Cyber Crime based Curve Fitting Analysis in Internet Traffic Sharing in Computer Network

Diwakar Shukla [1], Kapil Verma [2], Jayant Dubey [3] and Sharad Gangele [4]
[1]Deptt. of Mathematics and Statistics, Sagar University, Sagar M.P., India.
Associate Member, DST-Centre for Interdisciplinary Mathematical Science, Banaras Hindu University, Varanasi, U.P, India.
[2], Deptt. of Computer Science, M. P. Bhoj (Open) University, Bhopal, M.P, India.
[3] Deptt. Of Business Studies, B.T. Institute of Research and Technology, Seronja, Sagar, M.P., India
[4]Deptt. of Statistics, M.B. Khalsa College, Indore, M.P., India

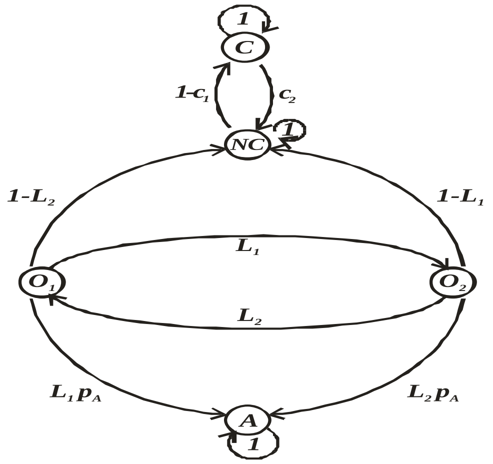
ABSTRACT
Many well-developed countries are having broadband services for there network connection but under developed countries are still having the dial-up-setup connection network. The cyber crime users are growing fast in the entire world and correspondingly the cyber criminals are also growing. The crime is performed by the users cyber only when the connectivity through internet is made. This paper extends the approach of interrelationship between traffic sharing and blocking probability of network between operators subject to conditions the user attracts for cyber crimes. The Markov chain model based approach provides a complicated relationship. This paper adopts a simplified form of same relationship assuming linearity among variables. Least square method is used to generate linear relationship in presence of cyber crime using coefficient of determination and 99 percents confidence interval it has been proved that the approximation is best.

Keywords
Cyber Criminals [CC]

1. INTRODUCTION
The use if internet and cyber crime are highly co-related factors. The internet service providers may use technique of cyber crime to improve upon their customers proportions. Cyber crime may be a hidden force used to generate internet users. The cyber crimes are like hacking, unwanted mailing, black mailing, threating, cheating to other through networks. Naldi (2002) has used Markov chain model for establishing the relationship between traffic sharing and blocking probability of network. Shukla and Thakur (2007) has extended the approach of Naldi (2002) by introducing the concept of cyber crime. They derived expressions for traffic sharing and blocking probability in complicated form. This paper uses least square curve fitting theory to express the same in simplified form in cyber crime setup. The values of traffic are generates from the Markov chain model and least square principle is applied on generated data to obtained an approximate linear relationship.

2. A REVIEW
The stochastic process has been used by many scientists and researchers for the purpose of statistical modelling whose detailed description is in Medhi [1], [2]. Chen and Mark [3] Studied the fast packet switch shared concentration and output queueing for a busy channel. Hambali and Ramani [4] evaluated multicast switch with a variety of traffic patterns. Newby and Dagg [6] have a useful contribution on the optical inspection and maintenance for stochastically deteriorating system. Dorea *et al.* [8] used Markov chain for the modelling of a system and derived some useful approximations. Yeian and Lygeres [10] discussed a work on stabilization of class of stochastic different equations with Markovian switching. Shukla *et al.* [11] presented for model based study for space division switches in computer network. Francini and Chiussi [7] advocated some interesting features for QoS guarantees to the unicast and multicast flow in multistage packet switch. On the reliability analysis of network a useful contribution is by Shukla *et al*. [13] whereas Paxson [9] introduced some of their critical experiences while measuring the internet traffic. Shukla *et al*. [14], [15], [16], [17], [18], [19] and [20] presented different dimensions of Internet traffic sharing in the light of share loss analysis. Shukla *et al.* [21], [22], [23], [24], [25] and [26] have given some Markov Chain model applications in view to disconnectivity factor, multi marketing and crime based analysis. Shukla and Thakur [27] presented Index based internet traffic analysis of users by a Markov chain model. Shukla *et al.* [28], [29], [30], [31] and [32] studied cyber crime analysis for multidimensional effect in computer network and internet traffic sharing. Shukla *et al*. [33], [34], [35], [36], [37], [38], [39] and [40] presented the elasticity property and its impact on parameters of internet traffic sharing in presence blocking probability of computer network specially when two operators are in business competitions with each other in a market. Shukla *et al.* [42] presented analysis of user web browsing using Markov chain model for iso-browser share probability. Shukla *et al.* [43] studied least square curve fitting for Iso-failure in web browsing using Markov chain model. Shukla *et al.* [44], [45], [46] discussed least square curve fitting in internet access traffic sharing in two operator environment.

3. DEFINING A SYSTEM



Transition probability matrix is

states $X^{(n)}$ (→), $X^{(n-1)}$ (↓)

$$
\begin{array}{c|ccccc}
 & O_1 & O_2 & NC & C & A \\
\hline
O_1 & 0 & L_1(1-p_A) & 1-L_1 & 0 & L_1 p_A \\
O_2 & L_2(1-p_A) & 0 & 1-L_2 & 0 & L_2 p_A \\
NC & 0 & 0 & c_1 & 1-c_1 & 0 \\
C & 0 & 0 & c_2 & 1-c_2 & 0 \\
A & 0 & 0 & 0 & 0 & 1
\end{array}
$$

3.1 Some Results for n^{th} Attempts

The starting conditions (state distribution before the call attempt) are

$$
\left.\begin{array}{l}
P\left[X^{(0)}=O_1\right]=p \\
P\left[X^{(0)}=O_2\right]=1-p \\
P\left[X^{(0)}=NC\right]=0 \\
P\left[X^{(0)}=A\right]=0
\end{array}\right\} \quad ...(3.1)
$$

Theorem 3.1 : If users attempt are between O_1 and O_2 then the n^{th} step transitions probability is

$$
\left.\begin{array}{ll}
P\left[X^{(n)}=O_1\right]=p\sqrt{(L_1L_2)^n}\left[(1-p_A)^n\right] & even \\
P\left[X^{(n)}=O_1\right]=(1-p)L_2\sqrt{(L_1L_2)^{n-1}}\left[(1-p_A)^n\right] & odd \\
P\left[X^{(n)}=O_2\right]=(1-p)\sqrt{(L_1L_2)^n}\left[(1-p_A)^n\right] & even \\
P\left[X^{(n)}=O_2\right]=pL_1\sqrt{(L_1L_2)^{n-1}}\left[(1-p_A)^n\right] & odd
\end{array}\right\} ...(3.2)
$$

4. QUALITY OF SERVICE [QoS]

There are various categories type of user as (i) **Faitful user [FU]-A** user who is faithful to an operator O_1 otherwise, he goes to abandon state but does not attempt for O_2. The converse of it may as he attempt for O_2 and goes to state A. This describeds faitful users for operator O_1 and O_2 (ii) **Impatient user [IU]-** User who moves between the two operators O_1 and O_2 only all the time until call completes or abandon the process. (iii) **Non cyber criminals [NCC]** (IV) **Cyber Criminals [CC]**. Cyber Criminals are two types **(a) Non-Serious Cyber Criminals [NSCC] (b) Serious Cyber Criminals [SCC].** The quality of services provides by operators is a function of blocking probabilities (L_1 and L_2) faced by operators in the network. More and more blocking probability leads to lesser quality of service for users.

5. TRAFFIC SHARING AND CALL CONNECTION

5.1 Traffic Sharing by Non-Cyber Criminals [NCC]

$$
\left[\bar{P}_1^{(n)}\right]_{NCC}^{Even}=\left\{\begin{array}{l}
\dfrac{(1-L_1)c_1}{1-L_1L_2(1-p_A)^2}\left[p\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^n}\right\}\right. \\
\left.+(1-p)L_2(1-p_A)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^{n-2}}\right\}\right]
\end{array}\right\} ...(5.1)
$$

$$
\left[\bar{P}_1^{(n)}\right]_{NCC}^{Odd}=\left\{\begin{array}{l}
(1-L_1)c_1\left[p+(1-p)L_2(1-p_A)\right] \\
\dfrac{1-\sqrt{\left[1-\sqrt{L_1L_2(1-p_A)^2}\right]^n}}{1-L_1L_2(1-p_A)^2}
\end{array}\right\} ...(5.2)
$$

Similar for O_2

$$
\left[\bar{P}_2^{(n)}\right]_{NCC}=(1-L_2)c_1\left[\sum_{\substack{i=0\\ i=even}}^{n-2}P\left\{X^{(1)}=O_2\right\}+\sum_{\substack{i=0\\ i=even}}^{n-2}P\left\{X^{(1)}=O_2\right\}\right] ...(5.3)
$$

$$
\left[\bar{P}_2^{(n)}\right]_{NCC}^{Even}=\left\{\begin{array}{l}
\dfrac{(1-L_2)c_1}{1-L_1L_2(1-p_A)^2} \\
\left[(1-p)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^n}\right\}\right. \\
\left.+pL_1(1-p_A)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^{n-2}}\right\}\right]
\end{array}\right\} ...(5.4)
$$

$$
\left[\bar{P}_2^{(n)}\right]_{NCC}^{Odd}=\left\{\begin{array}{l}
(1-L_2)c_1\left[(1-p)+pL_2(1-p_A)\right] \\
\dfrac{1-\sqrt{\left[\sqrt{L_1L_2(1-p_A)^2}\right]^n}}{1-L_1L_2(1-p_A)^2}
\end{array}\right\} ...(5.5)
$$

5.2 Traffic Sharing By Cyber Criminals [CC]

$$\left[\bar{P}_1^{(n)}\right]_{CC}^{Even}=\left\{\begin{array}{l}\dfrac{(1-L_1)(1-c_1)}{1-L_1L_2(1-p_A)^2}\\ \left[p\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^n}\right\}\right.\\ \left.+(1-p)L_2(1-p_A)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^{n-2}}\right\}\right]\end{array}\right\}...(5.6)$$

$$\left[\bar{P}_1^{(n)}\right]_{CC}^{Odd}=\left\{\begin{array}{l}(1-L_1)(1-c_1)\left[p+(1-p)L_2(1-p_A)\right]\\ \dfrac{1-\sqrt{\left[\sqrt{L_1L_2(1-p_A)^2}\right]^n}}{1-L_1L_2(1-p_A)^2}\end{array}\right\}...(5.7)$$

Similar for O_2

$$\left[\bar{P}_2^{(n)}\right]_{CC}=\left\{\begin{array}{l}(1-L_2)(1-c_1)\\ \left[\sum_{\substack{i=0\\ i=even}}^{n-2}P\left\{X^{(i)}=O_2\right\}+\sum_{\substack{i=0\\ i=even}}^{n-2}P\left\{X^{(i)}=O_2\right\}\right]\end{array}\right\}...(5.8)$$

$$\left[\bar{P}_2^{(n)}\right]_{CC}^{Even}=\left\{\begin{array}{l}\dfrac{(1-L_2)(1-c_1)}{1-L_1L_2(1-p_A)^2}\\ \left[(1-p)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^n}\right\}\right.\\ \left.+pL_1(1-p_A)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^{n-2}}\right\}\right]\end{array}\right\}...(5.9)$$

$$\left[\bar{P}_2^{(n)}\right]_{CC}^{Odd}=\left\{\begin{array}{l}(1-L_2)(1-c_1)\left[(1-p)+pL_2(1-p_A)\right]\\ \dfrac{1-\sqrt{\left[\sqrt{L_1L_2(1-p_A)^2}\right]^n}}{1-L_1L_2(1-p_A)^2}\end{array}\right\}...(5.10)$$

5.3 Traffic Sharing By Non-Serious Cyber Criminals [NSCC]

$$\left[\bar{P}_1^{(n)}\right]_{NSCC}^{Even}=\left\{\begin{array}{l}(1-L_1)(1-c_1)c_1\left[P+(1-p)L_2(1-p_A)\right]\\ \dfrac{1-\sqrt{\left[\sqrt{L_1L_2(1-p_A)^2}\right]^{n-3}}}{1-L_1L_2(1-p_A)^2}\end{array}\right\}...(5.11)$$

Similar for O_2

$$\left[\bar{P}_2^{(n)}\right]_{NSCC}\left\{\begin{array}{l}=(1-L_2)(1-c_1)c_1\\ \left[\sum_{\substack{i=0\\ i=even}}^{n-3}P\left\{X^{(i)}=O_2\right\}+\sum_{\substack{i=0\\ i=even}}^{n-3}P\left\{X^{(i)}=O_2\right\}\right]\end{array}\right\}...(5.12)$$

$$\left[\bar{P}_1^{(n)}\right]_{NSCC}^{Even}=\left\{\begin{array}{l}(1-L_2)(1-c_1)c_1\left[(1-p)+pL_1(1-p_A)\right]\\ \dfrac{1-\sqrt{\left[\sqrt{L_1L_2(1-p_A)^2}\right]^{n-3}}}{1-L_1L_2(1-p_A)^2}\end{array}\right\}...(5.13)$$

$$\left[\bar{P}_2^{(n)}\right]_{NSCC}^{Odd}=\left\{\begin{array}{l}\dfrac{(1-L_2)(1-c_1)c_1}{1-L_1L_2(1-p_A)^2}\\ \left[(1-p)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^n}\right\}\right.\\ \left.+pL_1(1-p_A)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^{n-3}}\right\}\right]\end{array}\right\}...(5.14)$$

5.4 Traffic Sharing By Serious Cyber Criminals [SCC]

$$\left[\bar{P}_1^{(n)}\right]_{SCC}^{Even}=\left\{\begin{array}{l}(1-L_1)(1-c_1)(1-c_2)\\ \left[p+(1-p)L_2(1-p_A)\right]\dfrac{1-\sqrt{\left[\sqrt{L_1L_2(1-p_A)^2}\right]^{n-3}}}{1-L_1L_2(1-p_A)^2}\end{array}\right\}...(5.15)$$

$$\left[\bar{P}_1^{(n)}\right]_{SCC}^{Odd}=\left\{\begin{array}{l}\dfrac{(1-L_1)(1-c_1)(1-c_2)}{1-L_1L_2(1-p_A)^2}\\ \left[p\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^n}\right\}\right.\\ \left.+(1-p)L_2(1-p_A)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^{n-3}}\right\}\right]\end{array}\right\}...(5.16)$$

Similar for O_2

$$\left[\bar{P}_2^{(n)}\right]_{SCC}=\left\{\begin{array}{l}(1-L_2)(1-c_1)(1-c_2)\\ \left[\sum_{\substack{i=0\\ i=even}}^{n-3}P\left\{X^{(i)}=O_2\right\}+\sum_{\substack{i=0\\ i=odd}}^{n-3}P\left\{X^{(i)}=O_2\right\}\right]\end{array}\right\}...(5.17)$$

$$\left[\bar{P}_2^{(n)}\right]_{SCC}^{Even}=\left\{\begin{array}{l}(1-L_2)(1-c_1)(1-c_2)\left[(1-p)+pL_1(1-p_A)\right]\\ \dfrac{1-\sqrt{\left[\sqrt{L_1L_2(1-p_A)^2}\right]^{n-3}}}{1-L_1L_2(1-p_A)^2}\end{array}\right\}...(5.18)$$

$$\left[\bar{P}_2^{(n)}\right]_{SCC}^{Odd}=\left\{\begin{array}{l}\dfrac{(1-L_2)(1-c_1)(1-c_2)}{1-L_1L_2(1-p_A)^2}\\ \left[(1-p)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^n}\right\}\right.\\ \left.+pL_1(1-p_A)\left\{1-\sqrt{\left[L_1L_2(1-p_A)^2\right]^{n-3}}\right\}\right]\end{array}\right\}...(5.19)$$

6. BEHAVIOR OVER LARGE NUMBER OF ATTEMPTS

$$\bar{P}_1\left[\lim_{n\to\infty}\bar{P}_1^{(n)}\right], i=1,2$$

$$\left[\bar{P}_1\right]_{NCC}=\frac{(1-L_1)c_1}{1-L_1L_2(1-p_A)^2}\left[p+(1-p)L_2(1-p_A)\right]...(6.1)$$

$$\left[\bar{P}_2\right]_{NCC}=\frac{(1-L_2)c_1}{1-L_1L_2(1-p_A)^2}\left[(1-p)+pL_1(1-p_A)\right]...(6.2)$$

$$\left[\bar{P}_1\right]_{CC}=\frac{(1-L_1)(1-c_1)}{1-L_1L_2(1-p_A)^2}\left[p+(1-p)L_2(1-p_A)\right]...(6.3)$$

$$\left[\bar{P}_2\right]_{CC}=\frac{(1-L_2)(1-c_1)}{1-L_1L_2(1-p_A)^2}\left[(1-p)+pL_1(1-p_A)\right]...(6.4)$$

$$\left[\bar{P}_1\right]_{NSCC}=\frac{(1-L_1)(1-c_1)c_1}{1-L_1L_2(1-p_A)^2}\left[p+(1-p)L_2(1-p_A)\right]...(6.5)$$

$$\left[\bar{P}_2\right]_{NSCC}=\frac{(1-L_2)(1-c_1)c_1}{1-L_1L_2(1-p_A)^2}\left[(1-p)+pL_1(1-p_A)\right]...(6.6)$$

$$\left[\bar{P}_1\right]_{SCC}=\frac{(1-L_1)(1-c_1)(1-c_2)}{1-L_1L_2(1-p_A)^2}\left[p+(1-p)L_2(1-p_A)\right]...(6.7)$$

$$\left[\bar{P}_2\right]_{SCC}=\frac{(1-L_2)(1-c_1)(1-c_2)}{1-L_1L_2(1-p_A)^2}\left[(1-p)+pL_1(1-p_A)\right]...(6.8)$$

7. LEAST SQUARE CURVE FITTING

We suggest a linear relationship where a, b are constants

$$\bar{P}_1=\hat{a}+\hat{b}.L_1 \qquad ....(7.1)$$

Let ($(\bar{P}_{1i,}L_{1i})\ i=1,2,3....n$ be n observations generated from equation (6.1, 6.3, 6.5, 6.7) keeping values fixed for p, p_A and L_2. Suppose n=9 and blocking probabilities for L_1 are (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9) then using (8.1), the generated data of $\bar{P}_1$ is in table (1, 2, 3, 4, 5 and 6). The $\hat{P}_1$ is obtained using line equation (8.4) with $\hat{a},\hat{b}$.

8. FITTING THE STRAIGHT LINE

We suggest an approximate the relationship between parameter P_1 and L_1 through a straight line $\hat{P}_1=a+b.L_1$. The normal equations are

$$\left.\begin{aligned}\sum_{i=1}^{n}P_{1i}&=n.a+b\sum_{i=1}^{n}L_1\\ \sum P_{1i}.L_{1i}&=a\sum_{i=1}^{n}L_1+b\sum_{i=1}^{n}L_1^2\end{aligned}\right\} \qquad ...(8.1)$$

By solving the above equation the least square estimate are a and b are (denoted as $\hat{a},\hat{b}$):

$$\hat{a}=\left\{\frac{1}{n}\sum_{i=1}^{n}P_{1i}-\hat{b}\sum_{i=1}^{n}L_1\right\} \qquad ...(8.2)$$

$$\hat{b}=\left\{\frac{n\sum_{i=1}^{n}P_{1i}L_1-(\sum_{i=1}^{n}P_1)(\sum L_1)}{n\sum_{i=1}^{n}L_1^2-(\sum_{i=1}^{n}L_1)^2}\right\} \qquad ....(8.3)$$

Where n is the number of observations in sample (n) and the resultant straight line is

$$\hat{P}_1=\left\{\hat{a}+\hat{b}\,L_1\right\} \qquad ....(8.4)$$

The coefficient of determination (COD) is defined as

$$\text{COD}=\left\{\frac{\sum(\hat{P}_{1i}-\bar{P}_1)^2}{\sum(P_{1i}-\bar{P}_1)^2}\right\} \qquad ...(8.5)$$

Where $\bar{P}_1=\frac{1}{n}\sum P_{1i}$ is mean of original data of P_1 obtained through Markov chain model. The term $\hat{P}_1=\hat{a}+\hat{b}.L_1$ is the estimated value give observation L_1. The COD lies between 0 to 1. If the line is good fit then it is near to 1. We generate pair of value (L_1, P_1) from express tables (1, 2, 3, 4, 5, 6) by providing few fixed input parameter

Table 1 (By expression 6.1)

Fixed parameter p=0.4, L_2=0.3, p_A=02, C_1=0.3									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.1498	0.1358	0.1212	0.1061	0.0903	0.0738	0.0566	0.0386	0.0197
$\hat{P}_1$	0.1529	0.1366	0.1204	0.1042	0.0888	0.0717	0.0555	0.0393	0.0231
COD=0.9977									

$$\hat{a}=0.16908;\quad \hat{b}=-0.16222;\hat{P}_1=a+b.L_1;\quad \hat{P}_1=0.16908-0.16222.(L_1) \qquad ...(8.4.1)$$

Table 2 (By expression 6.1)

Fixed parameter p=0.6, L_2=0.5, p_A=02, C_1=0.5									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.3533	0.3248	0.2942	0.2615	0.2262	0.1881	0.1469	0.1022	0.0534
$\hat{P}_1$	0.3685	0.3285	0.2912	0.2544	0.2167	0.1795	0.1422	0.1049	0.0677
COD=0.9924									

$$\hat{a} = 0.403034; \quad \hat{b} = -0.37261; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.403034 - 0.37261)(L_1) \qquad ...(8.4.2)$$

Table 3 (By expression 6.1)

Fixed parameter p=0.8, L_2=0.7, p_A=02, C_1=0.7									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.5579	0.5049	0.4499	0.3929	0.3337	0.2722	0.2082	0.1416	0.0723
$\hat{P}_1$	0.5684	0.5078	0.4472	0.3866	0.3261	0.2653	0.2047	0.1441	0.0835
COD=0.9981									

$$\hat{a} = 0.628966; \quad \hat{b} = -0.606033; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.628966 - 0.606033)(L_1) \qquad ...(8.4.3)$$

Table 4 (By expression 6.3)

Fixed parameter p=0.4, L_2=0.3, p_A=02, C_1=0.3									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.3494	0.3168	0.2829	0.2475	0.2106	0.1722	0.1321	0.0909	0.0460
$\hat{P}_1$	0.3567	0.3188	0.2810	0.2431	0.2053	0.1674	0.1296	0.0917	0.0539
COD=0.9977									

$$\hat{a} = 0.394521; \quad \hat{b} = -0.378522; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.394521 - 0.378522)(L_1) \qquad ...(8.4.4)$$

Table 5 (By expression 6.3)

Fixed parameter p=0.6, L_2=0.5, p_A=02, C_1=0.5									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.3533	0.3248	0.2942	0.2615	0.2262	0.1881	0.1469	0.1022	0.0534
$\hat{P}_1$	0.3685	0.3285	0.2912	0.2541	0.2167	0.1795	0.1422	0.1049	0.0644
COD=0.9924									

$$\hat{a} = 0.403034; \quad \hat{b} = -0.37261; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.403034 - 0.37261)(L_1) \qquad ...(8.4.5)$$

Table 6 (By expression 6.3)

Fixed parameter p=0.8, L_2=0.7, p_A=02, C_1=0.7									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.2391	0.2164	0.1928	0.1684	0.1433	0.1166	0.0892	0.0607	0.0313
$\hat{P}_1$	0.2436	0.2176	0.1916	0.1657	0.1397	0.1137	0.0877	0.0618	0.0358
COD=0.9981									

$$\hat{a} = 0.269557; \quad \hat{b} = -0.25973; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.269557 - 0.25973)(L_1) \qquad ...(8.4.5)$$

Table 7 (By expression 6.5)

Fixed parameter p=0.4, L_2=0.3, p_A=02, C_1=0.3									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.1048	0.0955	0.0849	0.0742	0.0632	0.0516	0.0396	0.0277	0.0138
$\hat{P}_1$	0.1077	0.0956	0.0843	0.0729	0.0616	0.0502	0.0389	0.0275	0.0162
COD=0.9976									

$$\hat{a} = 0.118356; \quad \hat{b} = -0.11356; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.118356 - 0.11356)(L_1) \qquad ...(8.4.7)$$

Table 8 (By expression 6.5)

Fixed parameter p=0.6, L_2=0.5, p_A=02, C_1=0.5									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.1767	0.1624	0.1471	0.1307	0.1131	0.0941	0.735	0.0511	0.0267
$\hat{P}_1$	0.1829	0.1643	0.1456	0.1277	0.1084	0.0897	0.0711	0.0525	0.0338
COD=0.9925									

$$\hat{a} = 0.201517; \quad \hat{b} = -0.18631; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.201517 - 0.18631)(L_1) \qquad ...(8.4.8)$$

Table 9 (By expression 6.5)

Fixed parameter p=0.8, L_2=0.7, p_A=05, C_1=0.7									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.1674	0.1515	0.1355	0.1179	0.1001	0.0817	0.0625	0.0425	0.0217
$\hat{P}_1$	0.1705	0.1523	0.1341	0.1166	0.0978	0.0796	0.0614	0.0432	0.0251
COD=0.9981									

$$\hat{a} = 0.18869; \quad \hat{b} = -0.18181; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.18869 - 0.18181)(L_1) \qquad ...(8.4.9)$$

Table 10 (By expression 6.7)

Fixed parameter p=0.4, L_2=0.3, p_A=02, C_1=0.3, C_2=0.3									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.2795	0.2534	0.2263	0.1988	0.1685	0.1377	0.1056	0.0722	0.0368
$\hat{P}_1$	0.2853	0.2551	0.2248	0.1945	0.1642	0.1339	0.1036	0.0734	0.0431
COD=0.9976									

$$\hat{a} = 0.315617; \quad \hat{b} = -0.30282; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.315617 - 0.30282)(L_1) \qquad ...(8.4.10)$$

Table 11 (By expression 6.7)

Fixed parameter p=0.6, L_2=0.5, p_A=02, C_1=0.4 ,C_2=0.5									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.2122	0.1949	0.1765	0.1569	0.1357	0.1129	0.0881	0.0613	0.0322
$\hat{P}_1$	0.2195	0.1971	0.1747	0.1524	0.1333	0.1077	0.0853	0.0633	0.0406
COD=0.9925									

$$\hat{a} = 0.24182; \quad \hat{b} = -0.22357; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.24182 - 0.22357)(L_1) \qquad ...(8.4.11)$$

Table 12 (By expression 6.7)

Fixed parameter p=0.8, L_2=0.7, p_A=02, C_1=0.6, C_2=0.7									
L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
P_1	0.0956	0.0865	0.0771	0.0674	0.0572	0.0467	0.0357	0.0243	0.0124
$\hat{P}_1$	0.0974	0.0877	0.0767	0.0663	0.0559	0.0455	0.0351	0.0247	0.0143
COD=0.9981									

$$\hat{a} = 0.107823; \quad \hat{b} = -0.10389; \hat{P}_1 = a + b.L_1; \quad \hat{P}_1 = (0.107823 - 0.10389)(L_1) \qquad ...(8.4.12)$$

9. CONFIDENCE OF INTERVALS (COI)

The 100(1- α) percent confidence interval for a and b are

$$\hat{a} \pm \left\{ t_{(n-2)} \frac{\alpha}{2} \right\}.s \left[\sqrt{\frac{1}{n} + \frac{\overline{L_1}}{\sum_{i=1}^{n} (L_{1i} - \overline{L_1})^2}} \right] ...(9.1)$$

Where $\overline{L_1} = \frac{1}{n} \sum_{i=0}^{n} L_{1i}$. The $\overline{L_1}$ = 4.5 from table (6.1, 6.2, 6.3, 6.4, 6.5, 6.6)

$$\hat{b} \pm \left\{ t_{(n-2)}, \frac{\alpha}{2} \right\}.s \left[\sqrt{\sum_{i=1}^{n} (L_{1i} - \overline{L_1})^2} \right] \quad ...(9.2)$$

Where s= $\sqrt{\frac{\sum (P_i - \hat{P}_i)^2}{n-2}}$ and $t_{(n-2)} \frac{\alpha}{2}$ is obtained from standard table.

take α=0.05,n=9 then t_7,0.025=2.365

Table: 13 Confidence interval for a and b

Fixed parameter	Constant a	Constant b	Confidence Interval
p=0.4,L_2=0.3,p_A=0.2, C1=0.3	$\hat{a}$ =0.1690	$\hat{b}$ =-0.1622	(a=0.16381, a=0.17435) (b=-0.15800,b=-0.16642)
p=0.6,L_2=0.5,p_A=0.2, C1=0.5	$\hat{a}$ =0.403034	$\hat{b}$ =-0.372	(a=0.38117, a=0.42489) (b=-0.35522, b=-0.39003)
p=0.8,L_2=0.7,p_A=0.2, C1=0.5	$\hat{a}$ =0.6289	$\hat{b}$ =-0.6060	(a=0.61121, a=0.64673) (b=-0.59188, b=-0.62018,)
Average Estimates	$\bar{a} = 0.4003$	$\bar{b} = -0.3803$	$\hat{P}_1 = \bar{a} + \bar{b}(L_1)$ $\hat{P}_1 = 0.4003 - 0.3802(L_1)$

Table: 14 Confidence interval for a and b

Fixed parameter	Constant a	Constant b	Confidence Interval
p=0.4,L_2=0.3,p_A=0.2, C1=0.3	$\hat{a}$ =0.3945	$\hat{b}$ =-0.3785	(a=0.382227, a=0.406814) (b=-0.36873,b=-0.388315)
p=0.6,L_2=0.5,p_A=0.2, C1=0.5	$\hat{a}$ =0.4030	$\hat{b}$ =-0.3726	(a=0.381174, a=0.424893) (b=-0.355201, b=-0.390025)
p=0.8,L_2=0.7,p_A=0.2, C1=0.5	$\hat{a}$ =0.2695	$\hat{b}$ =-0.2597	(a=0.261945, a=0.277171) (b=-0.25366, b=-0.26579)
Average Estimates	$\bar{a} = 0.3557$	$\bar{b} = -0.3369$	$\hat{P}_1 = \bar{a} + \bar{b}(L_1)$ $\hat{P}_1 = 0.3557 - 0.3369.(L_1)$

Table: 15 Confidence interval for a and b

Fixed parameter	Constant a	Constant b	Confidence Interval
p=0.4,L_2=0.3,p_A=0.2, C1=0.3	$\hat{a}$ =0.1183	$\hat{b}$ =-0.1135	(a=0.114668, a=0.122044) (b=-0.110622,b=-0.116491)
p=0.6,L_2=0.5,p_A=0.2, C1=0.5	$\hat{a}$ =0.2015	$\hat{b}$ =-0.1863	(a=0.190587, a=0.212447) (b=-0.17761, b=-0.195011)
p=0.8,L_2=0.7,p_A=0.2, C1=0.7	$\hat{a}$ =0.1886	$\hat{b}$ =-0.1818	(a=0.183361, a=0.194019) (b=-0.17757, b=-0.18605)
Average Estimates	$\bar{a} = 0.1695$	$\bar{b} = -0.1605$	$\hat{P}_1 = \bar{a} + \bar{b}(L_1)$ $\hat{P}_1 = 0.1695 - 0.1605.(L_1)$

Table: 16 Confidence interval for a and b

Fixed parameter	Constant a	Constant b	Confidence Interval
p=0.4,L_2=0.3,p_A=0.2, C_1=0.2, C_2=0.3	$\hat{a}$ =0.3156	$\hat{b}$ =-0.3028	(a=0.305782, a=0.325452) (b=-0.294988,b=-0.310655)
p=0.6,L_2=0.5,p_A=0.2, C_1=0.4, C_2=0.5	$\hat{a}$ =0.2418	$\hat{b}$ =-0.2235	(a=0.228704, a=0.254936) (b=-0.213122, b=-0.231022)
p=0.8,L_2=0.7,p_A=0.2, C_1=0.6, C_2=0.7	$\hat{a}$ =0.1078	$\hat{b}$ =-0.1038	(a=0.104778, a=0.110868) (b=-0.101477, b=-0.106322)
Average Estimates	$\bar{a} = 0.2217$	$\bar{b} = -0.2101$	$\hat{P}_1 = \bar{a} + \bar{b}(L_1)$ $\hat{P}_1 = 0.2217 - 0.2101.(L_1)$

10. CONCLUSION

The expression showing the simple relationships between variables $\overline{P_1}$ *and* L_1, as derived by Naldi (2002) are complicated and having many input parameters like p, p_A, L_2 etc. If we keep all these six fixed, the expression of relationship is even not simple. By using of method least square the linear approximate relationship is displayed in table1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12. .The coefficients of determination (COD) have values near to 1 showing the best fitting of straight line between $\overline{P_1}$ *and* L_1. The confidence interval for estimated value $\hat{a}$ *and* $\hat{b}$ are tables 13, 14, 15 and 16 indication for good fitting of line.

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