A MACRO DEMOGRAPHIC AND SOCIO-ECONOMIC DEVELOPMENT MODEL

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1. Introduction

Population has occupied the attention of the statesmen and philosophers since ancient times, but it is only recently that scholars have attempted to investigate systematically the factors of population growth or decline and the specific way in which population changes may influence social institutions and human welfare.

The factors contributing to current interest in this field include :

1. The extension and improvement of the methods of collecting and analysing statistical data.
2. The contributions of other discplines such as, Economics, Sociology, Psychology and Mathematics to the understanding of population dynamics.
3. The continuous increase in the world population especially in the developing countries which suffer from the lack of adequate economic resources.

The definition of the population problems moved from one extreme to another from ancient history to the present. According to ancient Chinese philosophers, the problem was how to increase the population to the size at which the society became economically self-sufficient

and capable of defending itself.
The European merchantilists of the 17th and 18th centries found that the problem was how to increase the population to the size at which governments could meet the strong military, political and economic competition. Recently, however, the problem evolved into that of over-population and how to control the growth of population in order to achieve a better standard of living.

Most governments in developing societies now have, or are trying to develop, a national population policy, especially after the observed decline in the growth and birth rates in the developed countries. There is, however, a lack of systematic theory as to how to bring about the change in fertility level, on which population policies in the developing countries may be based. The fact that all developed societies have low fertility is well known, but the factors responsible for that are still subject to many questions and conflictions interpretations.
One of the recommendations of the World Population Conference, held in Bucharest in 1974, was that :

> "The Governments of member of states, the United Nations and its speciatised agencies intensify on the impact of different combinations of components of socio-economic development policies on demographic behaviour and trends as suggested in the report of the Cairo symposium on the consequences of population trend on socio-economic and environment variables."

This paper presents a model for demographic and socio-economic development indicators.

2. Review of the Available Literature

The relation between population growth and the socio-economic development took a lot of the demographer's efforts as well as the economist's efforts in trying to reconcile the demographic factors with the socio-economic factors by which they might have found the explanation or the solution for that difficult problem, mainly that a high population growth rate will obstruct the achievement of socio-economic development, yet at the same time socio-economic development is the way by which the population problem can be solved.

Weintraub (1962), constructed a single equation using the Least Squares Method with the actual mean birth rate (1953-1954) as a dependant variable and the mean per capita income (1953-1954), ratio of population classified as firm and mean infant mortality rate (1953-1954) as three independant variables. He depended upon cross section data about these variables from thirty countries, their crude birth rate varied from 46.6 to 14.8 per thousand. His study attempts to test empirically the hypothesis that economic growth will prevent excessive population growth.

Adelman (1963) constructed two models, one of them to explain the age specific fertility rate by the real per capita national income, per cent of labour force employed outside of agriculture, education index and the number of inhabitants per square mile. The other model explained the age specific mortality rate by population density, ratio of growth of per capita income, physiciance per thousand population,

an education index and per cent of labour force outside agriculture. Her model was a mutiple linear regression model for the logarithms of the variables. She depended upon data from thirty countries whose annual per capita ranged from $.125 to $.1900.

Heer (1966) tested both additive and multiplication relationships between male fertility as a dependant variable and per capita net product, newspaper circulation per thousand personnel aged fifteen and over, infant mortality rate, population density and per cent increase in per capita energy consumption as independent variables. He depended upon cross section data from 41 countries (24 developing and 17 developed) during the 1950 decade. He conclude that the indirect effect of economic development is a decline in fertility and that a reduction in fertility is a necessary condition for socio-economic development.

Friedlander and Silver (1967) tried to specify independent variables to separate economic from social and political variables, and to make distinct comparisons of fertility responses in developed and developing countries using regressional analysis. They determined positive and statistically significant relations between fertility and illiteracy, child mortality, proportion of agricultural population, the proportion of non-farm self-employment and over-crowded housing. They also found a negative significant relationship between fertility and communism The most important conclusion is that the signs of the regression coefficient for the separate level of development are the same as

those for all countries combined. They depended upon data from 112 countries (18 developed, 20 intermediate and 74 developing countries).

Ekanem (1973) examined Heer's relationship between fertility levels and socio-economic development. He depended upon data from developing countries but for two point in time. He found out that whether the the analysis of that relation is restricted to developing countries it is true that the increase in economic development implies a decrease in illiteracy as well as a decrease in infant mortality rate. He also concludes that a decrease in illiteracy as well as infant mortality rate are a necessary condition of low fertility.

Amanke (1973), tested the degree of association between socio-economic indicators which are per capita income, per cent urban, per cent of non-agricultural workers, per cent of female workers, per centage of literate females and family planning performance rate (sterilisation rate, I.U.D. insertion rate, conventional contraception use rate, budget expenditure rate). He depended upon cross-section data from sixteen Indian states during the 1960 decade.

Lanomitz (1973), depended upon Ekanem's data in order to determine whether the variables that have the major impact in explaining variation in fertility cross-section also pay the major role in explaining trends over time. He found out that over time the only variable that has had a significant impact of birth rate is per capita income. The World Bank (1974), used the step wise multiple

regression analysis to investigate the relation to size distribution of of income to fertility and its implication for development policy. The main conclusion of that study is that direct population policies and general development policies re-enforce each other in raising per capita income especially amongst the poor and reducing fertility.

Fergany (1975) used the multiple regression analysis to test the relation between C.B.R. and some development indicators..

The above are only examples of the models studied done at this point. There are also some other models designed for specific countries like Coale and Hoover (1985) for India, Hoover and Periman for Pakistan, and Newman & Allen (1976) for Nicaragua.

The mentioned models and studies could be characterised by :-

1. The relation between the level of fertility and the socio-economic development was explained by using either of the following techniques :-
   a. The simple regression analysis
   b. Multiple regression analysis
   c. Step wise regression analysis
2. The analysis assumed that the relation between the level of fertility and the socio-economic development indicators is linear.

3. The inter-relationship between the socio-economic indicators has been neglected.
4. The number of indicators were limited and does not represent most of the affective factors in the socio-economic development process.
5. The data used in constructing these models became out of date.

3. Construction of the Model

1. Let :-

   I. Y be a variable representing the level of fertility

   II. $X_1, X_2, X_3 \ldots X_n$ any n variables representing the socio-economic development indicators.

2. Assume that Y is a function of those n variables $X_1, X_2, X_3 \ldots\ldots X_n$ of the form :-

$$Y = F(X_1, X_2, X_3 \ldots\ldots, X_n) + \varepsilon \text{ where } \varepsilon \sim (0, 6^2)$$

3. The relation between Y and each variable could be as follows :-

$$Y = f_1(X_1) + \varepsilon_1 \quad \text{where} \quad \varepsilon_1 \sim N(0, 6_1^2)$$

$$Y = f_2(X_2) \quad \varepsilon_2 \quad \text{where} \quad \varepsilon_2 \sim N(0, 6_2^2)$$

$$Y = f_3(X_3) + \varepsilon_3 \quad \text{where} \quad \varepsilon_3 \sim N(0, 6_3^2)$$

till $Y_n = f_n(X_n) + \varepsilon_n$ where $\varepsilon_n \sim N(0, \sigma_n^2)$

where $F_1(X_1)$ could be one of the following functions :-

I) $f(X) = A + BX$

II) $f(X) = A \ EXP(BX)$

III) $f(x) = AX^B$

IV) $f(x) = A + B/X$

V) $f(x) = 1 / (A + BX)$

VI) $f(x) = X / (A + BX)$

where A,B are the parameters of the equation and the selection of one of these relation depend upon the value of R^2 which gives the percentage of the variation explained by the relation.

4. Assume that the relation between Y and the X's is as follows :-

$$Y = \alpha_1 Y + \alpha_2 Y + \alpha_3 Y + \ldots + \alpha_n Y$$

$$= \alpha_1 (f_1(x_1) + \varepsilon_1) + \alpha_2 (f_2(X_2) + \varepsilon_2) + \alpha_3 (f_3(x_3) + \varepsilon_3)$$

$$+ \ldots + \alpha_n (f_n(X_n) + \varepsilon_n)$$

$$= \sum_{i-1}^{n} (\alpha_i (f_i(x_i) + \varepsilon_i)$$

i.e. Y is the weighted function of each of the above

functional relations and the coefficients $\alpha_1, \alpha_2, \alpha_3 \ldots, \alpha_n$

should satisfy the following relation :

$$\sum_{i-1}^{n} \alpha_i = 1$$

5. The assumed model given in (2) shows that the variance of Y is :-

$$V(Y) = \alpha_1^2 \sigma_1^2 + \alpha_2^2 \sigma_2^2 + \alpha_3^2 \sigma_3^2 + \alpha_4^2 \sigma_4^2 + \ldots \alpha_n^2 \sigma_n^2$$
$$+ 2\rho_{12} \alpha_1 \alpha_2 \sigma_1 \sigma_2 + 2\rho_{13} \alpha_1 \alpha_3 \sigma_1 \sigma_3 + \ldots$$
$$+ 2\alpha_{1n} \alpha_1 \alpha_n \alpha_1 \alpha_n + \ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$\ldots\ldots\ldots\ldots\ldots\ldots + 2\rho_{(n-1)\,n} \alpha_{n-1} \alpha_n \sigma_{n-1} \sigma_n$$

where :-

σ_1^2 is the variance of ε_i

$\rho_{i,J}$ is the correlation coefficient between ε_i & ε_J

$i, J = 1,2,3, \ldots, ., n$ & $i \neq J$

6. To achieve the minimum of the variance of Y under the condition that $\Sigma_i \alpha = 1$, the Lagrange's multiplier method can be used to determine the a's that minimise the function :

$$V(Y) = (\alpha_1^2 \sigma_1^2 + \alpha_2^2 \sigma_2^2 + \ldots\ldots$$
$$+ 2\rho_{(n-1)\,n}\, \alpha_{n-1}\, \alpha_n\, \sigma_{n-1}\, \sigma_n$$

$$+ \lambda (\alpha_1 + \alpha_2 + \alpha_3 + \ldots\ldots + \alpha_n - 1)$$

where λ is the Lagrange's multiplier.

7. To determine the α's, the following equation should be obtained :-

$$-\ \delta V(Y)/\delta\alpha_i = 0,\ i = 1,2,3,\ldots.n$$

$$-\ \delta V(Y)/\delta\lambda = 0$$

which could be written in the matrix form :-

$$
\begin{bmatrix}
\sigma_1^2 & \rho_{12}\sigma_1\sigma_2 & \rho_{13}\sigma_1\sigma_3 & \cdots & \rho_{1n}\sigma_1\sigma_n & 1 & 0.5 \\
\rho_{12}\sigma_1\sigma_2 & \sigma_2^2 & \rho_{23}\sigma_2\sigma_3 & \cdots & \rho_{2n}\sigma_2\sigma_n & 1 & 0.5 \\
\rho_{13}\sigma_1\sigma_3 & \rho_{23}\sigma_2\sigma_3 & \rho_3^2 & \cdots & \rho_{3n}\sigma_3\sigma_n & 1 & 0.5 \\
\cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\
\rho_{1n}\sigma_1\sigma_n & \rho_{2n}\sigma_2\sigma_n & \rho_{3n}\sigma_3\sigma_n & \cdots & \sigma_n^2 & 1 & 0.5 \\
1 & 1 & 1 & \cdots & 1 & 0 & 0
\end{bmatrix}
\begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \cdots \\ \alpha_n \\ \lambda \end{bmatrix}
=
\begin{bmatrix} 0 \\ 0 \\ 0 \\ \cdots \\ 0 \\ 1 \end{bmatrix}
$$

The solution of the above system of equations gives the values of α's by which the construction of the model completes.

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4. Definition of the Model's Variables and Data Collection

The model consists of one dependent variable representing the level of fertility and a dependent variables representing the most affecting factors in the socio-economic development process which acting together - and of course with other factors- to produce a certain level of development.

The crude birth rate selected as an index of the level of fertility because it is affected with many factors such as the age-sex structure, nuptiality condition and marital fertility which are associated with the level of the socio-economic development.

The independent variables Table (1) selected according to :-

1. The absolute value of the correlation coefficient between these indicators and the crude birth rate should be more than 0.5.
2. The availability of the data about these indicators in international data sources.(1)

The data needed could be obtained by two approaches.

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(1) In fact the availability of the data and the difficulty of measuring some factors constructed a major limitation to variables to be included like old social security systems, the political system, political conflicts, individual freedom and the degree of religiousity.

The first one depends upon time series data for one country and the other depends upon a cross-section data from a number of countries at the same point of time. The last alternative more suitable for this study because it is very difficult to find a reasonable time series data for most of the socio-economic indicators even in some developed countries like the USA and if it is found it would suffer from defection especially in the developing countries, and the use of the cross-section approach makes it feasible to consider the largest range of observed variation on the variables considered.

The countries selected tables (2) with a way to satisfy the following conditions :-

1. Representing different developing stages
2. Cover the five continents in the world
3. The population of every country over 1.5 million (1)
4. The missing values from the selected socio-economic indicators for every country should be less than four values.

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(1) In order to eliminate countries that may have special conditions due to their size and the data about such countries usually suffered from defections.

The selected socio-economic development indicators could be classified according to their nature as follows :-

a. Economic Indicators

1. Per Capita Gross National Product

This indicator is commonly used as a proxy for economic development, but it could not be used alone because some countries may have high per capita G.N.P. in spite of their economic development level still low like some of the Petroleum export countries. Data concerning this indicator suffered from the difference between the systems of national accounts.

The collected data (Europa Publications, 1973) about these indicators shows the following results :-

I The mean equal to 899.452

II The standard deviation equal to 873.945

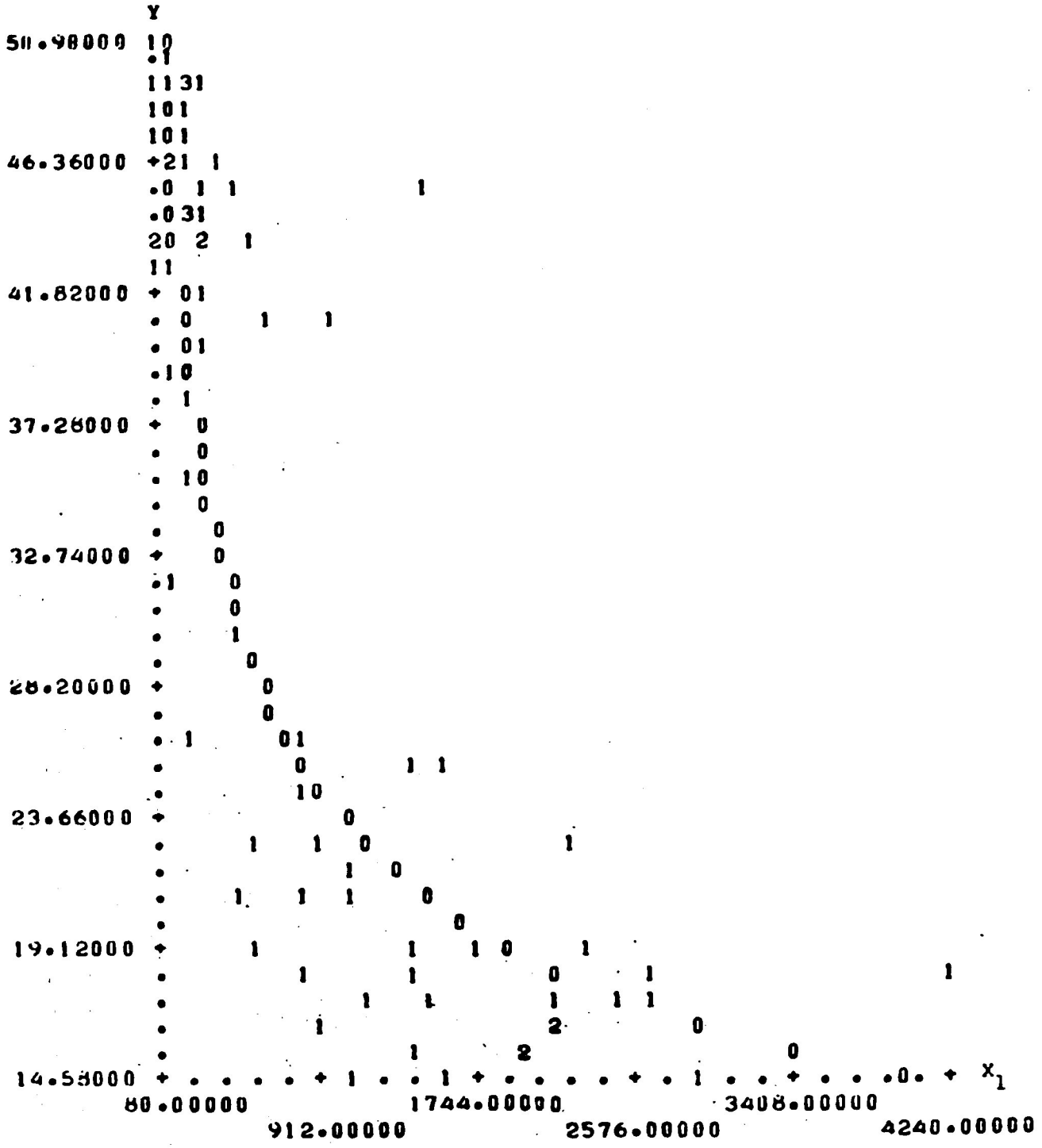
III The correlation coefficient between this indicator and the level of fertility equal to -0.74957 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (1)

2. Per Capita Energy Consumption

Energy consumption is sometimes thought to be even

Figure (1)

The Scatter Diagram and The Fitted Curve for the Relation Between the C.B.R. and Per Capita G.N.P.



more indicative of a country's level of development than per capita G.N.P. because it shows relative modernisation of power facilities. The data (U.N., 1973b) about this indicator shows :-

1 The mean equal to 2023.32

11 The standard deviation equal to 2354.5

111 The correlation coefficient between this indicator and the previous indicator is high and positive as expected 0.90645, and the correlation with the level of fertility is negative and the correlation coefficient equal - 0.75147 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (2).

3. Per Capita Steel Consumption

Steel is the basic material for industrialisation and construction, so this indicator could give a good idea about the level of industrialization in any country.

The data (U.N., 1973b) collected from this indicator shows that :-

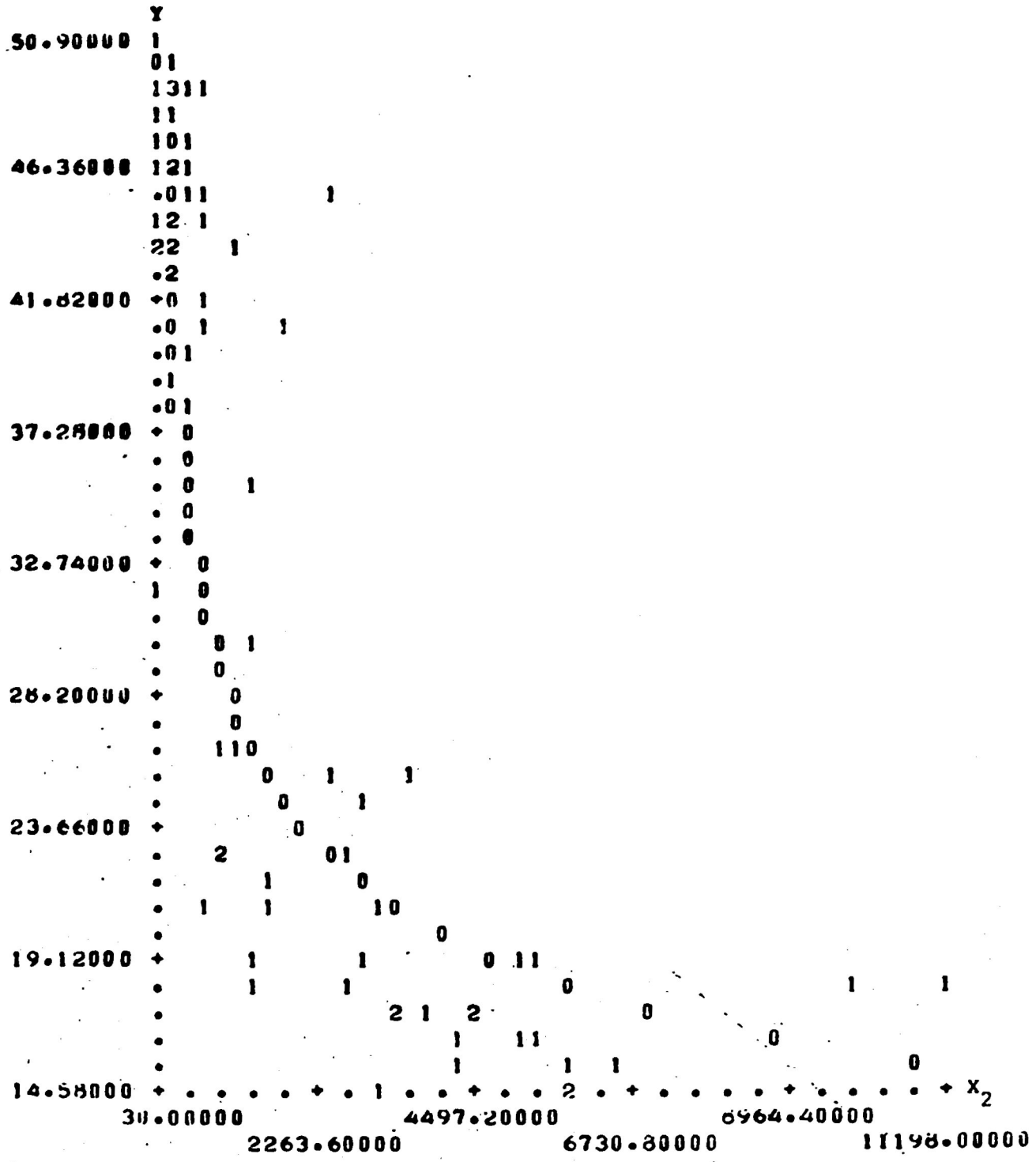
1 The arithmatic mean equal to 167.246

11 The standard deviation equal to 195.478

111 The correlation coefficicient between per capita steel consumption and the level of fertility equal

Figure (2)

The Scatter Diagram and the Fitted Curve for the Relation Between the C.B.R. and Per Capita Energy Consumption



to - 0.77617, and with the previous two indicators are 0.84498 to 0.849596 respectively which are significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (3).

4. Motor Vehicles in Use Per 1000 Population

This indicator is particularly relevant to the transportation network and should show to some degree the latent geographic mobility of population, goods and services. Ideally road and rail network figures should be included but good data is lacking. Data on numbers of bicycle - the prime method of transport in many developing areas - are impossible to obtain. However motor vehicles in use show the relative volume of transport which is an essential factor for the socio-economic development. The data about motor vehicles in use is available from S.Y.B. (U.N., 1973b) and it can easily be computed from which the following results could be deduced :

I The arithmatic mean equal to 70.3111

II The standard deviation equal to 101.191

III The correlation coefficient between this indicator and the level of fertility equal to - 0.63165 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (4).

Figure (3)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
Per Capita Steel Consumption

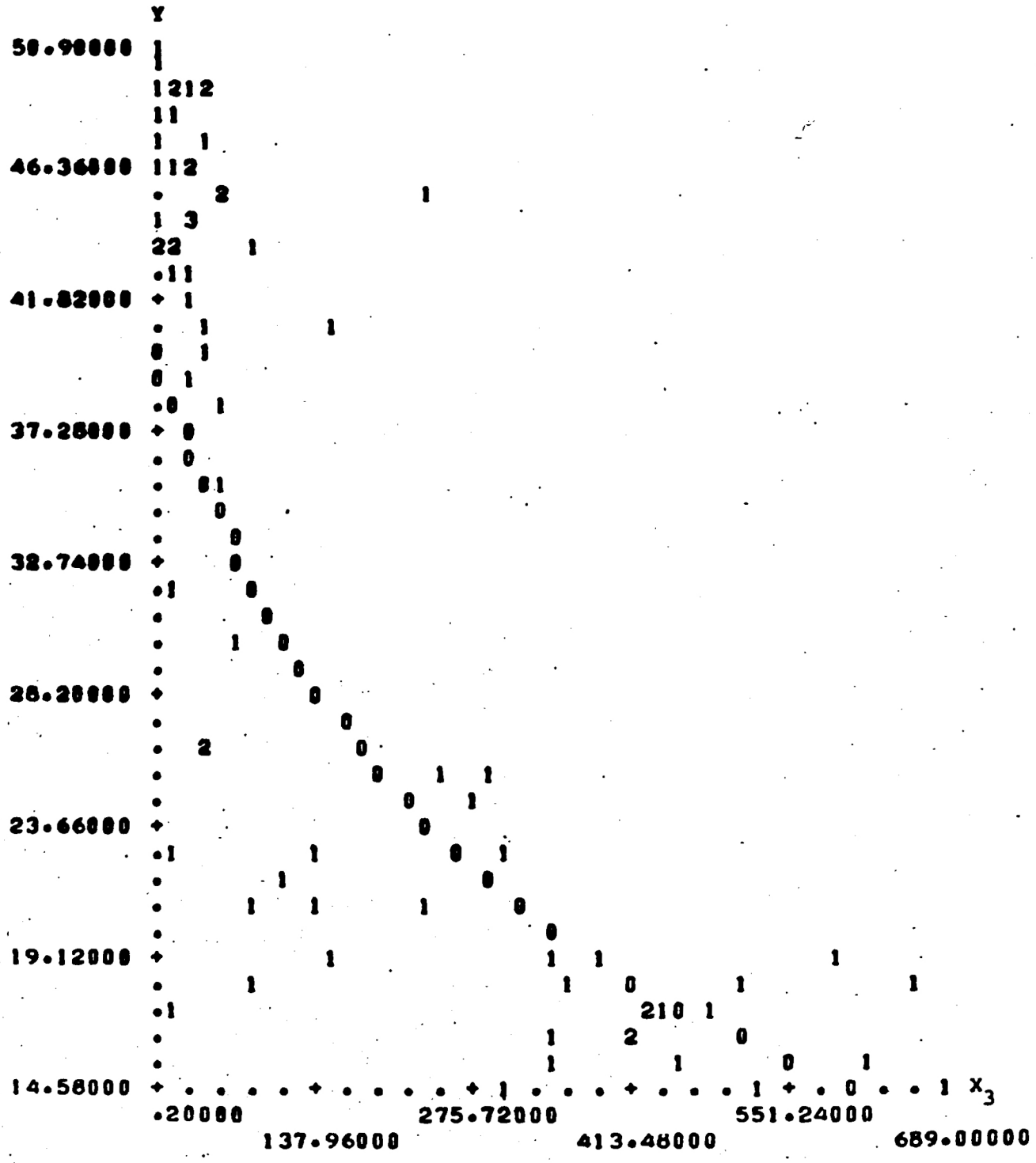
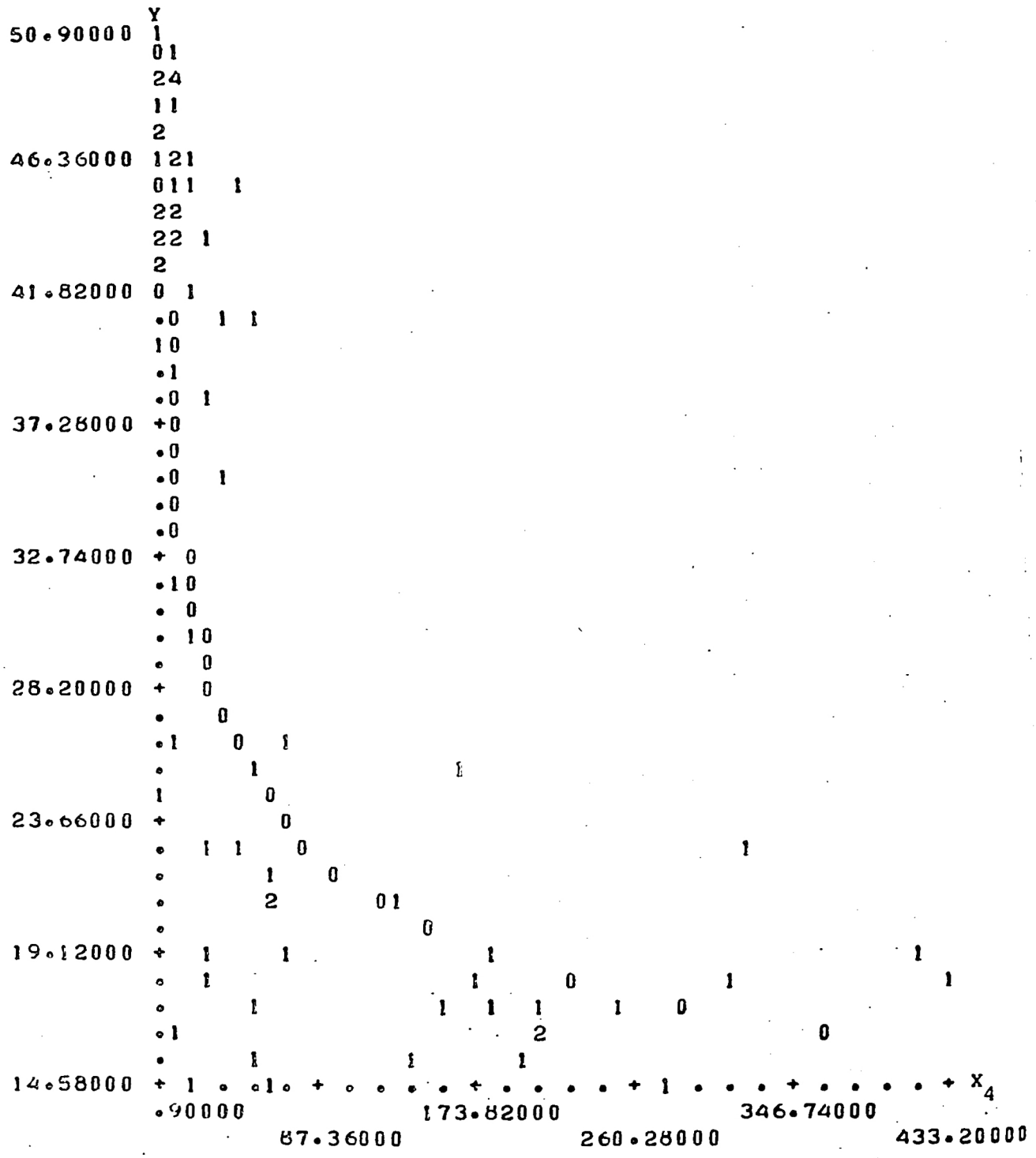


Figure (4)

The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
the No. of Motor Vehicles in Use Per 1000 Population



5. Number of Agricultural Tractors Per 1000 Hectares of Agricultural Land

Agriculture represents an important sector in many countries. The use of agricultural tractors means that modern and technological methods are applied in cultivating the land. It could reflect also that there is a lack of agricultural workers because the development in the other economic sector allures them. The data (U.N., 1975) & (F.A.O., 1972) about this indicator shows :-

1 The arithmetic mean equal to 12.807

11 The standard deviation equal to 22.6265

111 The correlation coefficient between these indicators and the level of fertility equal to - 0.59634 which is significant with 0.99 confidence coefficient. The scatter diagram shown in Figure (5).

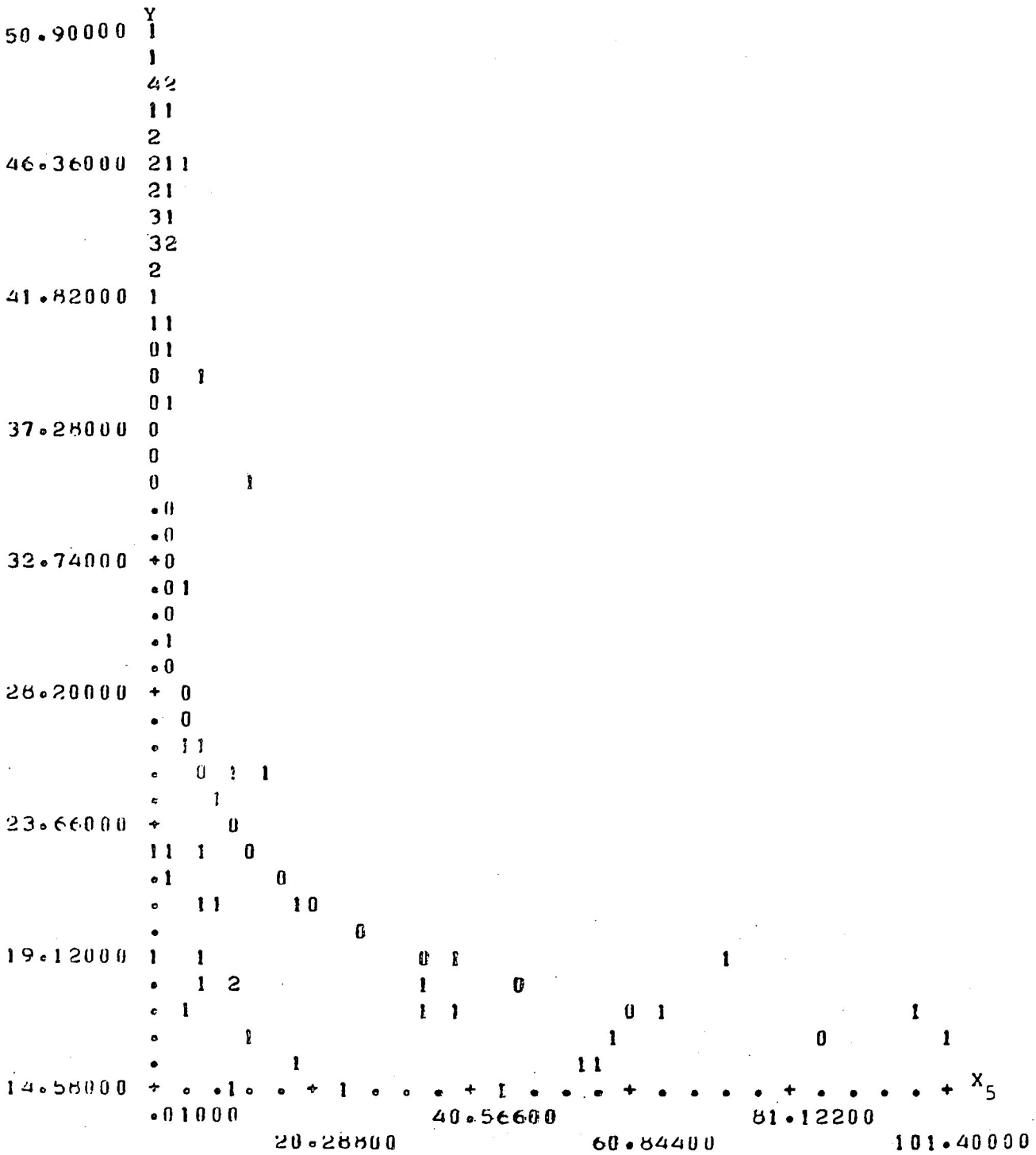
b. Cultural Indicators

1. Number of Radio Broadcasting Receivers Per Thousand Population

This is an indicator of community awareness, and it shows how many ears a government can reach for expounding its development policies.

Figure (5)

The Scatter Diagram and the Fitted Curve for the Relation Between the C.B.R. and the No. of Agricultural Tractors Per 1000 Hecters of Agricultural Land



In many developing areas the radio is the most important of adult education programmes. There are data available for many countries over time (UNESCO, 1973) although differences in measurement do exist because some measure the number of licenses, and others the number of receivers. In spite of that the following results could be deduced :-

1 The arithmetic mean equal to 212.25

11 The standard deviation equal to 213.82

111 The correlation coefficient between this indicator and the level of fertility equal to - 0.52977 which is significant with 0.95 confidence coefficient. The scatter diagram shows in Figure (6).

2. Number of T.V. Receivers Per Thousand Population

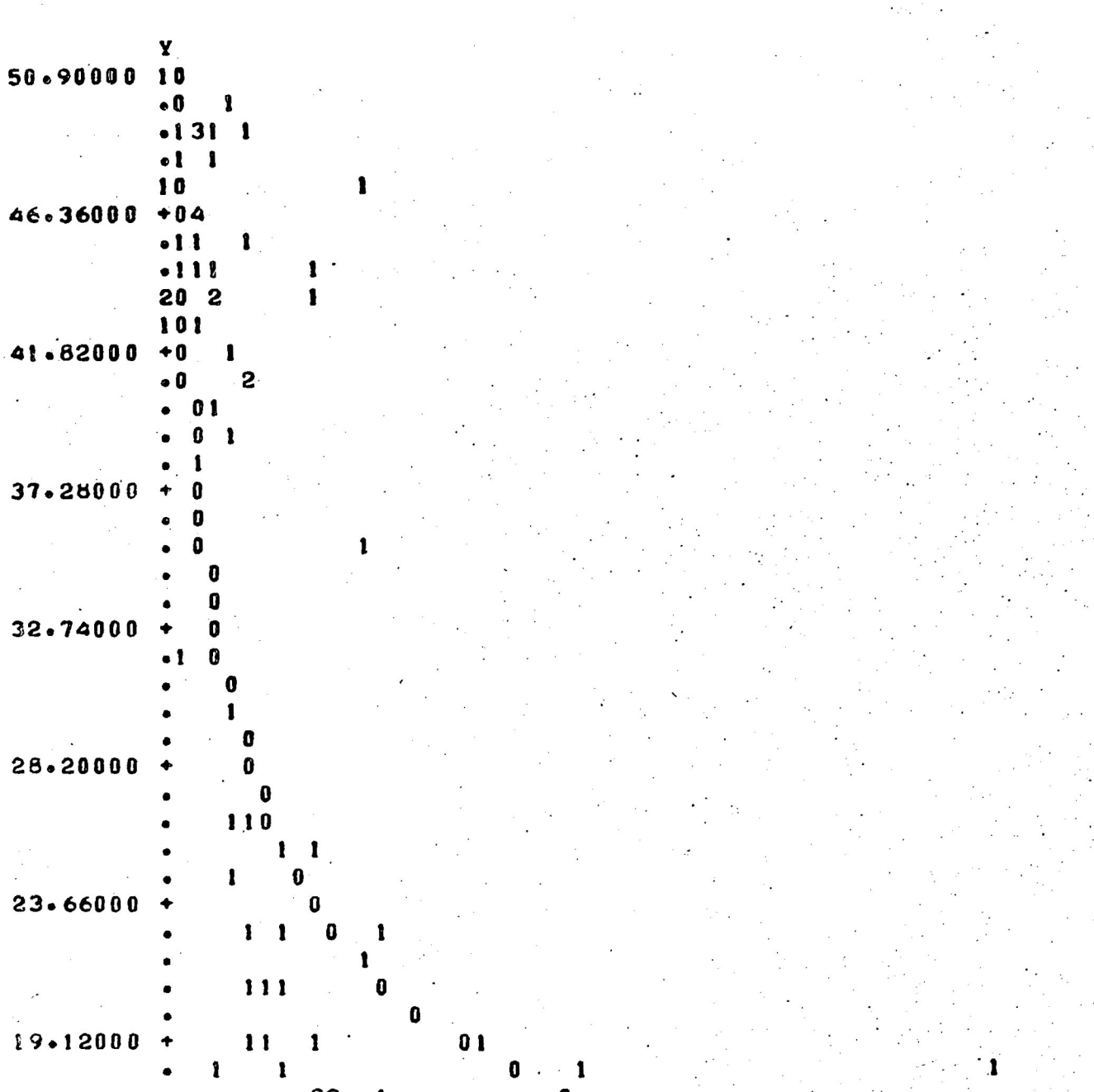
T.V. has a stronger effect than the radio in formulating the population attitude, and in promoting the government policies. More important might be its relation with the level of per capita G.N.P. since the wealthier the population the more money there is available for non-subsistence items. The data (UNESCO, 1973) about this indicator is available for most countries, but it suffered from the same difficulty that the previous indicator suffered from, but in spite of this it could be deduced that :

1 The arithmetic mean equal to 103.738

11 The standard deviation equal to 106.439

111 The correlation coefficient between this indicator

Figure (6)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
the No. of Radio Broadcasting Receiver
Per 1000 Population



and the level of fertility equal to - 0.83479 and with per capita G.N.P. 0.94541 which are significant with 0.95 confidence coefficient. The scatter diagram shown in Table (7).

3. Per Capita Newpaper Consumption

This indicator could be a good proxy for the awareness of population with respect to current events and it shows the actual level of reading ability, and also it should be strongly related to literacy if the available data is accurate enough. The following result could be deduced from the available data (UNESCO, 1973).

1 The arithmetic mean equal to 8.17155

11 The standard deviation equal to 11.563

111 The correlation coefficient between this indicator and the level of fertility equal to -. 0.6344 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (8).

4. Per Cent of Illiterate Population of 15 Years Old and Over

Illiteracy is the most dangerous handicap that the developing countries suffer from. Literacy is the means of informing people of the need for change and for simulating acceptance of new ideas, so it is the way to improve the quality of life, and the participation in the world's affairs.

Figure (7)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
No. of T.V. Receivers Per 1000 Population

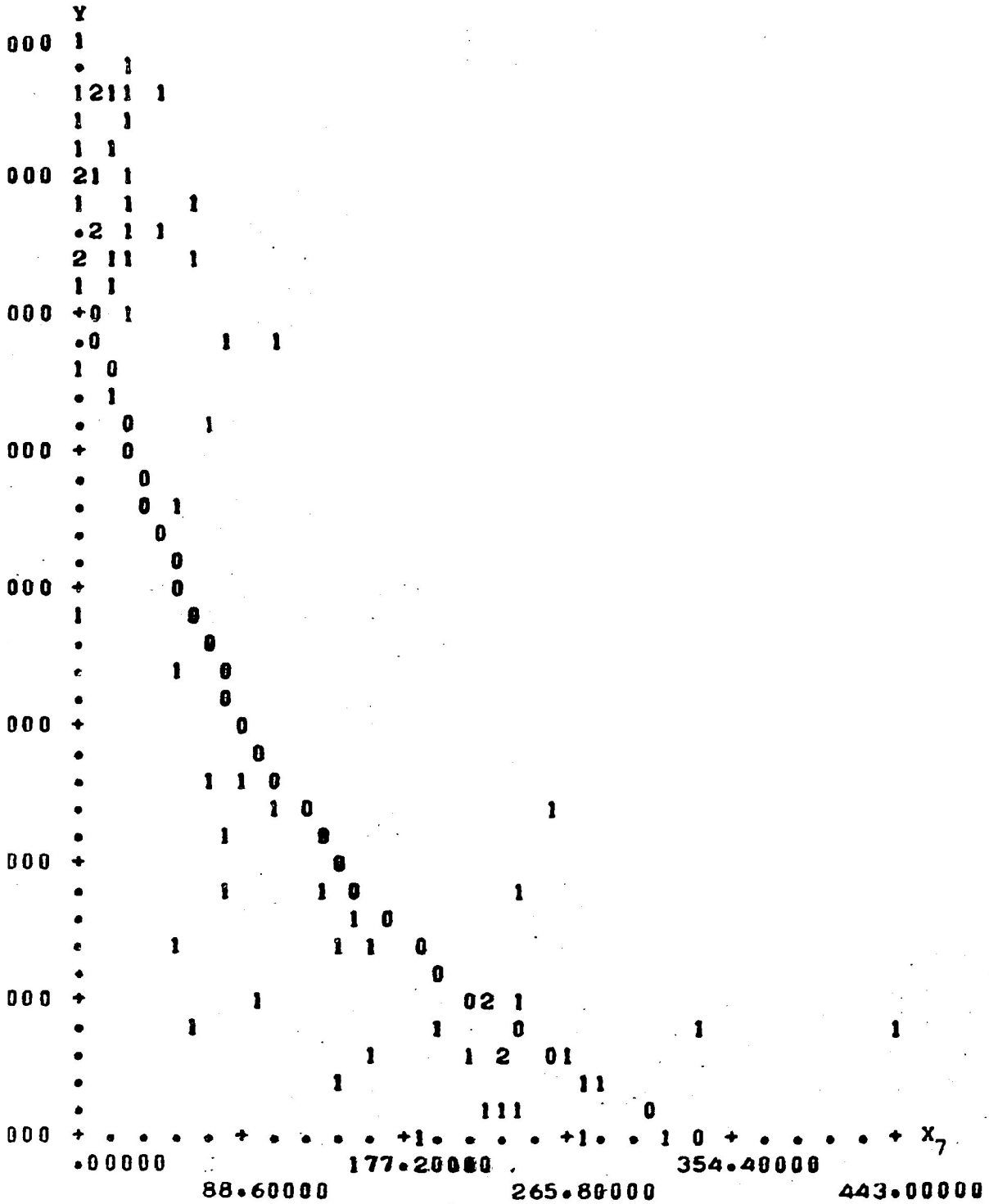
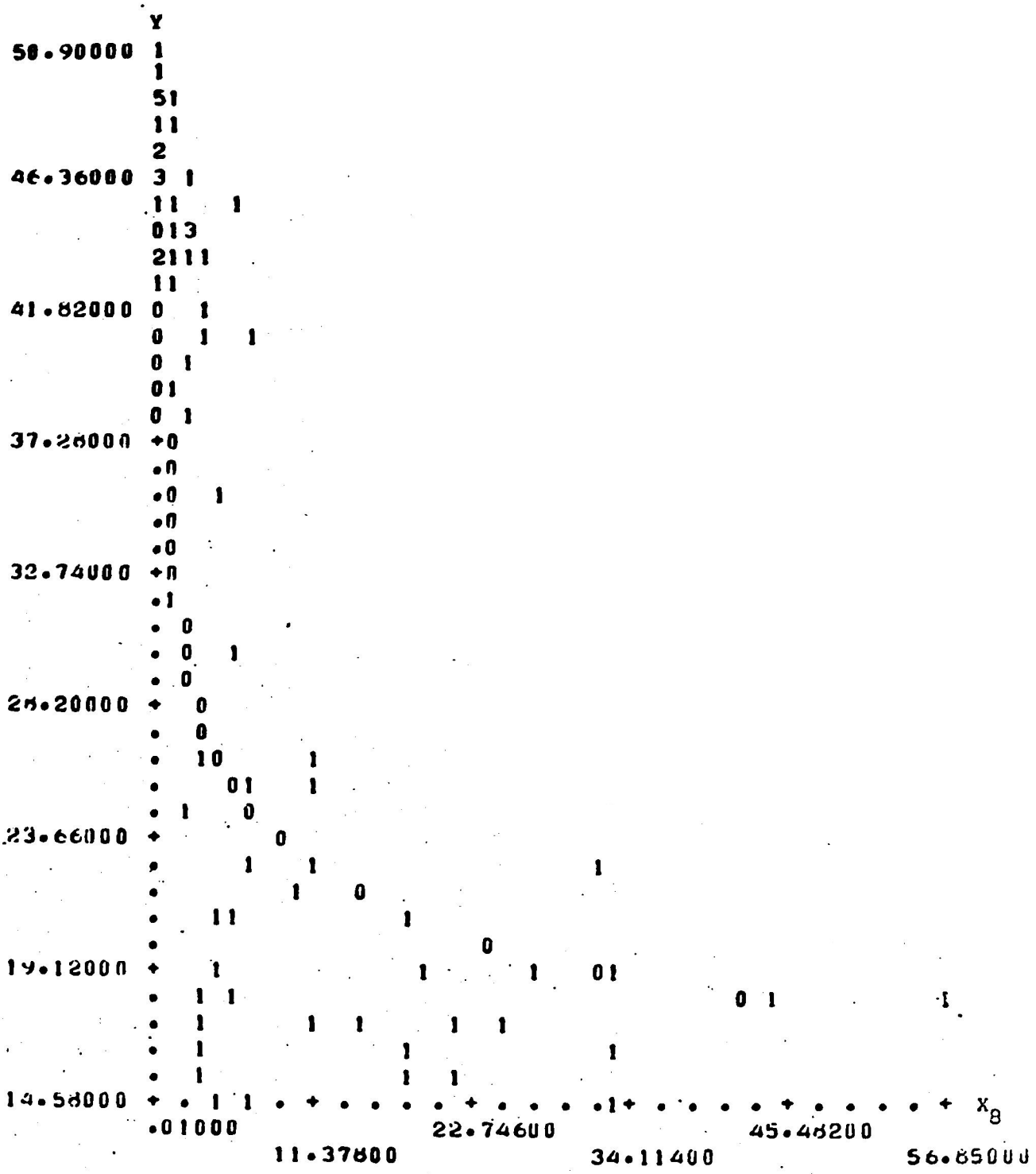


Figure (8)

The Scatter Diagram and the Fitted Curve for the Relation Between the C.B.R. and Per Capita News Paper Consumption



It should be highly associated with the socio-economic development level and the level of fertility as well. The data about this indicator is normally derived from national censuses of special sample surveys of literacy, so that they are not usually available for different time periods. Definitions of literacy vray from country to country and a high degree of incomparability exists amongst countries, and even for particular countries over time.

Underestimation may also result when a literacy survey self evaluation. The available data (UNESCO, 1965 & 1973) shows

1 The arithmetic mean equal to 27.551

11 The standard deviation equal to 26.565

111 The correlation coefficient between this indicator and the level of fertility is equal to 0.82967 which is significant with 0.95 confidence coefficient. The scatter diagram shows in Figure (9).

c. Health and Nutrition Indicators

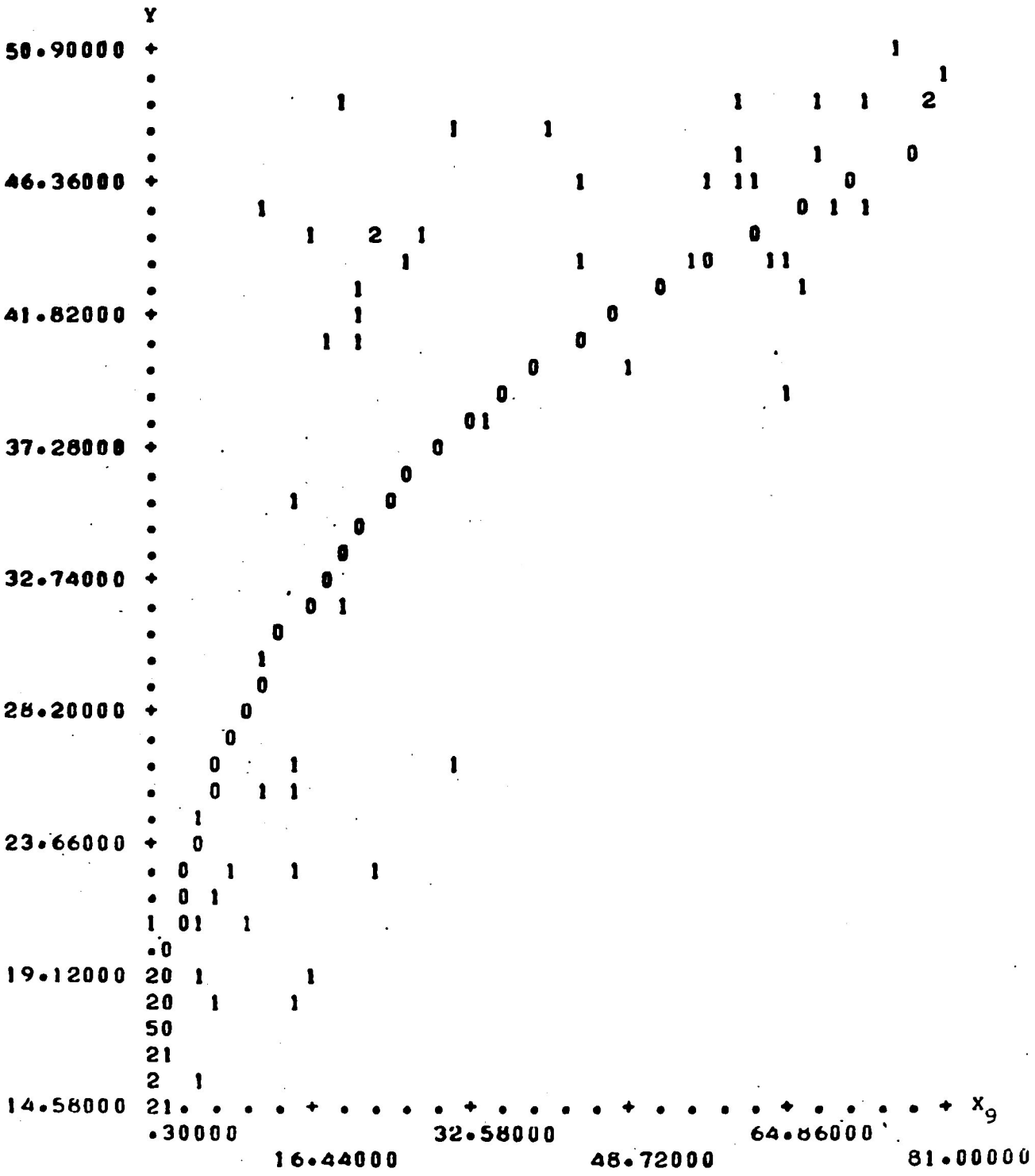
1. No. Population Per Physician

2. No. Population Per Hospital Bed

These are useful indicators for showing the health services available to the population.

However, they have several limitations. The distribution of medical personnel throughout the country is

Figure (9)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
Per Cent of Illiterate Population Aged 15 Years
and Over



uneven and the definitions of the qualifications of medical personnel vary from country to country. In addition physicians and hospitals are usually clustered in urban areas and therefore the ratio may not give an accurate picture. In spite of that the available data (U.N., 1973) shows :-

1 The arithmetic means are 3698.9600 and 437.384 respectively.

11 The standard deviations are 5257.681 and 553.530 respectively.

111 The correlation coefficient between the level of fertility and those indicators are 0.57968 and 0.588984 respectively, which is significant with 0.95 confidence coefficient.

The scatter diagram are shown in Figures (10) and (11).

The importance of the health services in addition to its social effect is that in all countries where the family planning programme has been established there is to some degree of integration of family planning with health services. The medical and health professions have usually been the key agents in pioneering family planning efforts.

3. Dietary Energy Supply (Kilo-Calories Per Person Per Day

Nutrition indicators are extremely useful for assessing the health of the population. This indicator should be highly associated with the level of the socio-economic development,

Figure (10)
The Scatter Diagram and the Fitted Curve for the Relation Between the C.B.R. and the No. of Population Per Physicians

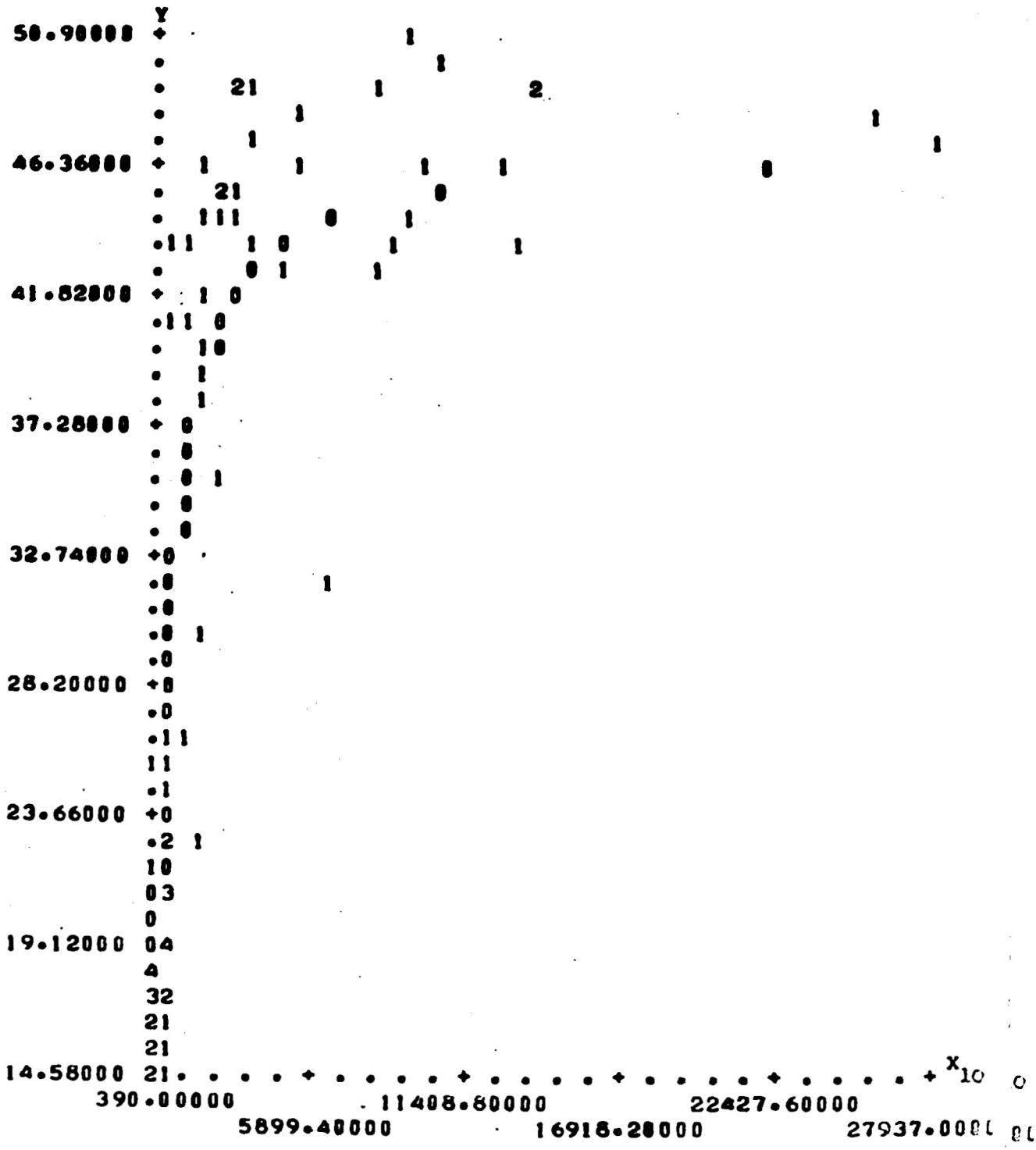
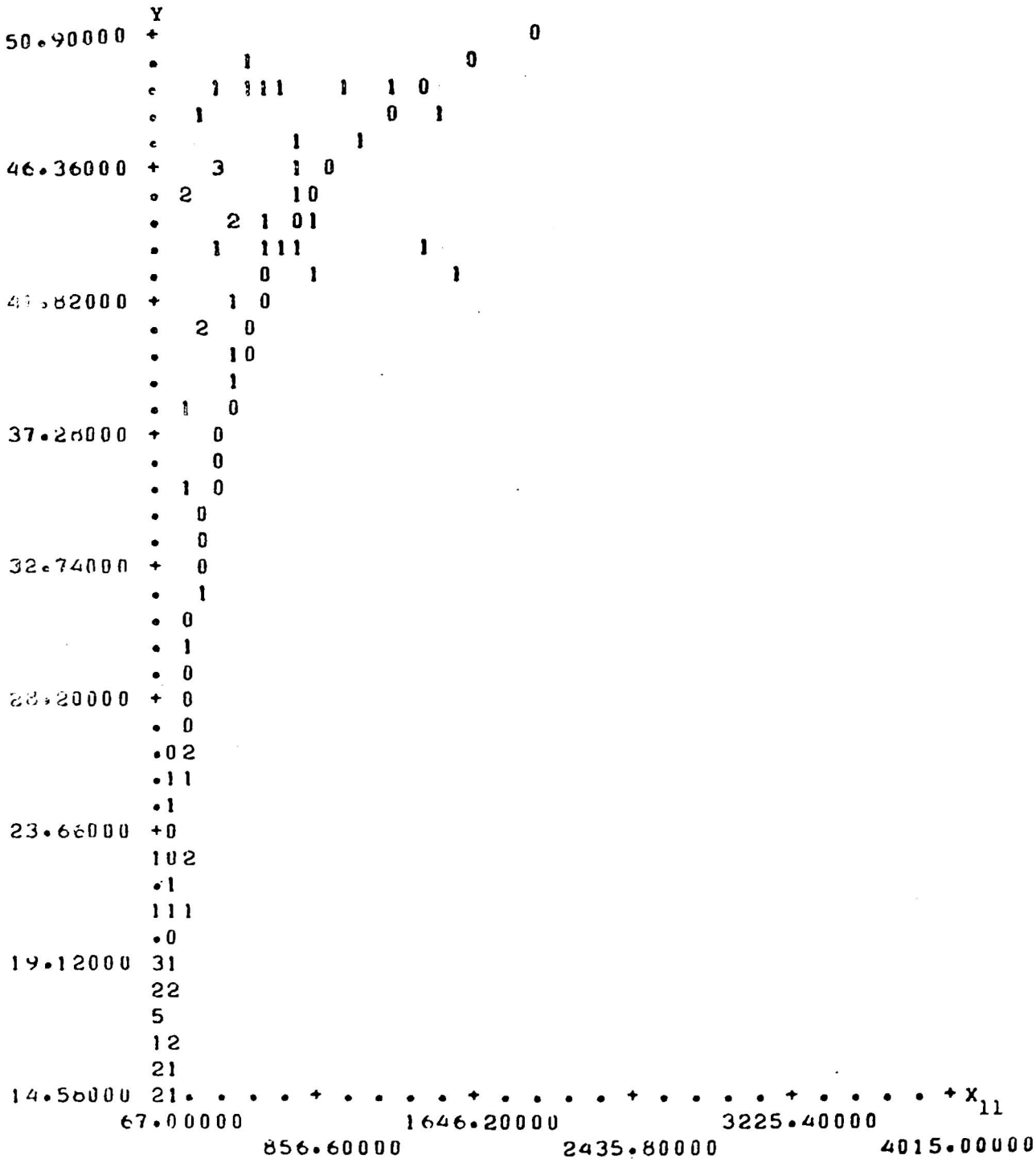


Figure (11)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
the No. of Population Per Hospital Beds



and with the level of fertility also.

The following results deduced from the available data (Population Reference Bureau, 1975) :-

1 The arithmatic mean equal to 2683.36

11 standard deviation equal to 509.99

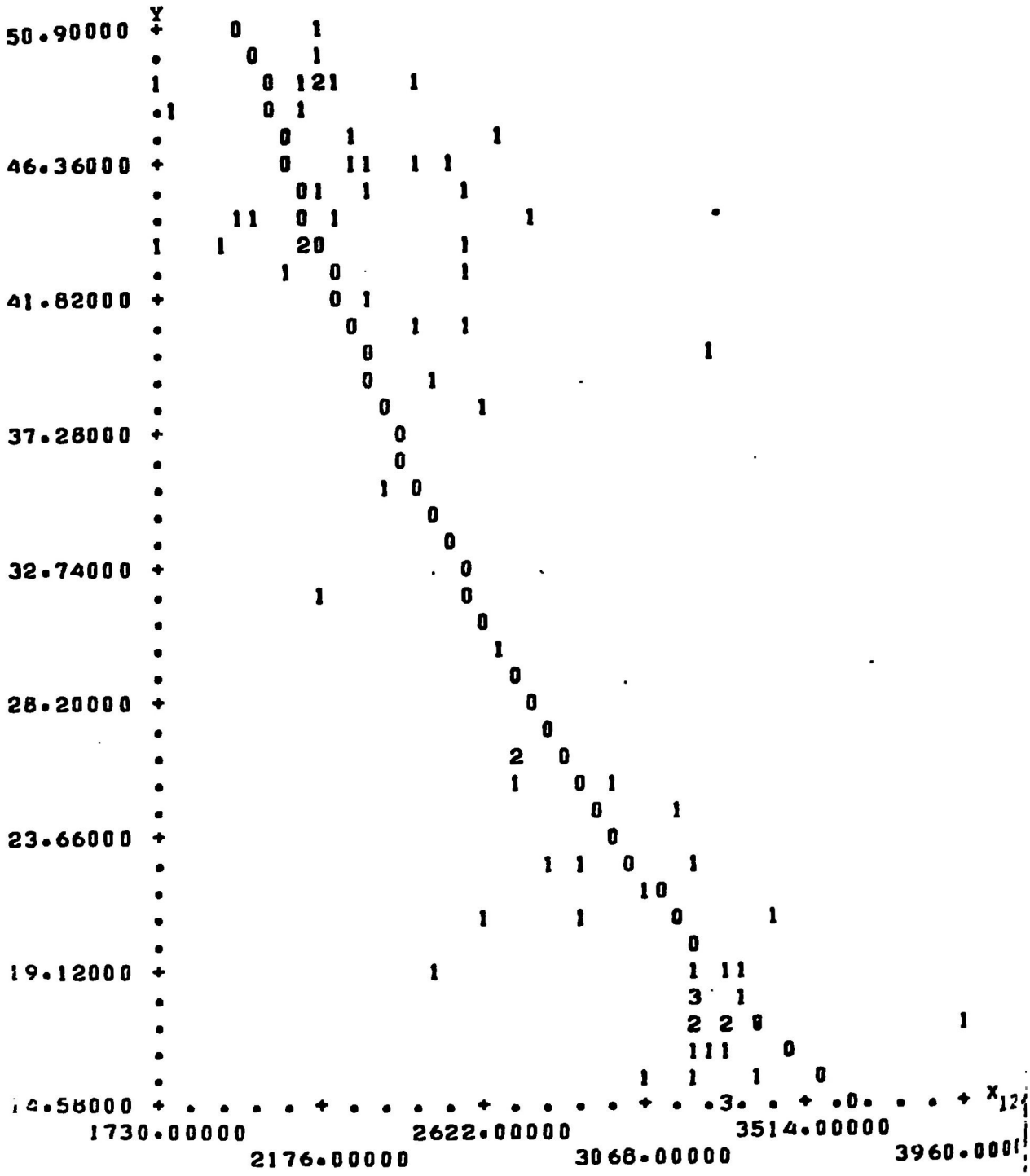
111 The correlation coefficient between this indicator and the level of fertility equal to - 0.85984 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (12).

d. Education Indicator

1. School Enrolment Ratio for the First and Second Levels of Education

School enrolment ratios are the most useful indicators of the flow of human resources, they illustrate the generating capacity for future stock. There is a close interrelation between this indicator and the existence of compulsory education law, but of course the existence of such a law does not ensure that all children within the stipulated age range will be found in the school. Developing countries caught between a lack of resources and high birth-rates, often find it difficult to provide free public education to all children that are required by law to attend the school, the same situation as in other services.

Figure (12)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
Per Capita Dietry Energy Supply



Lack of homogeneity among countries'school systems make it extremely difficult to achieve consistent indicators of enrolment even of durational schooling, varies as does the entrance age requirement.

The available data (UNESCO, 1972) about this indicator shows the following results :-

1 The arithmetic mean equal to 67.34

11 The standard deviation equal to 20.3109

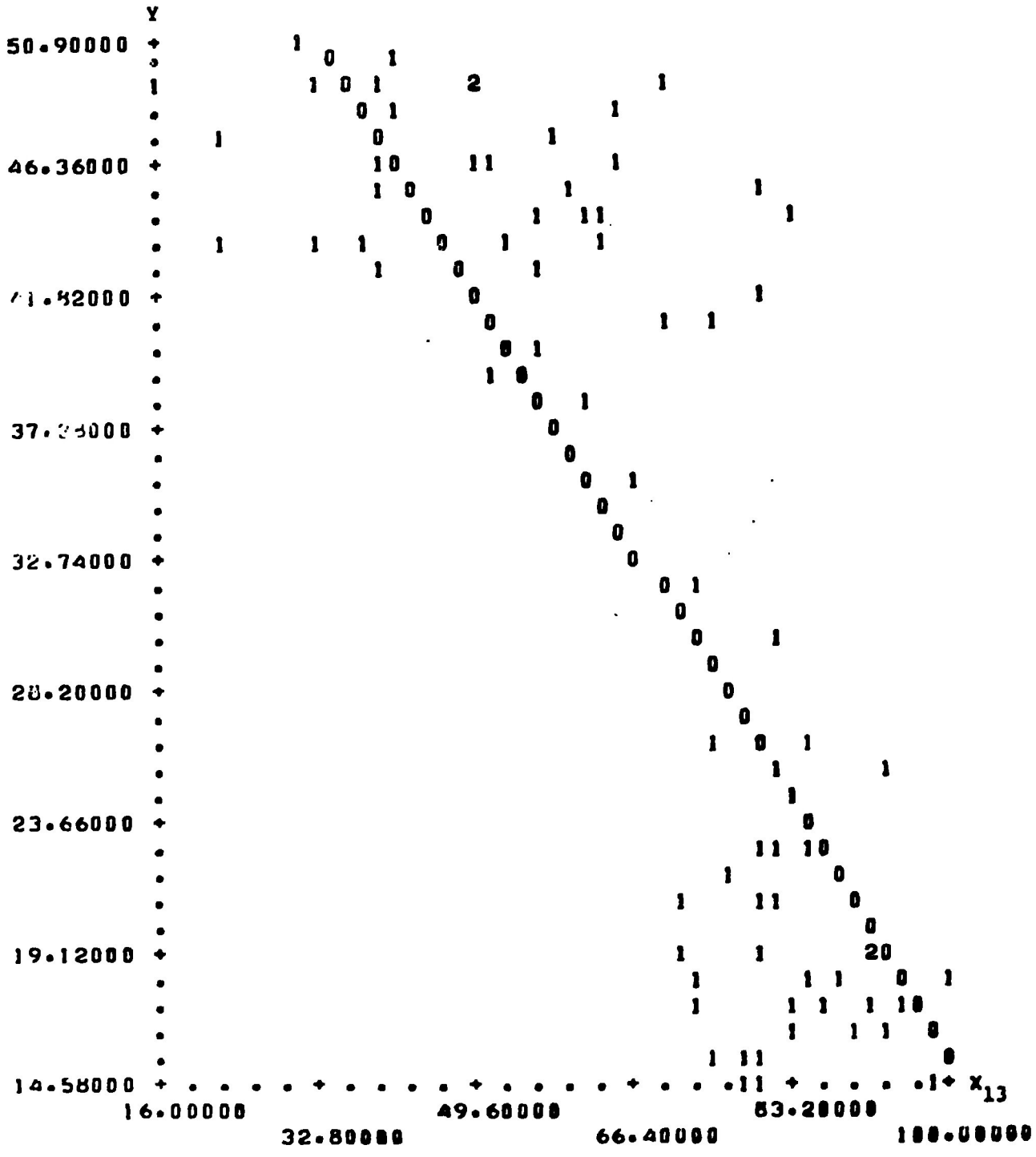
111 The correlation coefficient between this indicator and the level of fertility equal to - 0.789 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (13).

2. Number of Students at the Third Level of Education Per 100 Thousand Population

This indicator gives a good idea about that part of the population who have joined in higher education (such as universities, higher technical schools, teacher training colleges and theological schools, etc.). This indicator gives also an idea about the capabilities of the society to make use of the modern technologies. Data about this indicator suffered from most defictions that the previous indicators suffered from.

The following results could be deduced from the available data (UNESCO, 1972).

Figure (.13)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
the School Enrolment Ratio for the First
and Second Level of Education



1 The arithmetic mean equal to 629.712

11 The standard deviation equal to 610.596

111 The correlation coefficient between this indicator and the level of fertility equal to - 0.62135 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (14).

3. Per Capita Consumption of Printing Paper Other than Newsprint and Writing Paper

This indicator could give an idea about the volume of scientific material printed in the society, such columes reflect the number of scientists who wrote such material, and the number of readers as well, so it could be highly associated with the previous indicator, i.e., the number of students at the third level of Education Per 1000 Population.

The following results can be deduced from the avail - able data (UNESCO, 1972) about this indicator :-

1 The arithmetic mean equal to 10.060

11 The standard deviation equal to 13.887

111 The correlation coefficient between this indicator and the level of fertility equal to - 0.69815 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (15)

Figure (14)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
the No. of Students at the Third Level of
Education per 100 Thousand Population

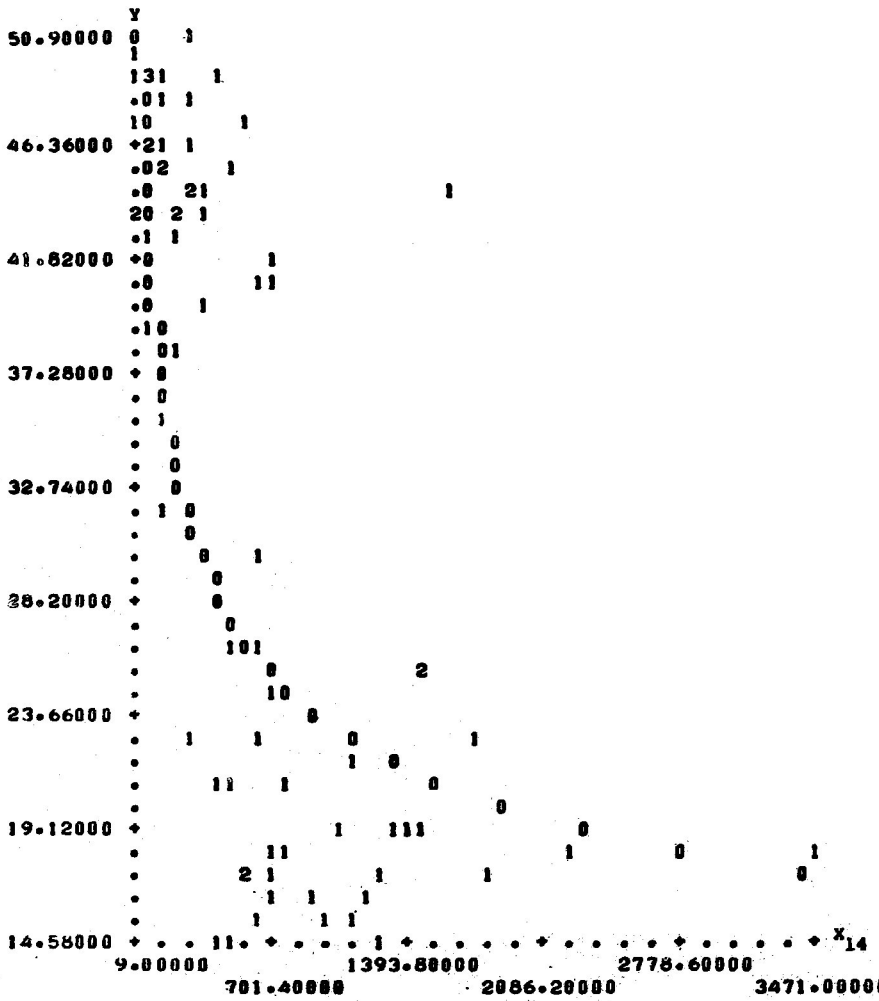
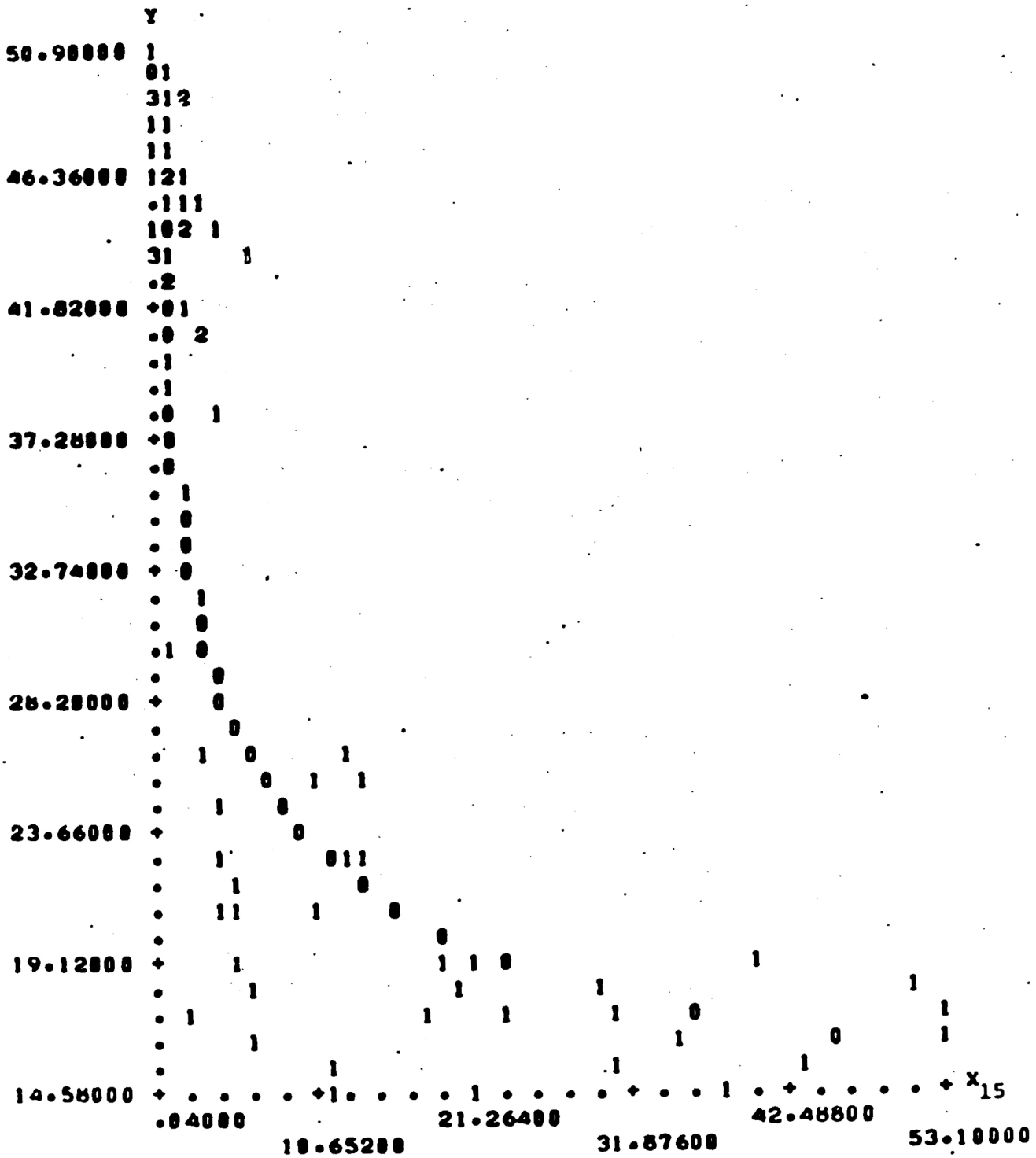


Figure 1 (19)
The Scatter Diagram and the Fitted Curve for
the Relation Between the G.D.P. and
Per Capita Consumption of Printing Paper



e. Demographic Indicators

1. Life Expectancy at Birth

This indicator is a useful estimate of human resource potential (e.g. labour force) and is highly associated with both health and economic indicators. The accuracy of the data about such indicators and the other demographic indicators depends upon the accuracy of the demographic statistics in the country which is affected by the socio-economic development level.

The available data (U.N., 1973) about this indicator shows :-

I The arithmetic mean equal to 61.4028

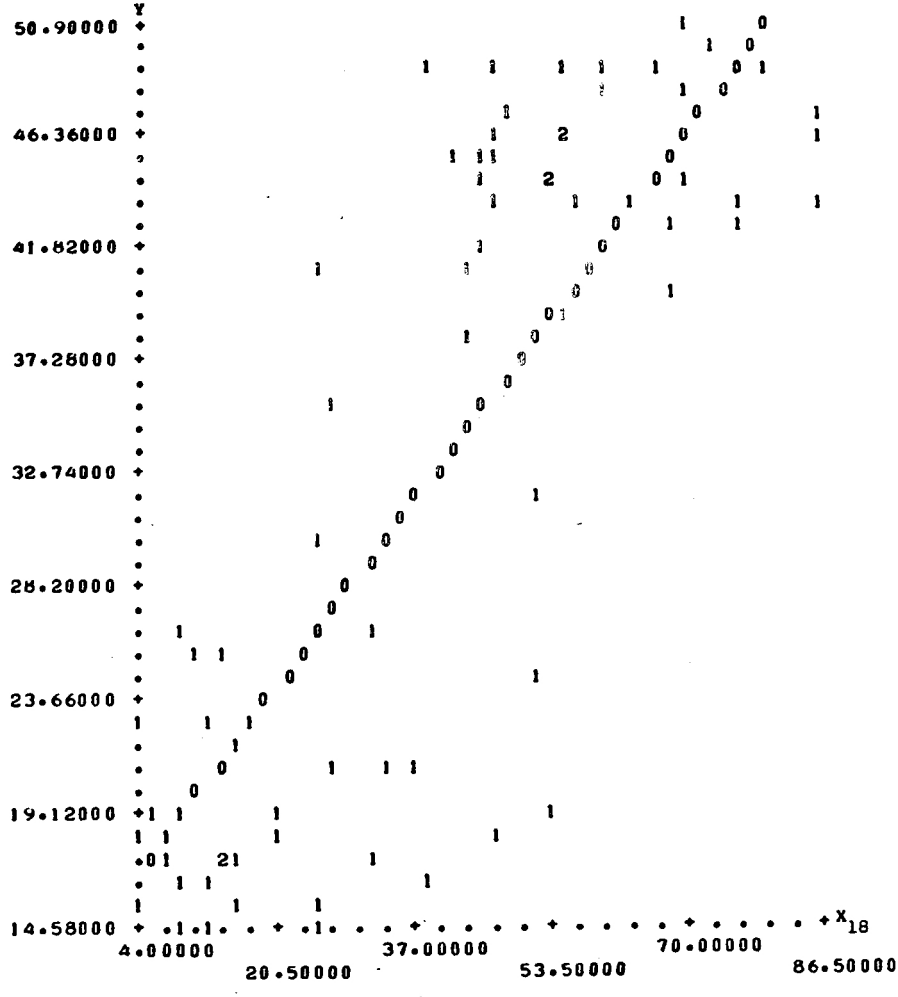
II The standard deviation equal to 10.1576

III The correlation coefficient between this indicator and the level of fertility equal to - 0.39661 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Table (16).

2. Infant Mortality Rate

A sufficiently close approximation to chances of dying between birth and tha attainment of the first birthday can be given by this indicator. It could be used as an indicator of the health condition of the community and hence the level of living. Data (Bureau of Census, 1973) about this indicator shows :-

Figure (18)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
Per Cent of Population Economically Active in Agriculture
to Total Economically Active Population



I The arithmetic mean equal to 66.8493

II The standard deviation equal to 49.0078

III The correlation coefficient between this indicator and the level of fertility equal to 0.86408 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Table (17).

3. Per Cent of Population Economically Active in Agricultural to Total Population

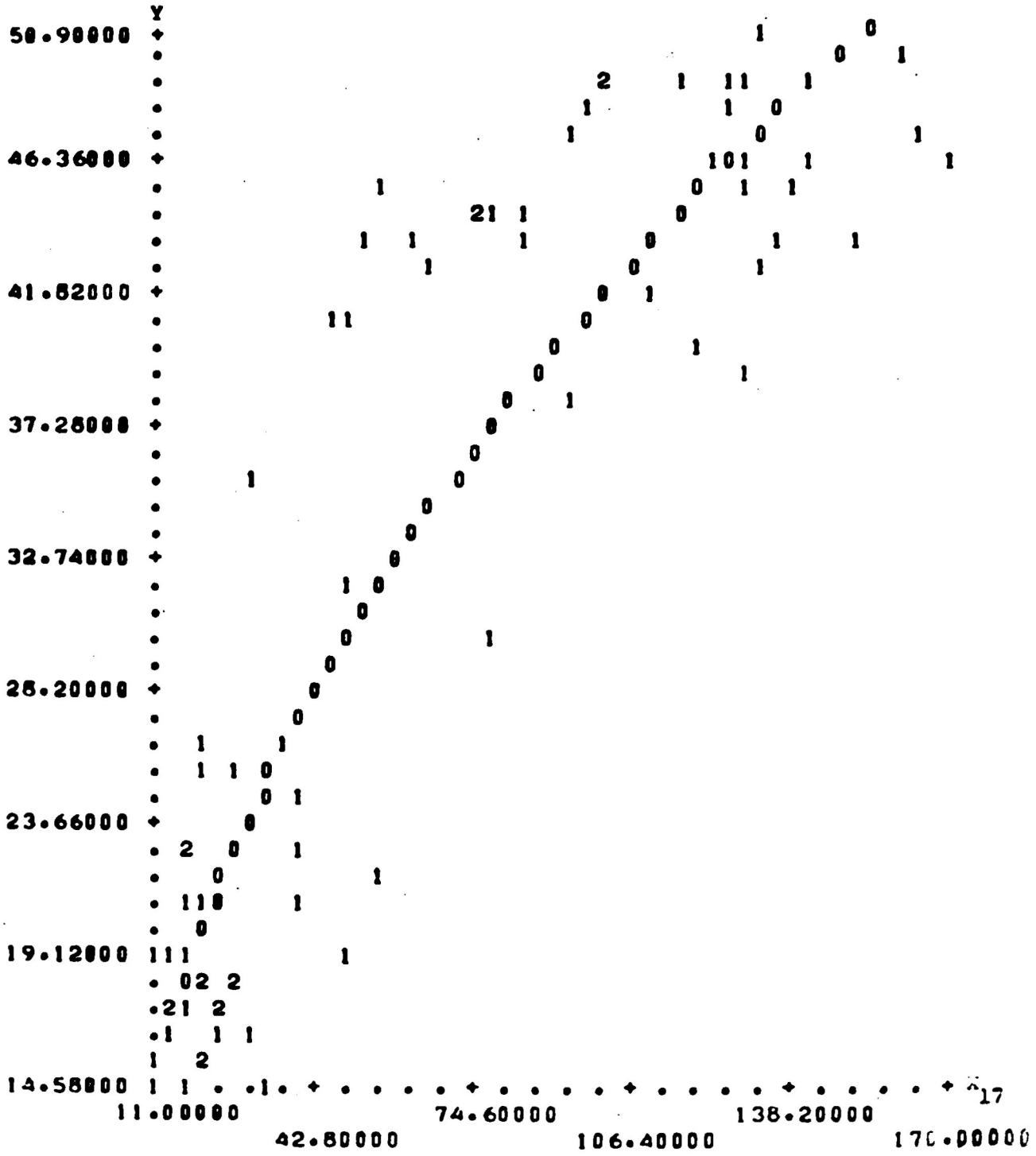
This indicator refers to the population who engage in or attempts to engage in agricultural products. The agricultural population tends to be set off more distinctly from other population groups in its cultural traits, living standards and social institutions, than the population dependent on any other major branches of economic activity. This is so because in most countries the people who make their living from the land are to a comparative extent geographically isolated, and because the home life of a farming household is intimately connected with the operation of a farm. The more highly developed a country in economic is the less Per Cent of economically active in agriculture. The available data (FAO, 1972) gives the following results :

I The arithmetic mean equal to 39.5206

II The standard deviation equal to 23.907

III The correlation coefficient between this indicator

Figure (17)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
Infant Mortality Rate



and the level of fertility equal to 0.80328 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (18).

4. Per Cent of Female Active Population to Total Economically Active

Female Population and specially female active population could play a big roll in the socio-economic process. This indicator should be highly associated with the economic indicators.

Data about this indicator suffered from the difference in the definition of the female active population between the countries. But the following results could be deduced from the available data (ILO, 1971 & 1974) :-

I The arithmatic mean equal to 24.555

II The standard deviation equal to 122.977

III The correlation coefficient between this indicator and the level of fertility equal to - 0.77279 which is significant with 0.95 confidence coefficient. The scatter diagram shown in Figure (19).

The correlation matrix, Table (3) gives an idea about the inter-relationship between the variables of the

Figure (18)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
Per Cent of Population Economically Active in Agriculture
to Total Economically Active Population

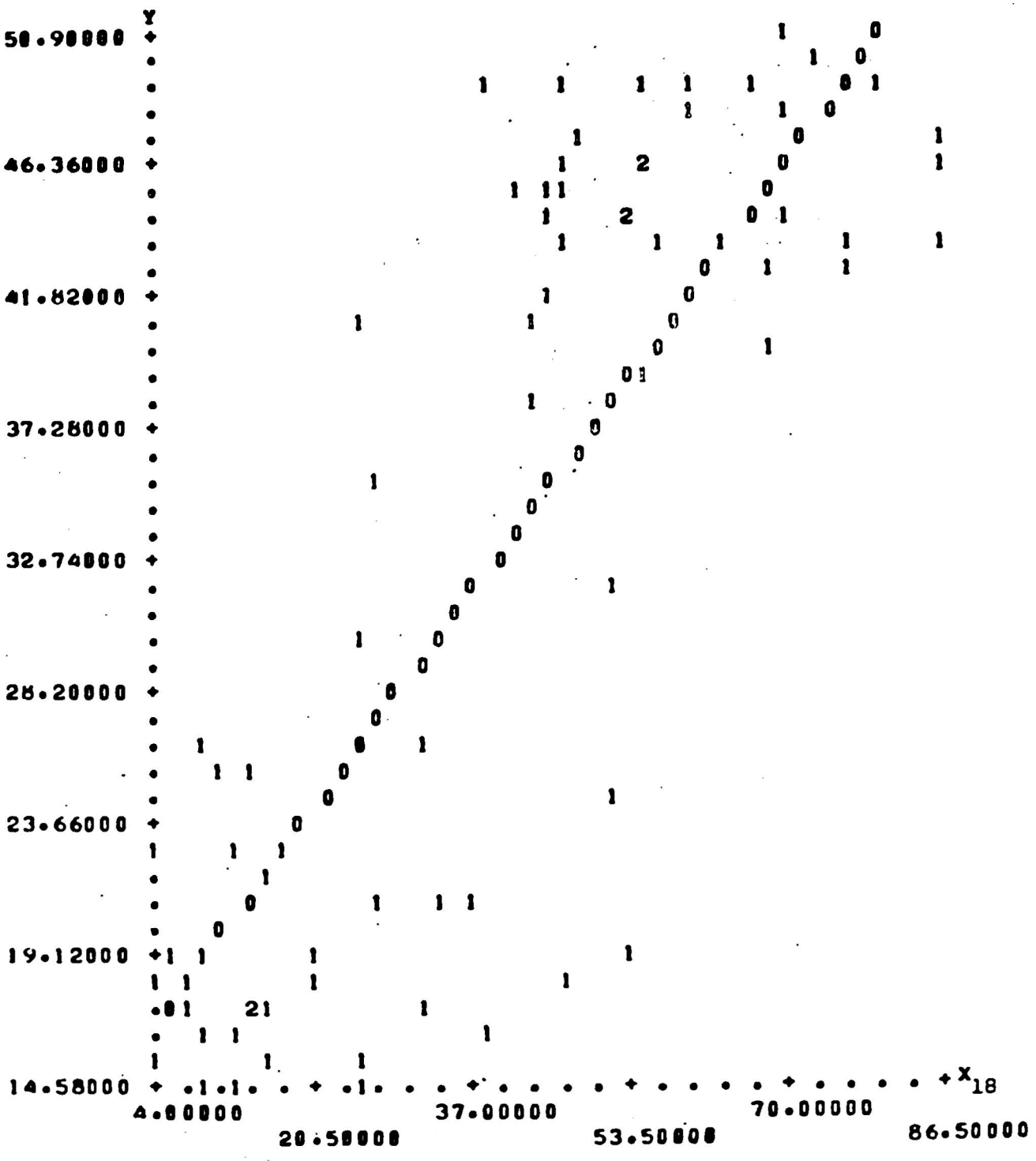
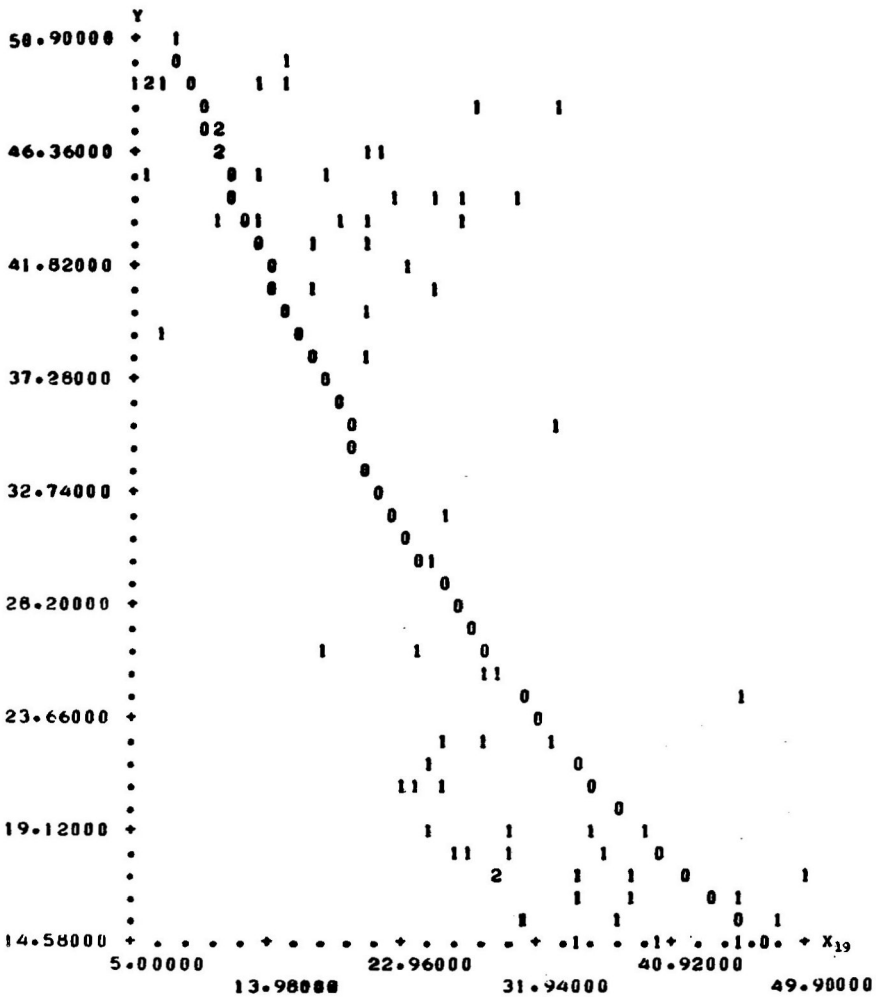


Figure (19)
The Scatter Diagram and the Fitted Curve for
the Relation Between the C.B.R. and
Per Cent of Female Population to Total
Economically Active Population



model. The important point here is that these indicators either represent a socio-economic condition or do have a socio-economic effect. They act as interact together and with other factors to produce a certain level of development and such a level effects the attitude of the people when making any decision and nuptiality decision represent one kind of these decisions.

5. Estimation of the Model's Parameters

Applying the steps mentioned in section 3 to the collected data about the Crude Birth Rate, and the 19 socio-economic indicators, the following results could be deduced :

1. The relation between the C.B.R. and every indicator is found to be as follows :-

I) $Y = 287.985\ (X_1)^{-0.35972}$ as shown in Fig. (1)

II) $Y = 178.087\ (X_2)^{-0.26311}$ as shown in Fig. (2)

III) $Y = 1/(0.025552 + 0.00007\ (X_3)$ as shown in Fig.(3)

IV) $Y = 59.8473\ (X_4)^{-0.26311}$ as shown in Fig. (4)

V) $Y = 34.9764\ (X_5)^{-0.17063}$ as shown in Fig. (5)

VI) $Y = 155.254\ (X_6)^{-0.33124}$ as shown in Fig. (6)

VII) $Y = 1/(0.02311 + 0.00013\ (X_7)$ as shown in Fig(7)

VIII) $Y = 34.0878\ (X_8)^{-0.16704}$ as shown in Fig. (8)

IX) $Y = 16.1667\ (X_9)^{-0.24632}$ as shown in Fig. (9)

X) $Y = 47.1372 - (17042.05(X_{10})$ as shown in Fig.(10)

XI) $Y = X_{11}/3.66132 + 0.01777(X_{11})$ as shown in Fig.(11)

XII) $Y = 220.451\ \text{EXP}\ (-0.00075(X_{12})$ as shown in Fig.(12)

XIII) $Y = 67.3065 - 0.51447\ (X_{13})$ as shown in Fig.(13)

XIV) $Y = 121.683\ (X_{14})^{-0.23961}$ as shown in Fig.(14)

XV) $Y = 40.1728\ (X_{15})^{-0.23397}$ as shown in Fig.(15)

XVI) $Y = 104.442 - 1.16902\ (X_{16})$ as shown in Fig.(16)

XVII) $Y = 4.88352\ (X_{17})^{0.46541}$ as shown in Fig.(17)

XVIII) $Y = 15.0745 + 0.44499\ (X_{18})$ as shown in Fig. (18)

XIX) $Y = 64.2815\ EXP\ (-0.0315\ (X_{19})$ as shown in Fig.(19)

2. The above relations used in predicting the C.B.R. and the residuals of every relation has been calculated, Table (6) show the reseduals matrix.

3. The mean and the variance for every series of the residuals has been calculated, Table (7) as well as the correlation between those of residuals, Table (8).

4. The above results can be used in solving the system of equations mentioned in section 3.2.2 and the model could be in the following form :-

$$Y = \alpha_1 A_1 (X_1)^{B_1} + \alpha_2 A_2 (X_2)^{B_2} + \alpha_3/(A_3 + B_3 (X_3))$$

$$+ \alpha_4 A_4 (X_4)^{B_4} + \alpha_5 A_5 (X_5)^{B_5} + \alpha_6 A_6 (X_6)^{B_6}$$

$$+ \alpha_7/(A_7 + B_7 (X_7)) + \alpha_8 A_8 (X_8)^{B_8}$$

$$+ \alpha_9 A_9 (X_9)^{B_9} + \alpha_{10} A_{10} (B_{10} / (X_{10}))$$

$$+ \alpha_{11} (X_{11}) / (A_{11} + B_{11} + (X_{11}) + \alpha_{12} A_{12} EXP (B_{12} (X_{12}))$$

$$+ \alpha_{13} (A_{13} + B_{13} (X_{13})^{B} + \alpha_{14} A_{14} (X_{14})^{B_{14}}$$

$$+ \alpha_{15} A_{15} (X_{15})^{B_{15}} + \alpha_{16} (A_{16} + B_{16} (X_{16}))$$

$$+ \alpha_{17} A_{17} (X_{17})^{B} + \alpha_{18} (A_{18} (X_{18}))$$

$$+ \alpha_{19} A_{19} EXP (B_{19} (X_{19}))$$

Table (9) gives the values of A,B,α.

5. To examine the capability of the independent variable of explaining the dependent variable C.B.R., the model is used to predict the values of Y and computing the results deom which the following measurement has been calculated :-

I The sum of the residuals is 19.2326.

II The sum of the absolute value of the residuals is 213.1.

III The residuals sum of squares is 895.78

IV The value of $R^2 = 0.9286$ i.e. the model explains 92.86% of the total variation which is very high.

6. To compare results produced by the proposed model with the results produced by the multiple linear regression model, the last one applied on the same data as shown in Table (9)from which the following measurements are deduced :-

I The sum of the residuals is - 0.147

II The sum of the absolute value of the residuals is 229.439

III The residual sum of squares is 1446.7528

IV The value of R^2 = 0.9087, i.e. the model explained 90.87% of the total variation.

6. Conclusion

The levels of fertility and subsequently the growth of population depend mainly on the socio-economic conditions of the certain levels of socio-economic development, married couples freely, opt for smaller families. Thus family planning practices spread as a natural development within the framework of the development process, as shown simpler in Figure (20).

The effort to understand and eventually bring about a change in the level of fertility, therefore requires :

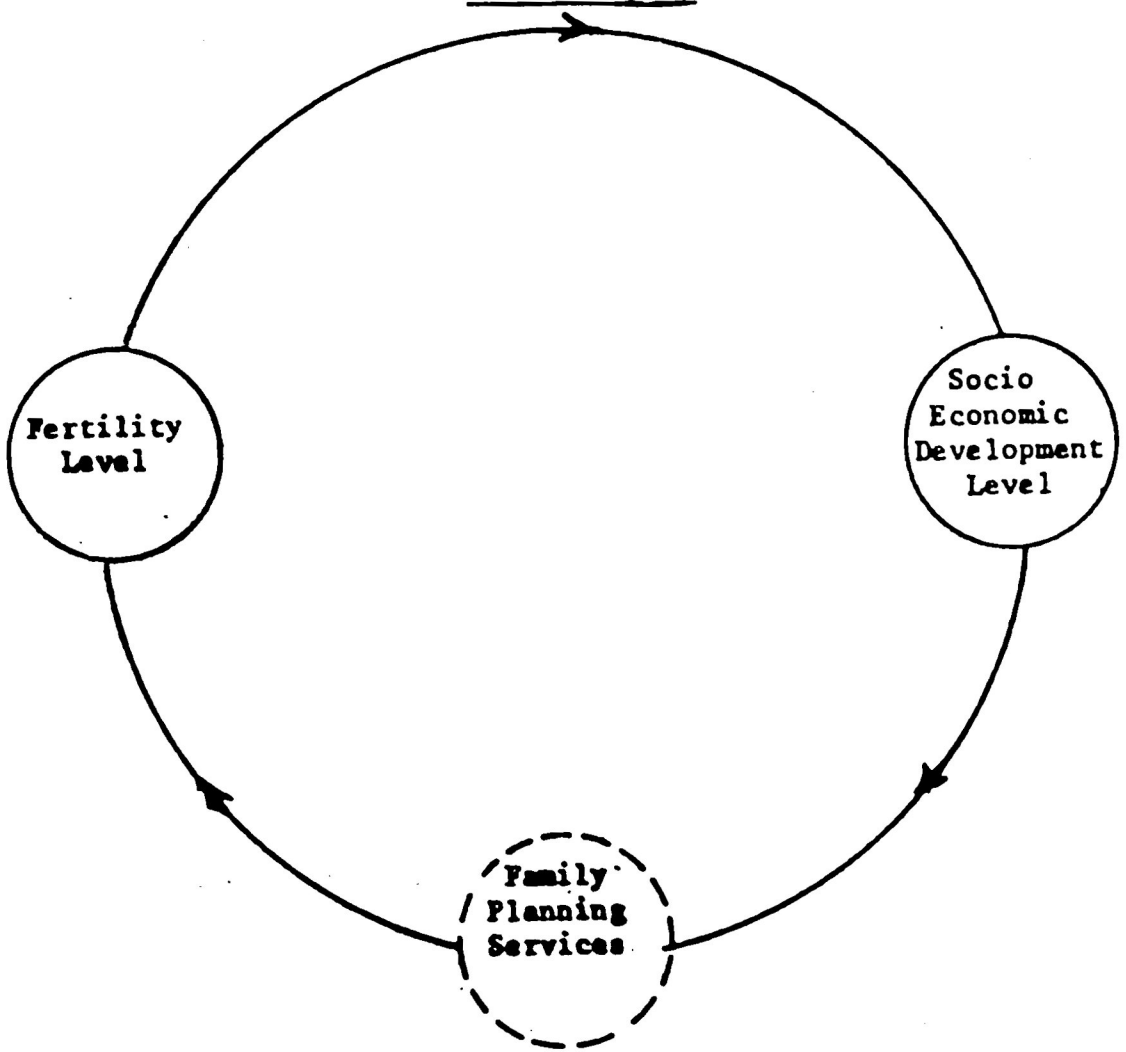
(1) The identification of relevant socio-economic factors and the analysis of the manner in which they interact with family planning activities.

(2) The acceleration of the socio-economic development process.

A MAcro-Demographic and Socio-Economic Development model has been constructed in this paper by which the level of fertility is explained by nineteen socio-economic development level in any society, and may be used in formulating population policies within the framework of the socio-economic development plam.

Planners may select the best indicator "mix" which would help in achieving a reasonable level of fertility and a desirable rate of population growth. taking into account the available resources as well as the values of the society.

FIGURE (20)



The Simple Circular Relationship between the Level of Development and the Level of Fertility

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Table (3)

The Correlation Matrix

	Y	X1	X2	X3	X4	X5
Y	1.00000					
X1	-0.74957	1.00000				
X2	-0.75147	0.90645	1.00000			
X3	-0.77617	0.84498	0.89596	1.00000		
X4	-0.63165	0.91250	0.81287	0.69773	1.00000	
X5	-0.59634	0.60391	0.54697	0.62739	0.51778	1.00000
X6	-0.52917	0.74089	0.78348	0.66048	0.66829	0.30610
X7	-0.83479	0.93541	0.91872	0.89155	0.85563	0.64115
X8	-0.63440	0.86879	0.81872	0.71674	0.89913	0.50348
X9	0.82967	-0.63323	-0.63339	-0.63999	-0.53731	-0.49874
X10	0.57968	-0.46800	-0.43781	-0.44515	-0.36007	-0.30821
X11	0.58864	-0.46477	-0.43575	-0.44963	-0.37577	-0.32707
X12	-0.85984	0.73740	0.72835	0.71157	0.62856	0.59620
X13	-0.78901	0.68200	0.65514	0.64897	0.38027	0.43110
X14	-0.62135	0.77084	0.77841	0.66941	0.72874	0.27568
X15	-0.69815	0.88104	0.78551	0.75659	0.78551	0.73662
X16	-0.89661	0.71129	0.68449	0.69982	0.60573	0.53139
X17	0.86408	-0.69428	-0.66156	-0.67896	-0.59358	-0.52257
X18	0.60328	-0.78476	-0.72560	-0.71333	-0.69505	-0.54581
X19	-0.77279	0.54424	0.62748	0.67233	0.39660	0.42005

Table (1)

Definition of the Variable Considered, the Time Period and the Availability of the Data

Symbol of the variable		Variable Definition	Time Period	No. of missing values
	I	Dependent variable		
Y		Crude Birth Rate	1965-70	0
	II	Independent variables		
	A	Economic Indicators		
X1	1	Per Capita Gross National Product	1969	0
X2	2	Per Capita Energy Consumption	1969-72	1
X3	3	Per Capita Steel Consumption	1968-72	1
X4	4	No. of motor vehicles in use per 1000 population	1967-72	1
X5	5	No. of agricultural tractors per 1000 Hecters of agricultural land	1969-71	1
	B	Cultural Indicators		
X6	1	No. of radio broadcasting receivers per 1000 population	1970-72	0
X7	2	No. of TV receivers per 1000 population	1970-72	0
X8	3	Per Capita News Paper consumption	1970-72	0
X9	4	Per cent of illiterate population aged 15 years and over	1968-70	18

Table (1)

(Continued)

X10	C	Health and Nutrition Indicators		
X10	1	No. of population per physicians	1969-70	0
X11	2	No. of population per hospital beds	1969-70	0
X12	3	Dietry Energy Supply	1969-71	1
	D	Education Indicators		
X13	1	School enrolment ratio for the 1st and 2nd levels of education	1965-67	0
X14	2	No. of students at the 3rd level of education per 100,000 population	1965-67	0
X15	3	Per Capita consumption of printing paper other than news print and writing paper	1970-72	1
	E	Demographic Indicators		
X16	1	Life Expectancy at Birth	1965-70	2
X17	2	Infant Mortality Rate	1969-72	0
X18	3	Per Cent of Population Economically Active in Agriculture to Total Economically Active Population	1970	0
X19	4	Per cent of Female Active Population to Total Economically Active Population	1968-72	0

(Continued)

		ASIA**		
35	I	Hong Kong	4.2	0
36	II	India	538.9	0
37	III	Indonesia	121.2	0
38	IV	Iran	28.4	0
39	V	Iraq	9.7	0
40	VI	Israel	2.9	0
41	VII	Japan	104.4	0
42	VIII	Jordan	2.3	0
43	IX	Pakistan	62.1	0
44	X	Philipines	38.1	0
45	XI	Singapore	2.1	0
46	XII	Sri Lanka	12.6	0
47	XIII	Syria	6.2	0
48	XIIV	Thailand	36.2	0
49	XV	Turky		
		EUROPE***		
50	I	Austria	7.4	1
51	II	Belgium	9.7	1
52	III	Czechoslovakia	14.5	1
53	IV	Denmark	4.9	1
54	V	Finland	4.7	1
55	VI	France	50.8	1
56	VII	Germany D.R.	17.1	1
57	VIII	Germany F.R.	59.4	1
58	IX	Greece	8.9	0
59	X	Hungary	10.3	0
60	XI	Ireland	2.9	1
61	XII	Italy	53.7	0
62	XIII	Netherland	13.0	1
63	XIV	Norway	3.9	1
64	XV	Poland	32.8	0
65	XVI	Portugal	9.6	1
66	XVII	Rumania	20.3	1
67	XVIII	Spain	33.3	0
68	XIX	Sweden	8.0	1
69	XX	Switzerland	6.3	1
70	XXI	Yugoslavia	20.4	0
		OCEANIA		
71	I	Australia	12.5	1
72	II	New Zealand	2.8	1
73	III	U.S.S.R.	242.8	1

* South Africa and Rhodesia has been excluded because data is available for the whole of the Population in some instance and in other instances for the white population only.

** Malaysia has not been considered because data obtained from international data sources for the various indicators are in some instances for the whole of the country and in others for its parts.

*** The above conditions apply to data for the U.K.

Table (2)

The Group of Countries Considered, Population and the Availability of Data

No.	The Name of the Country	Population 1970	No. of missing obs.
	AFRICA*		
1	I Algeria	14.0	0
2	II Egypt	33.9	0
3	III Ghana	9.0	1
4	IV Liberia	1.5	0
5	V Libia	1.9	0
6	VI Madagascar	6.9	0
7	VII Morocco	15.5	0
8	VIII Sudan	15.8	0
9	IX Tanzania	13.2	0
10	X Tunisia	5.1	0
11	XI Uganda	8.6	0
	AMERICA N. & C.		
12	I Canada	21.4	1
13	II Costa Rica	1.8	0
14	III Cuba	8.4	0
15	IV Dominican	4.3	0
16	V El-Selvador	3.4	1
17	VI Guatemala	5.1	0
18	VII Hiti	4.1	0
19	VIII Honduras	2.7	0
20	IX Jamaica	1.9	0
21	X Mexico	50.7	0
22	XI Nicageria	2.0	0
23	XII Panama	1.5	0
24	XIII Puerto Rica	2.7	3
25	XIIV U.S.A.	204.8	1
	AMERICA S.		
26	I Argentina	24.3	0
27	II Brazil	93.0	0
28	III Chile	9.8	0
29	IV Columbia	21.4	0
30	V Ecuador	6.1	0
31	VI Paraguay	2.4	0
32	VII Peru	13.6	0
33	VIII Uruguay	2.9	0
34	IX Venezuela	10.9	1

Table (3)
(continued)

	X6	X7	X8	X9	X10	X11
X6	1.00000					
X7	0.75141	1.00000				
X8	0.70616	0.84191	1.00000			
X9	-0.48220	-0.72542	-0.56455	1.00000		
X10	-0.35926	-0.50361	-0.37138	0.60199	1.00000	
X11	-0.32088	-0.49426	-0.37793	0.59560	0.50144	1.00000
X12	0.48549	0.76257	0.60337	-0.7061	-0.58459	-0.52631
X13	0.53426	0.72905	0.58044	-0.86595	-0.69827	-0.60263
X14	0.78146	0.76678	0.74497	-0.61114	-0.41819	-0.35342
X15	0.63773	0.86636	0.81434	-0.58247	-0.37361	-0.38554
X16	0.50607	0.79156	0.62013	-0.90265	-0.71071	-0.60269
X17	-0.51697	-0.77853	-0.61810	0.89576	0.68532	0.56616
X18	-0.59020	0.66106	-0.69513	0.73063	0.67378	0.55662
X19	4.3828	-0.82660	0.41899	-0.80370	-0.42229	-0.49299

	X12	X13	X14	X15	X16	X17
X12	1.00000					
X13	0.71153	1.00000				
X14	0.56265	0.71125	1.00000			
X15	0.62962	0.55312	0.60974	1.00000		
X16	0.78914	0.88832	0.63563	0.63296	1.00000	
X17	-0.72190	-0.86421	-0.62779	-0.63696	-0.97061	1.00000
X18	-0.71843	-0.81307	-0.61565	-0.69998	-0.86912	0.84267
X19	0.62236	0.72691	0.56293	0.49621	0.74266	-0.74753

	X18	X19
X18	1.00000	
X19	-0.81307	1.00000

Table (4.5)

Some Statistical Measurement
for the Variables

Variable	Mean	Standard Deviation
Y	32.6608	13.2437
X1	899.4520	873.9450
X2	2023.3200	2354.5000
X3	167.2460	195.4780
X4	70.3111	101.1910
X5	12.8073	72.6265
X6	212.2530	213.8220
X7	103.7380	106.4390
X8	8.1716	11.5630
X9	27.5510	26.5650
X10	3698.9600	5257.6810
X11	437.3840	553.5300
X12	2883.3600	509.9900
X13	67.3430	20.3110
X14	629.7120	610.5960
X15	10.1060	13.8860
X16	61.4030	10.1580
X17	66.8490	49.0080
X18	437.3840	553.5300
X19	24.5550	11.0890

Table (5)

The Mean and Standard Deviation
for the Residuales

Variable	Mean	Standard Deviation
X1	0.78815	7.84858
X2	0.67225	8.48179
X3	2.63445	8.04668
X4	1.11168	8.86913
X5	1.10932	9.40608
X6	1.28825	10.39110
X7	2.09922	6.36413
X8	0.97311	9.33559
X9	0.70260	6.08409
X10	0.00001	6.63863
X11	1.39040	5.46179
X12	0.71184	7.47379
X13	0.00031	8.13663
X14	1.48955	10.43039
X15	0.70686	8.79263
X16	0.00010	5.86443
X17	0.55017	5.99970
X18	0.00011	7.88785
X19	1.10170	8.55618

Table (6)

The Correlation Matrix
for the Residuales

	X1	X2	X3	X4	X5
X1	1.00000				
X2	0.84811	1.00000			
X3	0.63035	0.57141	1.00000		
X4	0.78941	0.64020	0.60172	1.0000	
X5	0.51909	0.55841	0.50597	0.55683	1.00000
X6	0.67248	0.69594	0.58057	0.66880	0.56036
X7	0.73834	0.66124	0.76558	0.77989	0.54082
X8	0.43247	0.36882	0.32046	0.44979	0.42776
X9	0.49137	0.42336	0.59843	0.49518	0.45416
X10	0.53034	0.45708	0.57606	0.42817	0.39567
X11	0.69042	0.55791	0.63793	0.68230	0.48027
X12	0.50281	0.46095	0.46127	0.39898	0.22942
X13	0.68638	0.63110	0.52505	0.63021	0.54200
X14	0.61715	0.60421	0.52449	0.49812	0.62235
X15	0.70415	0.78768	0.44579	0.60687	0.48637
X16	0.63795	0.62178	0.39550	0.56716	0.51608
X17	0.58187	0.49625	0.40493	0.54516	0.46918
X18	0.75796	0.69707	0.59644	0.78525	0.55603
X19	0.29424	0.28029	0.46462	0.28896	0.38852

	X6	X7	X8	X9	X10
X6	1.00000				
X7	0.71318	1.00000			
X8	0.44006	0.52316	1.00000		
X9	0.51164	0.64502	0.53281	1.00000	
X10	0.48341	0.53299	0.29947	0.38004	1.00000
X11	0.50592	0.62005	0.25177	0.55726	0.37207
X12	0.43738	0.39134	0.26772	0.28029	0.36984
X13	0.62836	0.62481	0.56087	0.61553	0.38723
X14	0.60103	0.59380	0.57314	0.49005	0.43996
X15	0.59290	0.59296	0.42462	0.38705	0.26833
X16	0.54835	0.59465	0.64874	0.54228	0.36011
X17	0.52084	0.61883	0.59757	0.53688	0.28195
X18	0.68535	0.77385	0.50636	0.44269	0.43941
X19	0.43496	0.46763	0.55381	0.59971	0.35354

Table (6)
(continued)

	X11	X12	X13	X14	X15
X11	1.00000				
X12	0.38395	1.00000			
X13	0.50681	0.37467	1.00000		
X14	0.36919	0.33725	0.74934	1.00000	
X15	0.50470	0.33593	0.62714	0.53650	1.00000
X16	0.43650	0.28864	0.74242	0.69992	0.58497
X17	0.39569	0.12497	0.62736	0.58739	0.52709
X18	0.49648	0.35331	0.67645	0.62885	0.62213
X19	0.34949	0.14643	0.58550	0.50458	0.31603

	X16	X17	X18	X19
X16	1.00000			
X17	0.84695	1.00000		
X18	0.67032	0.61911	1.00000	
X19	0.45613	0.44380	0.29869	1.00000

Table (7)

The Estimated Parameters of the Model

Variable	A	B	α
1	287.98500	-0.35972	-0.2890
2	178.08700	-0.26311	0.0477
3	0.02552	0.00007	-0.2215
4	59.84730	-0.21954	0.0214
5	34.97640	-0.17063	0.0214
6	155.25400	-0.33124	-0.1470
7	0.02311	0.00013	0.1777
8	34.08780	-0.16704	-0.0778
9	16.16670	0.24632	0.1455
10	47.13720	-17042.05000	0.2679
11	3.66132	0.01777	0.3889
12	220.45100	-0.00075	0.2612
13	67.30650	-0.51447	-0.0623
14	121.68300	-0.23961	-0.0594
15	40.17280	-0.23397	0.0642
16	104.44200	-1.16902	0.0349
17	4.88352	0.43541	0.3617
18	15.07450	0.44499	0.1727
19	64.28150	-0.03135	0.0562

Table (8)

Observed, Predicted C.B.R.
and Residuals according to the
Proposed Models

No. of obs.	Observed Y	Predicted Y	Residual
1	49.1000	47.5782	1.5218
2	38.7300	42.9110	- 4.1810
3	46.6000	47.4051	- 0.8051
4	49.8000	47.8186	1.9814
5	45.9000	47.1846	- 1.2345
6	46.0000	45.4491	0.5509
7	49.5000	47.8683	1.6317
8	48.9000	48.4511	0.4439
9	47.0000	42.3747	4.6253
10	46.3000	43.3856	2.9144
11	43.2000	43.4301	- 0.2301
12	18.1300	20.7076	- 2.5776
13	45.1000	37.8124	7.2876
14	26.6000	25.4987	1.1013
15	48.5000	40.9984	7.5016
16	43.7800	41.5303	2.2497
17	43.9000	44.9314	- 1.0314
18	43.9000	50.0331	- 6.1331
19	49.0000	43.4204	5.5796
20	35.5000	30.0159	5.4841
21	43.2000	41.2129	1.9871
22	46.0000	43.7637	2.2363
23	41.1000	34.6404	6.4597
24	25.8500	28.5757	- 2.7257
25	17.8500	22.4878	- 4.6378
26	21.9000	23.9166	- 2.0166
27	37.8000	34.7528	3.0472
28	29.6000	35.4435	- 5.8435
29	44.6000	39.0169	5.5831
30	44.9000	43.1974	1.7026
31	44.6000	39.2337	5.3663
32	41.8000	43.8197	- 2.0197
33	22.6000	25.5110	- 2.9110

Table (8)

(Continued)

34	40.9000	37.4844	3.4156
35	23.1000	26.9364	- 3.8364
36	42.8000	43.2253	- 0.4253
37	48.3000	49.7970	- 1.4970
38	45.4000	48.9707	- 3.5707
39	49.3000	44.8785	4.4215
40	25.3500	18.9671	6.3829
41	18.7000	22.8336	- 4.1334
42	49.1000	46.7352	2.3648
43	50.9000	46.3222	4.5778
44	44.7000	46.5610	- 1.8610
45	26.2000	28.4120	- 2.2120
46	31.9700	34.4869	- 2.5169
47	47.5000	44.1919	3.3081
48	42.8000	39.0885	3.7115
49	39.9000	40.9850	- 1.0850
50	17.1800	16.9995	0.1805
51	15.1500	18.1058	- 2.9559
52	15.2800	15.5232	- 0.2432
53	16.2800	19.2923	- 3.0123
54	15.8800	18.8794	- 2.9994
55	17.0000	15.1204	1.8796
56	14.7000	14.7116	- 0.0116
57	18.5800	17.0847	1.4953
58	18.0500	20.5580	- 2.5080
59	14.5800	16.3935	- 1.8135
60	21.3000	17.5007	3.7993
61	18.0500	18.6215	- 0.5715
62	18.9800	16.1754	2.8049
63	17.6800	14.6849	2.9951
64	16.3300	19.3254	- 2.9454
65	21.0300	26.3537	- 5.3237
66	24.1500	21.6828	2.4672
67	20.6300	26.2207	- 5.5907
68	14.7300	17.4801	- 2.7501
69	17.4000	16.3632	1.0366
70	19.4000	27.5138	- 8.1138
71	19.5700	20.1329	- 0.5629
72	22.5000	22.3967	0.1033
73	17.6000	15.6331	1.9649

Table (9)

Observed, Predicted C.B.R. and the Residuals according to Multi Linear Regression Model

No. of obs	Observed Y	Predicted Y	Residual
1	49.10000	50.39880	- 1.29881
2	38.73000	45.54430	- 6.81429
3	46.60000	47.44390	- 0.84393
4	49.80000	50.76940	- 0.96939
5	45.90000	46.84600	- 0.94596
6	46.00000	48.74700	- 2.74740
7	49.50000	43.79950	5.70049
8	48.90000	47.96520	0.93480
9	47.00000	46.65030	0.34974
10	46.30000	44.42740	1.87260
11	43.20000	47.38060	- 4.18062
12	18.13000	20.02480	- 1.89479
13	45.10000	38.18400	6.91599
14	26.60000	31.05130	- 4.45127
15	48.50000	43.79560	4.70441
16	43.78000	44.67960	- 0.89957
17	43.90000	46.09180	- 2.19182
18	43.90000	53.47290	- 9.57289
19	49.00000	48.60040	0.39957
20	35.50000	31.25860	4.24141
21	43.20000	35.70050	7.49950
22	46.00000	43.52210	2.47794
23	41.10000	33.05850	8.04150
24	25.85000	23.82180	2.02819
25	17.85000	16.70910	1.14095
26	21.90000	26.17940	- 4.27938
27	37.80000	34.38640	3.41365
28	29.60000	34.69600	- 5.09597
29	44.60000	39.03150	5.56849
30	44.90000	43.70090	1.19910
31	44.60000	35.95050	8.64947
32	41.80000	41.57750	0.22240
33	22.60000	27.75880	- 5.15881

Table (9)

(Continued)

34	40.90000	36.43650	4.46355
35	23.10000	23.37360	- 0.27359
36	42.80000	49.24070	- 6.44066
37	46.30000	46.98510	1.31495
38	45.40000	45.36090	0.03909
39	49.30000	45.93480	3.36521
40	25.35000	24.21550	1.13455
41	18.70000	23.35230	- 4.65229
42	49.10000	46.42860	2.67138
43	50.90000	52.81410	- 1.91408
44	44.70000	43.10250	1.59749
45	26.20000	28.70840	- 2.50841
46	31.97000	38.16220	- 6.19221
47	47.50000	42.23560	5.26444
48	24.80000	37.48260	5.31737
49	39.90000	35.20920	4.69085
50	17.18000	17.48560	- 0.30564
51	15.15000	16.57750	- 1.42747
52	15.28000	13.94410	1.33588
53	16.28000	12.88550	3.39450
54	15.89000	18.71650	- 2.83654
55	17.00000	20.89480	- 3.89481
65	14.70000	12.92850	1.77147
67	16.58000	18.74460	- 2.16464
68	18.05000	25.30490	- 7.25489
69	14.58000	17.45720	- 2.87720
60	21.30000	21.10630	0.19375
61	18.05000	18.21270	- 0.16274
62	18.98000	14.80450	4.17548
63	17.68000	14.35350	3.32655
64	16.38000	18.20770	- 1.82767
65	21.03000	28.60710	- 7.57714
66	24.15000	22.15190	1.99815
67	20.63000	27.37210	- 6.74213
68	14.73000	14.74630	- 0.16250
69	17.40000	15.42540	1.97460
70	19.40000	23.64880	- 4.24882
71	19.57000	19.66390	- 0.09388
72	22.50000	21.32970	1.17033
73	17.60000	17.40510	0.19494