.3285	.041
22.425	-.4970	9.9410	.0891	.8440	6.3664	.013
24.600	-.5868	12.1001	.0350	.9771	38.8861	.000
26.775	-.6498	14.2759	.0082	1.0000	82.2651	.000
28.950	-.6961	16.4516	.0021	1.0000	20.5667	.000
31.125	-.7316	18.6255	.0005	.9998	5.1421	.000

PROGRAM NORM2:

PER1=12.00 PER2= 9.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.200	7.0405	1.1193	.9875	.0082	.9918	.995
9.715	4.5989	1.6074	.9713	.0225	.9779	.993
12.230	2.7597	2.3938	.9554	.0322	.9687	.986
14.745	1.5368	3.5478	.9011	.0708	.9338	.964
16.003	1.0819	4.3229	.8517	.1029	.9066	.939
17.260	.7187	5.2366	.7761	.1524	.8677	.894
18.518	.4370	6.2630	.6956	.1769	.8496	.818
19.775	.2178	7.3901	.5914	.1869	.8424	.701
21.033	.0491	8.5784	.4916	.1303	.8845	.555
22.290	-.0822	9.8058	.3846	.0332	.9676	.397
23.548	-.1857	11.0524	.2775	.1053	1.1172	.248
24.805	-.2686	12.3055	.1965	.3093	1.4467	.135
27.320	-.3927	14.8188	.0827	.6758	3.0730	.026
29.835	-.4808	17.3354	.0247	.8866	8.5143	.002
32.350	-.5466	19.8490	.0086	1.0000	85.7977	.000
34.865	-.5976	22.3646	.0016	.9999	16.0875	.000

PROGRAM NORM2:

PER1=12.00 PER2=10.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.200	7.9339	1.1193	.9873	.0102	.9898	.997
9.800	5.1365	1.6296	.9726	.0239	.9765	.995
12.400	3.0752	2.4538	.9520	.0413	.9602	.991
15.000	1.7044	3.6977	.9090	.0744	.9306	.976
16.300	1.2105	4.5238	.8688	.1028	.9066	.958
17.600	.8171	5.5032	.8067	.1432	.8747	.922
18.900	.5158	6.5970	.7389	.1608	.8614	.857
20.200	.2844	7.7855	.6501	.1661	.8575	.758
21.500	.1071	9.0328	.5520	.1194	.8932	.617
22.800	-.0302	10.3111	.4475	.0372	.9640	.464
24.100	-.1379	11.5998	.3496	.1177	1.1330	.308
25.400	-.2248	12.8999	.2507	.2764	1.3812	.181
28.000	-.3548	15.4997	.1001	.5822	2.3879	.041
30.600	-.4475	18.1001	.0299	.8261	5.6429	.005
33.200	-.5169	20.6994	.0049	.9183	9.7880	.000
35.800	-.5708	23.3006	.0005	.9998	5.4328	.000

PROGRAM NORM2:

PER1=12.00 PER2=11.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.200	8.8273	1.1193	1.0000	.0015	1.0014	.998
9.885	5.5883	1.6696	.9816	.0162	.9840	.997
12.570	3.3702	2.5170	.9738	.0213	.9790	.994
15.255	1.8531	3.8554	.9363	.0511	.9512	.984
16.598	1.3202	4.7409	.8975	.0806	.9253	.969
17.940	.9028	5.7808	.8549	.1017	.9076	.941
19.283	.5851	6.9395	.7889	.1266	.8875	.888
20.625	.3429	8.1910	.6981	.1452	.8731	.799
21.968	.1588	9.4923	.5961	.1301	.8848	.673
23.310	.0170	10.8162	.4836	.0750	.9301	.519
24.653	-.0948	12.1519	.3735	.0177	1.0177	.366
25.995	-.1849	13.4951	.2688	.1570	1.1858	.226
28.680	-.3202	16.1812	.1150	.4837	1.9336	.059
31.365	-.4169	18.8652	.0376	.7634	4.1803	.008
34.050	-.4895	21.5481	.0147	.9525	18.4025	.000

PROGRAM NORM2:

12.00 PER2=12.00 SIGMA= 1.00

SC	EII	EI	P1	P1P2T	P1DP2T	PRT
200	9.7207	1.1193	1.0000	.0008	1.0007	.9992
970	6.1898	1.6690	.9982	.0004	.9995	.9986
740	3.6396	2.5864	.9854	.0113	.9887	.9966
510	1.9996	4.0005	.9567	.0341	.9670	.9893
895	1.4215	4.9557	.9278	.0550	.9478	.9788
280	.9804	6.0594	.8756	.0923	.9154	.9564
665	.6465	7.2881	.8089	.1288	.8858	.9131
050	.3963	8.5942	.7180	.1651	.8582	.8365
435	.2061	9.9493	.6142	.1761	.8502	.7224
820	.0596	11.3248	.4995	.1519	.8680	.5753
205	-.0554	12.7043	.3864	.0887	.9183	.4207
590	-.1484	14.0913	.2923	.0615	1.0652	.2743
360	-.2882	16.8586	.1357	.4048	1.6779	.0808
130	-.3887	19.6305	.0405	.6568	2.8931	.0139
900	-.4643	22.4002	.0109	.8812	7.8193	.0013
670	-.5233	25.1713	.0038	1.0000	38.2764	.0000

PROGRAM NORM2:

12.00 PER2=13.00 SIGMA= 1.00

SC	EII	EI	P1	P1P2T	P1DP2T	PRT
200	10.6141	1.1193	1.0000	.0005	1.0004	.9995
055	6.6297	1.7039	.9927	.0064	.9935	.9991
910	3.8961	2.6552	.9831	.0151	.9851	.9979
765	2.1159	4.1721	.9532	.0414	.9602	.9927
193	1.5073	5.1848	.9365	.0514	.9510	.9846
620	1.0462	6.3531	.8928	.0832	.9231	.9671
048	.7014	7.6408	.8322	.1182	.8942	.9306
475	.4432	9.0075	.7409	.1666	.8571	.8643
903	.2484	10.4135	.6382	.1925	.8384	.7611
330	.0990	11.8287	.5327	.1741	.8516	.6255
758	-.0193	13.2563	.4276	.1040	.9056	.4721
185	-.1147	14.6848	.3121	.0344	.9664	.3228
040	-.2588	17.5394	.1535	.3123	1.4527	.1056
895	-.3626	20.3954	.0567	.6437	2.7925	.0202
750	-.4409	23.2506	.0149	.8452	6.1915	.0023
605	-.5020	26.1042	.0028	1.0000	27.4909	.0000

PROGRAM NORM2:

12.00 PER2=14.00 SIGMA= 1.00

SC	EII	EI	P1	P1P2T	P1DP2T	PRT
200	11.5075	1.1193	1.0000	.0003	1.0002	.9997
140	7.1623	1.7152	1.0000	.0005	1.0004	.9995
080	4.1453	2.7209	.9903	.0085	.9915	.9987
020	2.2338	4.3293	.9766	.0189	.9813	.9951
490	1.5850	5.4158	.9523	.0385	.9628	.9890
960	1.1040	6.6539	.9203	.0595	.9438	.9750
430	.7493	8.0030	.8650	.0927	.9151	.9452
900	.4855	9.4242	.7996	.1116	.8995	.8888
370	.2873	10.8754	.7014	.1358	.8803	.7967
840	.1345	12.3401	.5767	.1618	.8606	.6700
310	.0138	13.8091	.4614	.1269	.8872	.5199
780	-.0838	15.2807	.3499	.0486	.9534	.3669
720	-.2316	18.2206	.1738	.2441	1.3220	.1314
660	-.3384	21.1604	.0657	.5721	2.3288	.0281
600	-.4191	24.1001	.0188	.8081	5.0713	.0036
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PROGRAM NORM2:

1=12.00 PER2=15.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.200	12.4009	1.1193	1.0000	.0000	.9999	1.0000
0.225	7.5803	1.7482	1.0000	.0003	1.0002	.9997
3.250	4.3631	2.7969	.9932	.0061	.9939	.9992
5.275	2.3273	4.5081	.9721	.0251	.9754	.9965
7.788	1.6550	5.6498	.9536	.0402	.9612	.9920
9.300	1.1567	6.9551	.9259	.0593	.9439	.9808
0.813	.7926	8.3676	.8789	.0882	.9189	.9564
2.325	.5245	9.8395	.8177	.1106	.9003	.9082
3.838	.3225	11.3425	.7333	.1270	.8872	.8264
5.350	.1674	12.8490	.6348	.1167	.8954	.7088
6.863	.0443	14.3638	.5000	.1272	.8870	.5636
8.375	-.0551	15.8740	.3794	.0882	.9187	.4129
1.400	-.2063	18.8999	.1986	.2008	1.2504	.1587
4.425	-.3159	21.9263	.0747	.4978	1.9859	.0375
7.450	-.3988	24.9483	.0199	.7388	3.7569	.0052
0.475	-.4638	27.9737	.0055	.9277	11.0621	.0004

PROGRAM NORM2:

1=12.00 PER2=16.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
7.200	13.2942	1.1193	1.0000	.0000	.9999	1.0000
.310	8.1017	1.7579	.9983	.0017	.9982	1.0000
3.420	4.5366	2.8898	.9950	.0045	.9954	.9995
.530	2.4063	4.6944	.9833	.0145	.9856	.9976
8.085	1.7132	5.8972	.9625	.0329	.9681	.9941
9.640	1.2018	7.2669	.9389	.0496	.9527	.9854
1.195	.8316	8.7356	.8844	.0910	.9165	.9649
2.750	.5591	10.2622	.8292	.1139	.8977	.9236
4.305	.3555	11.8040	.7450	.1420	.8756	.8508
5.860	.1976	13.3598	.6495	.1476	.8712	.7454
7.415	.0729	14.9133	.5332	.1372	.8792	.6064
8.970	-.0287	16.4736	.4236	.0770	.9283	.4562
2.080	-.1828	19.5785	.2270	.1776	1.2153	.1867
5.190	-.2948	22.6896	.0836	.4319	1.7565	.0475
8.300	-.3798	25.7985	.0310	.7646	4.1902	.0073
.410	-.4465	28.9087	.0078	.9226	11.0743	.0006

PROGRAM NORM2:

=12.00 PER2=17.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
.200	14.1876	1.1193	1.0000	.0000	.9999	1.0000
.395	8.5139	1.7869	1.0000	.0000	.9999	1.0000
.590	4.7253	2.9693	.9983	.0014	.9985	.9997
.785	2.4883	4.8735	.9921	.0064	.9936	.9984
.383	1.7652	6.1479	.9799	.0162	.9840	.9957
.980	1.2421	7.5820	.9555	.0347	.9663	.9887
.578	.8663	9.1087	.9283	.0469	.9551	.9719
.175	.5916	10.6811	.8758	.0698	.9346	.9370
.773	.3851	12.2739	.8060	.0830	.9232	.8729
.370	.2257	13.8695	.6946	.1135	.8980	.7734
.968	.0990	15.4692	.5881	.0955	.9127	.6443
.565	-.0038	17.0654	.4673	.0614	.9419	.4960
.760	-.1609	20.2607	.2578	.1667	1.1994	.2148
.055	-.2753	23.4668	.1020	[illegible]	[illegible]	[illegible]

PR[illegible] NORM2:

=12.0[illegible] PER2=18.00 SIGMA= 1.00

[illegible]SC	EII	EI	P1	P1P2T	P1DP2T	PRT
[illegible]	15.[illegible]	1.1193	1.0000	.0000	.9999	1.0000
[illegible]	[illegible]	1.8130	1.0000	.0000	.9999	1.0000
.740	4.9[illegible]	3.0247	.9984	.0016	.9983	1.0000
[illegible]	2.[illegible]	5.0432	.9911	.0079	.9921	.9989
[illegible]	1.[illegible]222	6.3780	.9778	.0194	.9809	.9968
[illegible]	1.2762	7.8597	.9564	.0369	.9644	.9910
[illegible]	.[illegible]	9.4399	.9233	.0590	.9442	.9778
[illegible]	[illegible]	11.0565	.8646	.0969	.9115	.9484
[illegible]	.4196	12.6848	.7970	.1222	.8910	.8944
[illegible]	[illegible]	14.3211	.7127	.1296	.8851	.8051
[illegible]	[illegible]	15.9568	.6095	.1228	.8905	.6844
[illegible]	[illegible]	17.5873	[illegible]	.0665	.9375	.5359
.360	-.137[illegible]	20.8586	.2773	.0935	1.1026	.2514
[illegible]	-.2543	24.1305	.1170	.3600	1.5604	.0749
[illegible]	-.3431	27.4002	.0344	.6045	2.5100	.0136
[illegible]	[illegible]	30.6694	.0044	.6845	2.9583	.0014

PR[illegible] NORM2:

=12.[illegible] PER2=19.00 SIGMA= 1.00

[illegible]SC	[illegible]II	EI	P1	P1P2T	P1DP2T	PRT
.200	15.7744	1.1193	1.0000	.0000	.9999	1.0000
.505	9.3533	1.8299	1.0000	.0000	.9999	1.0000
.730	[illegible]	3.1249	.9964	.0016	.9983	1.0000
.295	[illegible]	5.2638	.9923	.0070	.9930	.9992
.976	[illegible]	6.6683	.9835	.0143	.9853	.9976
.660	1.3104	8.2236	.9653	.0289	.9718	.9932
.543	.9271	9.8592	.9422	.0419	.9597	.9817
.075	.6405	11.5255	.9013	.0611	.9423	.9564
.790	.4305	13.2085	.8361	.0843	.9221	.9066
.390	.2762	14.8884	.7519	.0990	.9098	.8264
.073	.1466	16.5703	.6462	.0969	.9115	.7085
.755	.0407	18.2561	.5415	.0480	.9541	.5675
.120	-.1211	21.6178	.3018	.0910	1.0998	.2745
.455	-.2396	24.9869	.1246	.3153	1.4588	.0653
.350	-.3298	28.3567	.0377	.5697	2.3100	.0162
.215	-.4009	31.7146	.0094	.8088	4.9543	.0018

[illegible] NORM2:

=12.00 PER2=20.00 SIGMA= 1.00

[illegible]SC	[illegible]I	EI	P1	P1P2T	P1DP2T	PRT
[illegible]	[illegible].8678	1.1193	1.0000	.0000	.9999	1.0000
.650	9.3075	1.8506	1.0000	.0000	.9999	1.0000
[illegible]	[illegible].4364	3.2070	1.0000	.0000	.9999	1.0000
[illegible]	[illegible].6019	5.4617	.9971	.0023	.9976	.9994
.275	[illegible].8897	6.9308	.9969	.0073	.9920	.9982
[illegible]	[illegible].3395	8.5489	.9766	.0186	.9816	.9948
.725	[illegible]	10.2374	.9494	.0379	.9634	.9854
[illegible]	[illegible]	11.9483	.9061	.0646	.9399	.9641
[illegible]	[illegible]	13.6741	.8361	.1012	[illegible]	.9207
[illegible]	.2987	15.4002	.7578	.1166	[illegible]	[illegible]
[illegible]	.1678	17.1260	.6572	.1243	.8893	.7369
.350	.0611	18.8490	.5483	.0919	.9137	.5937
.800	-.1032	22.3006	.3122	.0231	1.0233	.3050
.250	-.2233	25.7494	.1350	.2570	1.3446	.1063
.700	-.3151	29.2015	.0489	.5868	2.4083	.0202
.150	-.3574	32.[illegible]	.0139	.8272	5.5556	.0024

APPENDIX 2

Result of Linear Regression

	$\frac{PER1}{PER2}$	$\frac{PER1}{\sigma^2}$	1
$PIDCR_1$	0.00107	-0.0025	0.8425
$EIICR_1$	0.00581	-0.0017	0.2949

5 Iterations in our Regression

PIDCR	$\frac{PER1}{PER2}$	$\frac{PER2}{PER1}$	$\frac{PER1}{\sigma^2}$	$\frac{PER2}{\sigma^2}$	1
1st It.	0.00115	-0.00014	-0.0009	0.00055	0.8397
2nd It.	0.00145	0.00021	-0.0037	-0.00038	0.8402
3rd It.	0.00114	0.00108	-0.0013	0.00023	0.8387
4th It.	0.0012	-0.00034	-0.0016	0.00107	0.8329
5th It.	0.00099	-0.00030	-0.0021	0.00076	0.85167

$EIICR_1$	$\frac{PER1}{PER2}$	$\frac{PER2}{PER1}$	$\frac{PER1}{\sigma^2}$	$\frac{PER2}{\sigma^2}$	1
Ist It.	0.01982	0.04148	0.00102	0.00113	0.2885
2nd It.	0.01967	0.04218	0.00276	0.00092	0.2854
3rd It.	0.02082	0.03960	0.00254	-0.00087	0.3115
4th It.	0.02628	0.03911	-0.00103	0.00327	0.299
5th It.	0.0221	0.04073	-0.00045	-0.00135	0.3148

APPENDIX III

Computer Program

```
     $PRT(16),Z(350),II(16),I1(16),BSC(16),AERV(16),P1EST(16)
      K=1
      DO 33 IJ=1,35
      READ(8,1)(NZ(JJ),JJ=K,K+9)
      K=K+10
    1 FORMAT(10I4)
   33 CONTINUE
  999 READ(9,*,END=9999)PER1,PER2,SC,SIGMA,SAYSC
      IF(PER1.EQ.99.)GO TO 9999
      SC=SC-SAYSC
      WRITE(6,66)
   66 FORMAT(//,12X,"PROGRAM  NORM1:")
      TSC=SC
      DO 67 IC=1,16
      IF(IC.EQ.5)SAYSC=SAYSC/2.0
      IF(IC.EQ.13)SAYSC=2.0*SAYSC
      II(IC)=0
      I1(IC)=0
      TSC=TSC+SAYSC
      BSC(IC)=TSC
      ASSC=BSC(IC)
      APER1=PER1
      CALL BULERV(NZ,ASSC,PER1,SIGMA,ERV)
      PER1=APER1
   67 AERV(IC)=ERV
      WRITE(6,103)PER1,PER2,SIGMA
  103 FORMAT(2X,"PER1=",F5.2,5X,"PER2=",F5.2,5X,"SIGMA=",F7.4)
      DO 40 L=1,16
      ERV=AERV(L)
      SC=BSC(L)
      CALL BULPR2(NZ,SC,ERV,PER2,SIGMA,PR2)
      PRT(L)=PR2
   40 CONTINUE
   68 CALL RANNOR(A,B)
      A1=(A*SIGMA*SQRT(PER1)+PER1)
      A2=(B*SIGMA*SQRT(PER2)+PER2)
      IF(A1.LT.0.0)A1=0.0
      IF(A2.LT.0.0)A2=0.0
      CALL BULII(BSC,A1,IND1)
      IF(IND1.EQ.16)GO TO 68
      IIND=IND1+1
      DO 69 IL=IND1+1,16
      II(IL)=II(IL)+1
   69 CONTINUE
      A2=A2+A1
      CALL BULII(BSC,A2,IND1)
      DO 70 IM=IIND,IND1
      I1(IM)=I1(IM)+1
   70 CONTINUE
      IF(II(7).LT.3800)GO TO 68
C     WRITE(6,101)
C 101 FORMAT(6X,"BSC",6X,"EII",9X,"EI",10X,"P1",7X,"P1EST",5X,
C    $"P1DP2T",8X,"PRT",4X,"P1DEST")
      WRITE(6,101)
  101 FORMAT(6X,"BSC",9X,"EI",10X,"P1",6X,"P1EST",9X,"PRT")
      DO 71 ID=1,16
      EI=BSC(ID)-AERV(ID)
      EII=(PER2-EI)/EI
      CALL PREST(PER1,PER2,SIGMA,EII,PPEST,XZ)
      P1DEST(ID)=PPEST
      PI1=I1(ID)
      PII=II(ID)
      PII=PII+0.0001
```

```
      P1EST(ID)=PRT(ID)*P1DEST(ID)
      P1DP2T(ID)=P1(ID)/(PRT(ID)+0.0001)
      P1P2T(ID)=(P1(ID)-PRT(ID))/P1(ID)
      DEN1=XZ*(P1DP2T(ID)-P1DEST(ID))
C     WRITE(6,906)DEN1
C 906 FORMAT(5X,"DEN=",F15.8)
      IF(P1P2T(ID).LT.0)P1P2T(ID)=-P1P2T(ID)
C     WRITE(6,100)BSC(ID),EII,EI,P1(ID),P1EST(ID),P1DP2T(ID),
C    $PRT(ID),P1DEST(ID)
C 100 FORMAT(3X,F7.3,1X,2(F10.4,1X),5(F10.4,1X))
      WRITE(6,100)BSC(ID),EI,P1(ID),P1EST(ID),PRT(ID)
  100 FORMAT(3X,F7.1,2X,4(F10.4,1X))
   71 CONTINUE
      GO TO 999
 9999 STOP
      END
      SUBROUTINE BULII(BSC,AA1,IND2)
      DIMENSION BSC(16)
      IF(AA1.LT.BSC(11))THEN
        IF(AA1.GT.BSC(1))THEN
          IF(AA1.LT.BSC(6))THEN
            IF(AA1.LT.BSC(4))THEN
              IF(AA1.LT.BSC(3))THEN
                IF(AA1.LT.BSC(2))THEN
                  IND2=1
                ELSE
                  IND2=2
                ENDIF
              ELSE
                IND2=3
              ENDIF
            ELSE
              IF(AA1.LT.BSC(5))THEN
                IND2=4
              ELSE
                IND2=5
              ENDIF
            ENDIF
        ELSE
            IF(AA1.LT.BSC(8))THEN
              IF(AA1.LT.BSC(7))THEN
                IND2=6
              ELSE
                IND2=7
              ENDIF
            ELSE
              IF(AA1.LT.BSC(9))THEN
                IND2=8
              ELSE
                IF(AA1.LT.BSC(10))THEN
                  IND2=9
                ELSE
                  IND2=10
                ENDIF
              ENDIF
            ENDIF
          ENDIF
        ELSE
          IND2=0
        ENDIF
      ELSE
        IF(AA1.LT.BSC(13))THEN
          IF(AA1.LT.BSC(12))THEN
            IND2=11
          ELSE
```

```
            IND2=12
          ENDIF
        ELSE
          IF(AA1.LT.BSC(15))THEN
            IF(AA1.LT.BSC(14))THEN
              IND2=13
            ELSE
              IND2=14
            ENDIF
          ELSE
            IF(AA1.LT.BSC(16))THEN
              IND2=15
            ELSE
              IND2=16
            ENDIF
          ENDIF
        ENDIF
      ENDIF
      RETURN
      END
      SUBROUTINE BULERV(NZ,SSC,T,SIGMA,ERV)
      DIMENSION NZ(350)
      III=0
      SSC1=SSC
      FLUXT=0.000000001
    4 IF(SSC.LT.0.0)GO TO 2
    6 ZZ=(SSC-T)/(SIGMA*SQRT(T))
      IF(ZZ.LE.0.0)THEN
        IF(ZZ.GE.-3.49)THEN
          LL=-100.*ZZ+1.
          FLUX=1.-NZ(LL)/10000.0
        ELSE
          FLUX=0.000001
        ENDIF
      ELSE
        IF(ZZ.LE.3.49)THEN
          LL=100.0*ZZ+1.
          FLUX=NZ(LL)/10000.0
        ELSE
          FLUX=0.9999999
        ENDIF
      ENDIF
      III=III+1
      IF(III.EQ.1)FLUX1=FLUX
      FLUXT=FLUXT+FLUX
      SSC=SSC-1.0
      GO TO 4
    2 EI=(FLUXT-FLUX1)/FLUX1
      ERV=SSC1-EI
      SSC=SSC1
      RETURN
      END
      SUBROUTINE BULPR2(NZ,SC,ERV,Q,SIGMA,PR2)
      DIMENSION NZ(350),Z(350)
      PR2=0
      JJJ=0
      SC=SC-ERV
      ZZ=(SC-Q)/(SIGMA*SQRT(Q))
C     WRITE(6,120)SC,ZZ
C 120 FORMAT(2X,"SC=",F7.4,"ZZ=",F9.6)
      IF(ZZ.LE.0.0)THEN
        IF(ZZ.GE.-3.49)THEN
          LL=-100*ZZ+1.
          FLUX=1.-NZ(LL)/10000.0
        ELSE
```

```
          ENDIF
        ELSE
          IF(ZZ.LE.3.49)THEN
            LL=100.0*ZZ+1.
            FLUX=NZ(LL)/10000.0
          ELSE
            FLUX=0.9999999
          ENDIF
        ENDIF
        PR2=1-FLUX
C       WRITE(6,29)SC,ERV,Q,BMEAN,SIGMA,PR2
C    29 FORMAT(2X,"SC=",F5.2,2X,"ERV=",F5.2,2X,"Q=",F5.2,
C      $2X,"BMEAN",F5.2,2X,"SIGMA=",F5.2,2X,"PR2=",F9.6)
        RETURN
        END
        SUBROUTINE PREST(PER1,PER2,SIGMA,EII,PDEST,DEN)
        EIICR1=0.0221*PER1/PER2-0.04073*PER2/PER1-0.00045*PER1/
       $SIGMA**2.0-0.00135*PER2/SIGMA**2.0+0.3148
        P1DCR=0.00099*PER1/PER2-0.0003*PER2/PER1-0.0021*PER1/
       $SIGMA**2.0+0.00076*PER2/SIGMA**2.0+0.85167
        IF(P1DCR.GT.1.0)P1DCR=0.9999
        IF(P1DCR.LT.0.0)P1DCR=0.0001
        IF(EII.GT.EIICR1)GO TO 117
        EIICR2=-2.326*SIGMA*PER2**0.5/(PER2+2.326*SIGMA*PER2**0.5)
        IF(EII.GT.EIICR2+0.025)GO TO 120
        EIICR2=EII-0.028
   120  OPTK=0.01360*PER1/PER2-0.02890*PER2/PER1-0.000600*PER1/SIGMA
       $**2.0+0.000177*PER2/SIGMA**2.0+.0793
C       WRITE(6,*)OPTK
        IF(OPTK.LT.0.0)OPTK=0.000001
C       X=EII-EIICR2
C       IF(X.GT..25)EAY=5*X-1.0
C       IF(X.GT.0.1.AND.X.LT.0.3)EAY=X
C       IF(X.LT.0.1)EAY=X**1.2
        PDEST=OPTK/(EII-EIICR2)**1.22+P1DCR
C       PDEST=OPTK/EAY+P1DCR
        DEN=(EII-EIICR2)**1.22
        GO TO 118
   117  C=0.10709*PER1/PER2-0.02933*PER2/PER1-0.00078*PER1/
       $SIGMA**2.0-0.00096*PER2/SIGMA**2.0+0.272
        IF(C.GT.1.0)C=0.9999
        IF(C.LT.0.0)C=0.0001
        PDEST=P1DCR**(C**(EII-EIICR1))
   118  CONTINUE
        RETURN
        END
```

APPENDIX IV

Comparison of Estimation and Table Probabilities

PER1= 5.00 PER2=10.00 SIGMA= .8000

BSC	EI	P1	P1EST	PRT
6.0	1.3945	.9986	.9997	.9997
6.6	1.7039	.9968	.9993	.9995
7.2	2.0941	.9936	.9980	.9991
7.8	2.5273	.9901	.9948	.9984
8.1	2.7672	.9873	.9921	.9978
8.4	3.0243	.9841	.9882	.9970
8.7	3.2923	.9792	.9832	.9960
9.0	3.5614	.9736	.9769	.9945
9.3	3.8364	.9696	.9692	.9925
9.6	4.1244	.9640	.9600	.9898
9.9	4.4186	.9565	.9490	.9861
10.2	4.7119	.9462	.9368	.9817
10.8	5.3003	.9230	.9068	.9678
11.4	5.9004	.8908	.8700	.9474
12.0	6.4996	.8502	.8239	.9162
12.6	7.0974	.7914	.7686	.8729

PROGRAM NORM1:

PER1= 5.00 PER2=10.00 SIGMA= 1.0000

BSC	EI	P1	P1EST	PRT
6.0	1.7272	.9858	.9952	.9955
6.6	2.0159	.9813	.9931	.9941
7.2	2.3625	.9764	.9894	.9920
7.8	2.7523	.9661	.9830	.9890
8.1	2.9759	.9593	.9782	.9868
8.4	3.1975	.9521	.9724	.9842
8.7	3.4344	.9424	.9650	.9808
9.0	3.6887	.9331	.9560	.9767
9.3	3.9383	.9242	.9459	.9719
9.6	4.2025	.9112	.9343	.9664
9.9	4.4691	.8983	.9205	.9591
10.2	4.7541	.8846	.9047	.9505
10.8	5.3199	.8512	.8689	.9292
11.4	5.9070	.8176	.8266	.9015
12.0	6.5022	.7707	.7764	.8643
12.6	7.0917	.7235	.7203	.8136

PROGRAM NORM1:

PER1= 5.00 PER2=15.00 SIGMA= .8000

BSC	EI	P1	P1EST	PRT
8.0	2.6908	.9997	.9999	1.0000
8.8	3.3752	.9987	.9993	1.0000
9.6	4.1244	.9981	.9973	1.0000
10.4	4.9081	.9960	.9925	.9994
10.8	5.3003	.9937	.9890	.9991
11.2	5.7027	.9916	.9847	.9987
11.6	6.0974	.9889	.9794	.9979
12.0	6.4970	.9871	.9732	.9969
12.4	6.9004	.9826	.9660	.9955
12.8	7.2965	.9790	.9578	.9934
13.2	7.7007	.9726	.9483	.9906
13.6	8.0974	.9634	.9376	.9868
14.4	8.9004	.9432	.9114	.9750
15.2	9.7007	.9103	.8786	.9564
16.0	10.4970	.8682	.8358	.9265
16.8	11.2965	.8132	.7817	.8830

PROGRAM NORM1:

PER1= 6.00 PER2= 5.00 SIGMA= .6000

BSC	EI	P1	P1EST	PRT
7.0	1.1434	.9694	.9906	.9979
7.6	1.4926	.9466	.9744	.9955
8.2	1.9130	.9097	.9444	.9893
8.8	2.4058	.8576	.8969	.9732
9.1	2.6624	.8293	.8672	.9591
9.4	2.9464	.7872	.8295	.9370
9.7	3.2253	.7442	.7865	.9066
10.0	3.5152	.6979	.7346	.8643
10.3	3.8095	.6489	.6754	.8106
10.6	4.1006	.5885	.7087	.7486
10.9	4.4084	.5250	.6504	.6700
11.2	4.6974	.4630	.5861	.5871
11.8	5.3026	.3451	.4452	.4129
12.4	5.9040	.2439	.3043	.2514
13.0	6.5000	.1592	.1956	.1342
13.6	7.0960	.0975	.1220	.0594

PROGRAM NORM1:

PER1= 6.00 PER2= 5.00 SIGMA= .2000

BSC	EI	P1	P1EST	PRT
7.0	.5317	1.0000	1.0000	1.0000
7.3	.8104	1.0000	1.0000	1.0000
7.6	1.1007	1.0000	.9995	1.0000
7.9	1.3996	1.0000	.9967	1.0000
8.1	1.5504	1.0000	.9935	1.0000
8.2	1.6997	1.0000	.9886	1.0000
8.4	1.8519	1.0000	.9817	1.0000
8.5	2.0000	.9997	.9730	1.0000
8.7	2.1481	.9997	.9623	1.0000
8.8	2.3003	.9995	.9493	1.0000
9.0	2.4496	.9992	.9347	1.0000
9.1	2.6004	.9979	.9182	1.0000
9.4	2.9006	.9929	.8813	1.0000
9.7	3.1963	.9726	.8410	1.0000
10.0	3.5000	.9353	.7972	.9996
10.3	3.8032	.8513	.7505	.9962

PROGRAM NORM1:

PER1= 6.00 PER2= 5.00 SIGMA= 1.0000

BSC	EI	P1	P1EST	PRT
7.0	1.8987	.8431	.8764	.9162
7.7	2.2286	.8148	.8340	.8907
8.4	2.6391	.7677	.7771	.8531
9.1	3.0955	.7122	.7091	.8023
9.5	3.3513	.6755	.6672	.7673
9.8	3.6124	.6452	.6268	.7324
10.2	3.8930	.6079	.6432	.6879
10.5	4.1868	.5652	.6082	.6406
10.9	4.4873	.5285	.5672	.5871
11.2	4.8004	.4889	.5245	.5319
11.6	5.1214	.4466	.4848	.4801
11.9	5.4488	.4043	.4366	.4207
12.6	6.1214	.3273	.3435	.3085
13.3	6.8066	.2527	.2601	.2119
14.0	7.5023	.1937	.1900	.1342
14.7	8.1938	.1391	.1367	.0778

11.54.04.UCLP, AA, P04 , 0.678KLNS.

PROGRAM NORM1:

PER1= 9.00 PER2= 9.00 SIGMA= .5000

BSC	EI	P1	P1EST	PRT
17.0	7.5000	.6803	.7749	.8389
17.8	8.2521	.5429	.6660	.6879
18.5	9.0000	.4082	.5176	.5000
19.3	9.7479	.2755	.3577	.3121
19.6	10.1237	.2200	.2831	.2296
20.0	10.5000	.1682	.2155	.1587
20.4	10.8763	.1261	.1637	.1056
20.8	11.2521	.0924	.1256	.0668
21.1	11.6241	.0650	.1037	.0409
21.5	12.0000	.0447	.0985	.0228
21.9	12.3759	.0313	.0527	.0122
22.3	12.7479	.0179	.0277	.0064
23.0	13.5000	.0084	.0056	.0013
23.8	14.2521	.0029	.0000	.0000
24.5	15.0000	.0005	.0000	.0000
25.3	15.7479	.0000	.0000	.0000

PROGRAM NORM1:

PER1= 9.00 PER2= 9.00 SIGMA= .7000

BSC	EI	P1	P1EST	PRT
17.0	7.5000	.6432	.7184	.7611
17.8	8.2510	.5455	.6239	.6368
18.5	9.0000	.4363	.5144	.5000
19.3	9.7490	.3445	.3993	.3632
19.6	10.1264	.3005	.3421	.2981
20.0	10.5000	.2587	.2885	.2389
20.4	10.8736	.2232	.2399	.1867
20.8	11.2510	.1895	.1976	.1423
21.1	11.6225	.1634	.1645	.1075
21.5	12.0000	.1305	.1354	.0778
21.9	12.3775	.1061	.1136	.0548
22.3	12.7490	.0853	.0994	.0375
23.0	13.5000	.0553	.0791	.0162
23.8	14.2510	.0337	.0303	.0062
24.5	15.0000	.0184	.0107	.0022
25.3	15.7490	.0103	.0034	.0007

PROGRAM NORM1:

PER1= 9.00 PER2= 9.00 SIGMA= .9000

BSC	EI	P1	P1EST	PRT
17.0	7.5132	.6043	.6706	.7088
17.8	8.2497	.5357	.5912	.6064
18.5	9.0000	.4554	.5065	.5000
19.3	9.7555	.3763	.4187	.3936
19.6	10.1318	.3376	.3736	.3409
20.0	10.5000	.3037	.3299	.2912
20.4	10.8679	.2674	.2885	.2451
20.8	11.2442	.2384	.2505	.2033
21.1	11.6200	.2066	.2159	.1660
21.5	12.0000	.1797	.1863	.1342
21.9	12.3796	.1550	.1586	.1056
22.3	12.7555	.1305	.1361	.0823
23.0	13.5000	.0937	.1056	.0485
23.8	14.2442	.0689	.0945	.0262
24.5	15.0000	.0461	.0675	.0132
25.3	15.7555	.0308	.0317	.0062

PROGRAM NORM1:

PER1= 9.00 PER2= 9.00 SIGMA= 1.1000

BSC	EI	P1	P1EST	PRT
17.0	7.5701	.5643	.6301	.6664
17.8	8.2880	.5041	.5655	.5832
18.5	9.0189	.4449	.5000	.5000
19.3	9.7564	.3821	.4289	.4129
19.6	10.1301	.3540	.3898	.3669
20.0	10.5030	.3205	.3556	.3264
20.4	10.8754	.2947	.3223	.2877
20.8	11.2486	.2687	.2872	.2483
21.1	11.6208	.2439	.2575	.2148
21.5	11.9969	.2211	.2301	.1841
21.9	12.3729	.2042	.2017	.1539
22.3	12.7453	.1821	.1789	.1292
23.0	13.4984	.1397	.1387	.0869
23.8	14.2486	.1063	.1096	.0559
24.5	14.9969	.0755	.0951	.0351
25.3	15.7453	.0547	.1017	.0207

PROGRAM NORM1:

PER1= 9.00 PER2= 9.00 SIGMA= 1.3000

BSC	EI	P1	P1EST	PRT
17.0	7.6862	.5682	.5949	.6293
17.8	8.3625	.5182	.5443	.5636
18.5	9.0680	.4646	.4915	.4960
19.3	9.7887	.4152	.4301	.4207
19.6	10.1509	.3889	.4017	.3859
20.0	10.5200	.3613	.3738	.3520
20.4	10.8832	.3387	.3424	.3156
20.8	11.2509	.3112	.3160	.2843
21.1	11.6248	.2885	.2871	.2514
21.5	11.9957	.2641	.2631	.2236
21.9	12.3665	.2417	.2371	.1949
22.3	12.7422	.2253	.2162	.1711
23.0	13.4909	.1854	.1733	.1251
23.8	14.2344	.1535	.1406	.0901
24.5	14.9863	.1241	.1159	.0630
25.3	15.7381	.1012	.0994	.0427

PROGRAM NORM1:

PER1= 9.00 PER2= 9.00 SIGMA= 1.5000

BSC	EI	P1	P1EST	PRT
17.0	7.8631	.5424	.5666	.5987
17.8	8.4871	.5022	.5240	.5438
18.5	9.1594	.4568	.4808	.4880
19.3	9.8556	.4099	.4297	.4247
19.6	10.1953	.3914	.4079	.3974
20.0	10.5639	.3720	.3830	.3669
20.4	10.9158	.3458	.3581	.3372
20.8	11.2651	.3233	.3339	.3085
21.1	11.6436	.3066	.3109	.2810
21.5	12.0009	.2884	.2882	.2546
21.9	12.3569	.2671	.2664	.2296
22.3	12.7406	.2510	.2430	.2033
23.0	13.4857	.2145	.2058	.1611
23.8	14.2136	.1835	.1732	.1251
24.5	14.9671	.1529	.1437	.0934
25.3	15.7174	.1304	.1202	.0681

10.05.09.UCLP, AA, P03 , 0.349KLNS.

PROGRAM NORM1:

PER1= 9.00 PER2=17.00 SIGMA= .8000

BSC	EI	P1	P1EST	PRT
20.0	10.5000	.9326	.8873	.9756
20.8	11.2492	.9037	.8585	.9591
21.5	12.0000	.8676	.8231	.9345
22.3	12.7508	.8239	.7797	.8997
22.6	13.1288	.7995	.7556	.8790
23.0	13.5000	.7655	.7294	.8554
23.4	13.8712	.7408	.6992	.8264
23.8	14.2492	.7137	.7228	.7967
24.1	14.6223	.6766	.6973	.7642
24.5	15.0000	.6461	.6663	.7257
24.9	15.3777	.6129	.6358	.6879
25.3	15.7508	.5745	.5999	.6443
26.0	16.5000	.5063	.5299	.5596
26.8	17.2492	.4363	.4563	.4721
27.5	18.0000	.3639	.3787	.3821
28.3	18.7508	.2961	.3051	.2981

PROGRAM NORM1:

PER1= 9.00 PER2=17.00 SIGMA= 1.0000

BSC	EI	P1	P1EST	PRT
20.0	10.4996	.8811	.8550	.9418
20.8	11.2509	.8466	.8201	.9177
21.5	11.9992	.8121	.7803	.8869
22.3	12.7472	.7755	.7349	.8485
22.6	13.1244	.7511	.7079	.8236
23.0	13.4996	.7239	.6817	.7995
23.4	13.8737	.6984	.6544	.7734
23.8	14.2509	.6718	.6756	.7454
24.1	14.6228	.6458	.6518	.7157
24.5	14.9992	.6161	.6265	.6844
24.9	15.3751	.5884	.5999	.6517
25.3	15.7472	.5592	.5722	.6179
26.0	16.4996	.5000	.5141	.5478
26.8	17.2509	.4371	.4539	.4761
27.5	17.9992	.3832	.3936	.4052
28.3	18.7472	.3279	.3349	.3372

PROGRAM NORM1:

PER1=17.00 PER2= 9.00 SIGMA= .7000

BSC	EI	P1	P1EST	PRT
20.0	3.3095	.9405	.9333	.9965
20.8	3.8128	.9163	.9078	.9932
21.5	4.3734	.8792	.8769	.9861
22.3	4.9847	.8401	.8394	.9719
22.6	5.3093	.8147	.8167	.9599
23.0	5.6393	.7877	.7924	.9452
23.4	5.9778	.7595	.7630	.9236
23.8	6.3275	.7244	.7312	.8980
24.1	6.6796	.6924	.6939	.8643
24.5	7.0407	.6601	.7589	.8238
24.9	7.4058	.6196	.7259	.7734
25.3	7.7703	.5808	.6891	.7190
26.0	8.5089	.4944	.5962	.5910
26.8	9.2538	.4085	.4881	.4522
27.5	10.0000	.3355	.3774	.3192
28.3	10.7503	.2646	.2735	.2033

BSC	EI	P1	P1EST	PRT
8.0	2.9020	.9962	.9988	.9991
8.8	3.5161	.9948	.9974	.9985
9.6	4.2025	.9912	.9938	.9973
10.4	4.9421	.9860	.9871	.9952
10.8	5.3199	.9807	.9822	.9936
11.2	5.7114	.9750	.9761	.9916
11.6	6.1010	.9703	.9689	.9890
12.0	6.4892	.9634	.9604	.9857
12.4	6.8959	.9574	.9504	.9817
12.8	7.2906	.9484	.9392	.9767
13.2	7.6919	.9400	.9259	.9699
13.6	8.0893	.9295	.9118	.9625
14.4	8.8920	.9035	.8774	.9418
15.2	9.6919	.8646	.8372	.9147
16.0	10.4825	.8209	.7882	.8770
16.8	11.2881	.7676	.7310	.8289

PROGRAM NORM1:

PER1=10.00 PER2= 5.00 SIGMA= .7000

BSC	EI	P1	P1EST	PRT
6.0	.4569	.9916	.9980	.9981
6.7	.5492	.9919	.9973	.9977
7.4	.6562	.9810	.9960	.9972
8.1	.7724	.9756	.9934	.9965
8.5	.8603	.9722	.9906	.9959
8.8	.9443	.9670	.9872	.9952
9.2	1.0364	.9582	.9827	.9943
9.5	1.1378	.9510	.9767	.9931
9.9	1.2458	.9429	.9694	.9916
10.2	1.3747	.9286	.9597	.9896
10.6	1.5234	.9187	.9472	.9868
10.9	1.6739	.9016	.9332	.9830
11.6	2.0101	.8632	.8992	.9719
12.3	2.4242	.8136	.8509	.9495
13.0	2.8972	.7503	.7880	.9099
13.7	3.4344	.6680	.7035	.8413

PROGRAM NORM1:

PER1=10.00 PER2= 5.00 SIGMA= 1.0000

BSC	EI	P1	P1EST	PRT
6.0	1.0511	.8939	.9490	.9608
6.7	1.1796	.8846	.9379	.9554
7.4	1.3231	.8719	.9247	.9495
8.1	1.4885	.8615	.9078	.9418
8.5	1.5780	.8518	.8979	.9370
8.8	1.6545	.8396	.8884	.9319
9.2	1.7604	.8266	.8756	.9251
9.5	1.8697	.8163	.8620	.9177
9.9	1.9932	.8049	.8473	.9099
10.2	2.1359	.7923	.8295	.8997
10.6	2.2705	.7784	.8119	.8888
10.9	2.4126	.7598	.7916	.8749
11.6	2.7277	.7242	.7480	.8438
12.3	3.0869	.6852	.6958	.8023
13.0	3.4929	.6349	.6348	.7486
13.7	3.9332	.5800	.6494	.6808

PROGRAM NORM1:

PER1=12.00 PER2=10.00 SIGMA= 1.0000

BSC	EI	P1	P1EST	PRT
20.0	7.5999	.6599	.6490	.7734
21.0	8.5397	.5835	.6498	.6772
22.0	9.5044	.5096	.5588	.5596
23.0	10.4831	.4186	.4632	.4404
23.5	10.9713	.3793	.4149	.3821
24.0	11.4640	.3367	.3637	.3228
24.5	11.9568	.2995	.3188	.2709
25.0	12.4516	.2661	.2733	.2206
25.4	12.9435	.2276	.2320	.1762
25.9	13.4433	.1979	.1988	.1401
26.4	13.9346	.1708	.1670	.1075
26.9	14.4302	.1471	.1408	.0808
27.9	15.4212	.1097	.1075	.0436
28.9	16.4127	.0753	.1099	.0217
29.9	17.4002	.0479	.0538	.0096
30.9	18.3907	.0297	.0224	.0040

PROGRAM NORM1:

PER1=18.00 PER2= 5.00 SIGMA= 1.0000

BSC	EI	P1	P1EST	PRT
20.0	3.7469	.6083	.6815	.7123
20.8	4.1329	.5610	.6389	.6480
21.5	4.5345	.5224	.5919	.5793
22.3	4.9812	.4808	.5349	.5000
22.6	5.2197	.4573	.5105	.4641
23.0	5.4791	.4312	.4738	.4168
23.4	5.7321	.4079	.4411	.3745
23.8	6.0001	.3830	.4052	.3300
24.1	6.2755	.3612	.3661	.2843
24.5	6.5643	.3376	.3339	.2451
24.9	6.8613	.3142	.2958	.2033
25.3	7.1718	.2973	.2614	.1660
26.0	7.8001	.2515	.2038	.1056
26.8	8.4569	.2147	.1624	.0618
27.5	9.1437	.1703	.1443	.0322
28.3	9.8453	.1373	.1351	.0154

PROGRAM NORM1:

PER1=18.00 PER2= 5.00 SIGMA= .6000

BSC	EI	P1	P1EST	PRT
20.0	2.4737	.8016	.7999	.9699
20.8	2.9208	.7403	.7484	.9382
21.5	3.4408	.6730	.6774	.8770
22.3	4.0217	.5844	.7064	.7642
22.6	4.3313	.5338	.6589	.6879
23.0	4.6547	.4876	.5991	.5987
23.4	4.9890	.4363	.5282	.5000
23.8	5.3344	.3929	.4581	.4052
24.1	5.6822	.3432	.3797	.3085
24.5	6.0400	.2913	.3034	.2206
24.9	6.4031	.2474	.2379	.1492
25.3	6.7669	.2067	.1858	.0951
26.0	7.5068	.1435	.1355	.0314
26.8	8.2544	.0865	.0581	.0078
27.5	9.0000	.0541	.0104	.0014
28.3	9.7484	.0308	.0000	.0000

PROGRAM NORM1:

PER1=14.00 PER2= 8.00 SIGMA= 1.0000

BSC	EI	P1	P1EST	PRT
16.0	3.3669	.8722	.8300	.9434
16.8	3.7567	.8379	.8507	.9332
17.5	4.1872	.8019	.8138	.9099
18.3	4.6608	.7652	.7721	.8810
18.6	4.9169	.7414	.7477	.8621
19.0	5.1845	.7114	.7198	.8389
19.4	5.4620	.6895	.6905	.8133
19.8	5.7495	.6664	.6596	.7852
20.1	6.0434	.6400	.6276	.7549
20.5	6.3515	.6095	.6835	.7190
20.9	6.6686	.5777	.6565	.6808
21.3	6.9884	.5515	.6233	.6368
22.0	7.6584	.4905	.5572	.5478
22.8	8.3519	.4321	.4824	.4522
23.5	9.0615	.3800	.4031	.3557
24.3	9.7849	.3175	.3238	.2643

PROGRAM NORM1:

PER1=14.00 PER2= 8.00 SIGMA= .8000

BSC	EI	P1	P1EST	PRT
16.0	2.8049	.9223	.9393	.9890
16.8	3.2295	.8944	.9141	.9821
17.5	3.7032	.8616	.8827	.9706
18.3	4.2333	.8216	.8434	.9515
18.6	4.5200	.7947	.8194	.9370
19.0	4.8144	.7705	.7931	.9192
19.4	5.1261	.7432	.7643	.8980
19.8	5.4489	.7169	.7292	.8686
20.1	5.7751	.6890	.6929	.8365
20.5	6.1160	.6567	.6513	.7967
20.9	6.4672	.6241	.7103	.7486
21.3	6.8125	.5889	.6752	.6985
22.0	7.5341	.5048	.5866	.5793
22.8	8.2700	.4244	.4910	.4562
23.5	9.0080	.3451	.3851	.3300
24.3	9.7505	.2772	.2877	.2206

PROGRAM NORM1:

PER1=10.00 PER2=10.00 SIGMA= .8000

BSC	EI	P1	P1EST	PRT
12.0	2.4553	.9839	.9909	.9936
12.8	2.9202	.9751	.9815	.9974
13.5	3.4319	.9612	.9671	.9952
14.3	4.0128	.9436	.9461	.9909
14.6	4.3296	.9304	.9330	.9875
15.0	4.6505	.9161	.9180	.9826
15.4	4.9830	.9016	.9010	.9761
15.8	5.3328	.8847	.8813	.9671
16.1	5.6750	.8622	.8597	.9554
16.5	6.0385	.8394	.8351	.9406
16.9	6.4064	.8124	.8077	.9222
17.3	6.7629	.7870	.7764	.8980
18.0	7.5068	.7121	.7045	.8365
18.8	8.2568	.6345	.7086	.7517
19.5	9.0000	.5605	.6331	.6517
20.3	9.7460	.4734	.5446	.5398

PROGRAM NORM1:

PER1=14.00 PER2=14.00 SIGMA= .8000

BSC	EI	P1	P1EST	PRT
16.0	2.8049	.9956	.9975	1.0000
16.8	3.2295	.9939	.9946	1.0000
17.5	3.7032	.9911	.9895	.9997
18.3	4.2333	.9868	.9817	.9994
18.6	4.5200	.9852	.9767	.9992
19.0	4.8144	.9829	.9709	.9989
19.4	5.1261	.9782	.9642	.9985
19.8	5.4489	.9732	.9566	.9978
20.1	5.7751	.9672	.9483	.9969
20.5	6.1160	.9625	.9392	.9957
20.9	6.4672	.9519	.9290	.9940
21.3	6.8125	.9412	.9185	.9918
22.0	7.5341	.9157	.8939	.9846
22.8	8.2700	.8842	.8645	.9719
23.5	9.0080	.8487	.8291	.9515
24.3	9.7505	.8038	.7861	.9207

PROGRAM NORM1:

PER1=12.00 PER2= 7.00 SIGMA= .8000

BSC	EI	P1	P1EST	PRT
12.0	1.7400	.9445	.9759	.9934
12.8	2.0308	.9306	.9616	.9904
13.5	2.3724	.9106	.9413	.9854
14.3	2.7695	.8843	.9138	.9767
14.6	2.9993	.8665	.8969	.9706
15.0	3.2269	.8460	.8785	.9625
15.4	3.4829	.8229	.8565	.9515
15.8	3.7438	.8025	.8319	.9370
16.1	4.0264	.7793	.8042	.9192
16.5	4.3181	.7517	.7727	.8962
16.9	4.6289	.7162	.7378	.8686
17.3	4.9430	.6782	.6983	.8340
18.0	5.6103	.5972	.7043	.7422
18.8	6.3085	.5175	.6198	.6255
19.5	7.0295	.4374	.5207	.4960
20.3	7.7632	.3543	.4081	.3594

PROGRAM NORM1:

PER1=13.00 PER2=11.00 SIGMA= 1.5000

BSC	EI	P1	P1EST	PRT
15.0	4.6698	.8394	.8472	.8980
15.8	4.9925	.8233	.8268	.8849
16.5	5.3747	.8021	.8042	.8708
17.3	5.7865	.7751	.7759	.8508
17.6	6.0016	.7624	.7622	.8413
18.0	6.2204	.7492	.7484	.8315
18.4	6.4359	.7353	.7320	.8186
18.8	6.6711	.7187	.7173	.8078
19.1	6.9219	.7022	.6972	.7910
19.5	7.1769	.6910	.6793	.7764
19.9	7.4376	.6776	.6610	.7611
20.3	7.7129	.6621	.6424	.7454
21.0	8.2815	.6305	.5986	.7054
21.8	8.8534	.5976	.6267	.6664
22.5	9.4736	.5593	.5899	.6179
23.3	10.1175	.5237	.5514	.5675

PROGRAM NORM1:

PER1=17.00 PER2= 9.00 SIGMA= 1.0000

BSC	EI	P1	P1EST	PRT
20.0	4.1734	.8406	.8586	.9452
20.8	4.6046	.8134	.8282	.9279
21.5	5.0612	.7824	.7934	.9049
22.3	5.5754	.7459	.7508	.8729
22.6	5.8440	.7247	.7268	.8531
23.0	6.1246	.7005	.6995	.8289
23.4	6.4156	.6779	.6729	.8051
23.8	6.7117	.6492	.6428	.7764
24.1	7.0213	.6204	.7020	.7422
24.5	7.3328	.5989	.6791	.7088
24.9	7.6526	.5732	.6512	.6700
25.3	7.9811	.5461	.6214	.6293
26.0	8.6556	.4894	.5573	.5438
26.8	9.3512	.4383	.4896	.4562
27.5	10.0653	.3809	.4130	.3632
28.3	10.7928	.3254	.3398	.2776

PROGRAM NORM1:

PER1=17.00 PER2= 9.00 SIGMA= 1.0000

BSC	EI	P1	P1EST	PRT
29.0	11.5236	.2789	.2697	.2005
29.8	12.2623	.2366	.2137	.1401
30.5	13.0070	.1926	.1665	.0918
31.3	13.7558	.1526	.1333	.0571
31.6	14.1242	.1329	.1235	.0446
32.0	14.5000	.1171	.1167	.0336
32.4	14.8758	.1039	.1211	.0256
32.8	15.2486	.0921	.1254	.0188
33.1	15.6275	.0821	.0927	.0139
33.5	16.0000	.0708	.0660	.0099
33.9	16.3725	.0587	.0474	.0071
34.3	16.7514	.0495	.0327	.0049
35.0	17.5000	.0353	.0153	.0023
35.8	18.2486	.0271	.0067	.0010
36.5	19.0000	.0200	.0027	.0004
37.3	19.7514	.0111	.0000	.0000

PROGRAM NORM1:

PER1= 9.00 PER2= 9.00 SIGMA= .3000

BSC	EI	P1	P1EST	PRT
17.0	7.5000	.7897	.7149	.9515
17.8	8.2532	.5884	.6520	.7939
18.5	9.0000	.3558	.4422	.5000
19.3	9.7468	.1713	.2126	.2061
19.6	10.1267	.1061	.1278	.1056
20.0	10.5000	.0595	.0801	.0485
20.4	10.8733	.0334	.0429	.0188
20.8	11.2532	.0153	.0142	.0062
21.1	11.6203	.0053	.0041	.0018
21.5	12.0000	.0018	.0009	.0004
21.9	12.3797	.0008	.0000	.0000
22.3	12.7468	.0003	.0000	.0000
23.0	13.5000	.0003	.0000	.0000
23.8	14.2532	.0000	.0000	.0000
24.5	15.0000	.0000	.0000	.0000
25.3	15.7468	.0000	.0000	.0000

PER1=19.00 PER2= 6.00 SIGMA= .8000

BSC	EI	PI	PIEST	PRT
31.0	11.5038	.0695	.0203	.0026
31.5	12.0000	.0561	.0086	.0011
32.0	12.5000	.0429	.0039	.0005
32.5	13.0000	.0334	.0000	.0000
32.8	13.2509	.0284	.0000	.0000
33.0	13.5000	.0250	.0000	.0000
33.3	13.7491	.0213	.0000	.0000
33.5	14.0000	.0192	.0000	.0000
33.8	14.2509	.0147	.0000	.0000
34.0	14.5000	.0118	.0000	.0000
34.3	14.7491	.0092	.0000	.0000
34.5	15.0000	.0032	.0000	.0000
35.0	15.5000	.0053	.0000	.0000
35.5	16.0000	.0037	.0000	.0000
36.0	16.5000	.0029	.0000	.0000
36.5	17.0000	.0021	.0000	.0000

PROGRAM NORM1:

PER1=19.00 PER2= 6.00 SIGMA= .8000

BSC	EI	PI	PIEST	PRT
31.0	11.5038	.0698	.0203	.0026
31.5	12.0000	.0529	.0086	.0011
32.0	12.5000	.0403	.0039	.0005
32.5	13.0000	.0324	.0000	.0000
32.8	13.2509	.0268	.0000	.0000
33.0	13.5000	.0239	.0000	.0000
33.3	13.7491	.0205	.0000	.0000
33.5	14.0000	.0176	.0000	.0000
33.8	14.2509	.0158	.0000	.0000
34.0	14.5000	.0139	.0000	.0000
34.3	14.7491	.0124	.0000	.0000
34.5	15.0000	.0108	.0000	.0000
35.0	15.5000	.0079	.0000	.0000
35.5	16.0000	.0053	.0000	.0000
36.0	16.5000	.0034	.0000	.0000
36.5	17.0000	.0032	.0000	.0000

PROGRAM NORM1:

PER1=19.00 PER2= 6.00 SIGMA= .8000

BSC	EI	PI	PIEST	PRT
37.0	17.5000	.0024	.0000	.0000
37.3	17.7961	.0016	.0000	.0000
37.6	18.0992	.0016	.0000	.0000
37.9	18.4021	.0013	.0000	.0000
38.1	18.5505	.0011	.0000	.0000
38.2	18.7018	.0008	.0000	.0000
38.4	18.8529	.0008	.0000	.0000
38.5	19.0000	.0005	.0000	.0000
38.7	19.1471	.0000	.0000	.0000
38.8	19.2982	.0000	.0000	.0000
39.0	19.4495	.0000	.0000	.0000
39.1	19.5979	.0000	.0000	.0000
39.4	19.9008	.0000	.0000	.0000
39.7	20.2039	.0000	.0000	.0000
40.0	20.5000	.0000	.0000	.0000
40.3	20.7961	.0000	.0000	.0000

PROGRAM NORM1:

PER1=19.00 PER2= 6.00 SIGMA= .8000

BSC	EI	P1	P1EST	PRT
19.0	2.3140	.8821	.8680	.9699
19.5	2.5050	.8632	.8503	.9625
20.0	2.7151	.8433	.8300	.9525
20.5	2.9227	.8172	.8103	.9418
20.8	3.0470	.8040	.7971	.9332
21.0	3.1680	.7887	.7849	.9251
21.3	3.2990	.7718	.7705	.9147
21.5	3.4346	.7580	.7555	.9032
21.8	3.5773	.7401	.7397	.8907
22.0	3.7051	.7235	.7255	.8790
22.3	3.8559	.7069	.7067	.8621
22.5	4.0119	.6914	.6869	.8438
23.0	4.3397	.6494	.6421	.7995
23.5	4.6772	.6094	.7080	.7486
24.0	5.0466	.5622	.6661	.6844
24.5	5.4343	.5238	.6148	.6103

PROGRAM NORM1:

PER1=19.00 PER2= 6.00 SIGMA= .8000

BSC	EI	P1	P1EST	PRT
25.0	5.8337	.4761	.5583	.5319
25.5	6.2563	.4295	.4954	.4483
26.0	6.6945	.3837	.4278	.3632
26.5	7.1412	.3414	.3583	.2810
26.8	7.3716	.3197	.3279	.2451
27.0	7.6027	.3030	.2951	.2090
27.3	7.8358	.2847	.2647	.1762
27.5	8.0732	.2661	.2371	.1469
27.8	8.3126	.2465	.2088	.1190
28.0	8.5500	.2306	.1871	.0968
28.3	8.7906	.2134	.1687	.0778
28.5	9.0349	.1941	.1543	.0618
29.0	9.5232	.1649	.1358	.0367
29.5	10.0148	.1376	.1567	.0207
30.0	10.5095	.1111	.0835	.0107
30.5	11.0060	.0923	.0421	.0054

PROGRAM NORM1:

PER1=19.00 PER2= 6.00 SIGMA= .8000

BSC	EI	P1	P1EST	PRT
25.0	5.8337	.4825	.5583	.5319
25.5	6.2563	.4367	.4954	.4483
26.0	6.6945	.3941	.4278	.3632
26.5	7.1412	.3469	.3583	.2810
26.8	7.3716	.3252	.3279	.2451
27.0	7.6027	.3038	.2951	.2090
27.3	7.8358	.2800	.2647	.1762
27.5	8.0732	.2584	.2371	.1469
27.8	8.3126	.2407	.2088	.1190
28.0	8.5500	.2201	.1871	.0968
28.3	8.7906	.2024	.1687	.0778
28.5	9.0349	.1872	.1543	.0618
29.0	9.5232	.1530	.1358	.0367
29.5	10.0148	.1233	.1567	.0207
30.0	10.5095	.0963	.0835	.0107
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PROGRAM NORM1:

PER1=19.00 PER2=11.00 SIGMA= 1.2500

BSC	EI	P1	P1EST	PRT
38.0	18.5059	.1198	.1135	.0351
38.8	19.2498	.0979	.1214	.0239
39.5	20.0000	.0845	.0990	.0150
40.3	20.7502	.0700	.0621	.0094
40.6	21.1252	.0624	.0482	.0073
41.0	21.5000	.0571	.0376	.0057
41.4	21.8748	.0508	.0290	.0044
41.8	22.2496	.0458	.0224	.0034
42.1	22.6247	.0405	.0172	.0026
42.5	23.0000	.0358	.0125	.0019
42.9	23.3753	.0329	.0092	.0014
43.3	23.7502	.0300	.0073	.0011
44.0	24.5000	.0234	.0040	.0006
44.8	25.2498	.0192	.0020	.0003
45.5	26.0000	.0139	.0000	.0000
46.3	26.7502	.0097	.0000	.0000

PROGRAM NORM1:

PER1=19.00 PER2=11.00 SIGMA= 1.2500

BSC	EI	P1	P1EST	PRT
38.0	18.5059	.1190	.1135	.0351
38.8	19.2498	.0984	.1214	.0239
39.5	20.0000	.0829	.0990	.0150
40.3	20.7502	.0618	.0621	.0094
40.6	21.1252	.0566	.0482	.0073
41.0	21.5000	.0511	.0376	.0057
41.4	21.8748	.0463	.0290	.0044
[illegible]	22.2496	.04[illegible]	.0224	.0034
42.1	22.6247	.0358	.0172	.0026
42.5	23.0000	.0321	.0125	.0019
42.9	23.3753	.0284	.0092	.0014
43.3	23.7502	.0253	.0073	.0011
44.0	24.5000	.0189	.0040	.0006
44.8	25.2498	.0134	.0020	.0003
45.5	26.0000	.0092	.0000	.0000
46.3	26.7502	.0068	.0000	.0000

PROGRAM NORM1:

PER1=19.00 PER2=11.00 SIGMA= 1.6000

BSC	EI	P1	P1EST	PRT
38.0	18.5646	.1821	.1495	.0778
38.8	19.2985	.1598	.1324	.0594
39.5	20.0315	.1441	.1202	.0446
40.3	20.7660	.1303	.1142	.0329
40.6	21.1358	.1232	.1149	.0281
41.0	21.5138	.1163	.1198	.0239
41.4	21.8908	.1092	.1311	.0202
41.8	22.2628	.0987	.1152	.0170
42.1	22.6331	.0895	.0969	.0143
42.5	23.0033	.0831	.0807	.0119
42.9	23.3729	.0757	.0671	.0099
43.3	23.7459	.0710	.0556	.0082
44.0	24.4950	.0600	.0373	.0055
44.8	25.2465	.0515	.0251	.0037
45.5	25.9937	.0410	.0163	.0024
46.3	26.7385	.0331	.0102	.0015

11.30.27.UCLP, AA, P03 , 0.573KLNS.

6.000	-.0486	1.0511	.4676	.0267	.9737	.4801
7.675	-.2714	1.3726	.3697	.0378	1.0389	.3557
9.350	-.4525	1.8265	.2801	.2642	1.3584	.2061
11.025	-.5939	2.4622	.2083	.6539	2.8855	.0721
11.863	-.6511	2.8665	.1691	.8144	5.3698	.0314
12.700	-.6978	3.3092	.1429	.9251	13.2275	.0107
13.538	-.7391	3.8334	.1072	.9785	44.6759	.0023
14.375	-.7732	4.4100	.0760	.9961	189.9737	.0003
15.213	-.8024	5.0596	.0576	1.0000	575.6614	.0000
16.050	-.8264	5.7589	.0498	1.0000	497.7760	.0000
16.888	-.8464	6.5109	.0249	1.0000	248.4113	.0000
17.725	-.8628	7.2905	.0150	1.0000	149.5371	.0000
19.400	-.8878	8.9160	.0029	1.0000	28.8178	.0000
21.075	-.9054	10.5718	.0010	.9999	9.5924	.0000
22.750	-.9184	12.2498	.0000	1.0830	.0005	.0000
24.425	-.9282	13.9244	.0000	1.0830	.0005	.0000

PROGRAM NORM2:

ER1=10.00 PER2= 2.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.000	.9028	1.0511	.6748	.1094	.9012	.7486
7.760	.4418	1.3872	.6155	.0826	.9236	.6664
9.520	.0584	1.8896	.4989	.0582	.9448	.5279
11.280	-.2233	2.5751	.3728	.0758	1.0816	.3446
12.160	-.3349	3.0069	.3316	.2795	1.3874	.2389
13.040	-.4296	3.5066	.2809	.4852	1.9413	.1446
13.920	-.5112	4.0921	.2017	.6489	2.8444	.0708
14.800	-.5778	4.7371	.1525	.8242	5.6674	.0268
15.680	-.6328	5.4467	.1173	.9360	15.4279	.0075
16.560	-.6780	6.2112	.0741	.9798	46.3434	.0015
17.440	-.7151	7.0212	.0419	1.0000	418.7736	.0000
18.320	-.7455	7.8590	.0266	1.0000	265.5323	.0000
20.080	-.7914	9.5866	.0100	1.0000	99.8507	.0000
21.840	-.8236	11.3404	.0025	1.0000	24.9506	.0000
23.600	-.8473	13.0985	.0000	1.0020	.0005	.0000
25.360	-.8654	14.8610	.0000	1.0020	.0005	.0000

PROGRAM NORM2:

ER1=10.00 PER2= 3.00 SIGMA= 1.00

BSC	EII	EI	P1	P1P2T	P1DP2T	PRT
6.000	1.8543	1.0511	.7569	.1476	.8713	.868
7.845	1.1108	1.4213	.6719	.2183	.8207	.813
9.690	.5523	1.9326	.5991	.2170	.8216	.729
11.535	.1121	2.6975	.4926	.1520	.8679	.567
12.458	-.0549	3.1742	.4393	.0476	.9543	.460
13.380	-.1961	3.7316	.3645	.0749	1.0806	.337
14.303	-.3110	4.3544	.3011	.2770	1.3825	.217
15.225	-.4079	5.0671	.2356	.5035	2.0123	.117
16.148	-.4868	5.8459	.1683	.6999	3.3261	.050
17.070	-.5505	6.6745	.1212	.8598	7.0902	.017
17.993	-.6026	7.5489	.0763	.9424	16.9644	.004
18.915	-.6446	8.4403	.0448	.9821	49.7430	.000
20.760	-.7077	10.2649	.0155	1.0000	155.3116	.000
22.605	-.7522	12.1064	.0045	1.0000	45.0908	.000
24.450	-.7849	13.9481	.0005	.9998	5.0105	.000
26.295	-.8100	15.7932	.0000	.9940	.0005	.000