LIVING STANDARD AND ECONOMIC GROWTH : A FRESH LOOK AT THE RELATIONSHIP THROUGH THE NONPARAMETRIC APPROACH

Indrani Chakraborty

Centre for Development Studies
Thiruvananthapuram

October 1997

I am grateful to Professor Aman Ullah for motivating me to undertake this research. This paper was presented in the Faculty Seminar at the Centre for Development Studies. I thank Dr.K.P.Kannan and Dr.K.Pushpangadan for useful suggestions. Thanks are also due to Dr.U.S.Mishra for his stimulating comments.

ABSTRACT

The relative role of economic growth vis-a-vis public action in raising living standards in developing countries has been a point of contention for quite some time now. The arguments on both sides are usually based on some estimated relationship between indicators of living standard and other variables. A critical review of the existing studies throws up some methodological issues among which misspecification of the model is most crucial. An alternative approach, viz. the nonparametric regression method, has been shown to be superior in taking care of this problem. Analysing the data for 88 developing countries we note that per capita income has positive significant effect on the life-expectancy at birth. However, we have not observed any relationship between the improvement in life-expectancy and change in income as well as the level of income, unlike some earlier studies. This study has the implication that well-targeted public policies may be successful in improving the standard of living in poor economies in the short-term. But for sustainability in the long-term, growth-based strategies are necessary.

JEL Classification : C14, I31

Key words: standard of living, model specification, nonparametric regression, public action vs. public expenditure.

Intoduction

In the earlier phase of development policies, till the seventies, the thrust was on raising income as reflected by GDP or GNP. But since the seventies the emphasis has shifted towards improving the standard of living where the term "the standard of living" means some direct measure of well-being of people. This shift in emphasis can be considered as a consequence of dissatisfaction with the income-based measures. Theoretical foundation of the term "standard of living" was laid by Sen (1987a, 1987b, 1988, 1993) through his writings on "capability approach". Following Sen, "the standard of living" is a matter of how people are doing and being i.e. the levels of functionings achieved by people and their capabilities to function. "Standard of living" is not a matter directly of opulence, commodities or utilities. However, the normative concern of this approach can be traced back to the pioneering work of Adam Smith (1776) in which he considered such functionings as "not being ashamed to appear in public"(Sen,1993). Prior to Sen, the proponents of "basic needs approach"[1] also emphasised the achievements in various social indicators that go well beyond the growth of GNP only. But the "basic needs approach", unlike the "capability approach", was based on commodity possession rather than functionings achievements.

---

1. The literature in this respect is quite extensive. To name a few are Streeten et.al.(1981), Adelman and Morriss(1973), and Streeten and Burki(1978).

In the process of shift in emphasis from “economic growth” to “improvement in standard of living” one of the important questions of development policy was - does the standard of living of a country depend on economic growth ? Some of the major studies viz. Isenman(1980), Sen(1981), Anand and Kanbur(1991) and Anand and Ravallion(1993) conclude that it is not economic growth but public services which plays a crucial role in improving the standard of living of a country. They cite the examples of Sri Lanka and China , the two exceptional countries, which have been able to improve their standards of living even with a very low level of per capita income. They observed that direct public provisioning of food, education and health was historically prevalent both in Sri Lanka and China which resulted in a standard of living in those countries comparable to that in any developed country. Analysing cross-country data from the developing countries , a recent study by Anand and Ravallion (1993), also came to a similar conclusion. Some other studies, on the other hand, observed a significant positive relationship between per capita income and the standard of living. These studies include Preston(1975), Rodgers(1979), Bhalla and Glewwe(1986), Bhalla(1988), Kakwani(1993), Pritchett and Summers(1996) among others. All these studies are based on cross-country data, with the exception of Bhalla and Glewwe(1986) and Bhalla(1988).These two studies were concerned with Sri Lanka only. The argument that emerges from these studies is that with an increase in income individual’s command over goods and services increases which directly or indirectly improve the standard of living.

It is interesting to note that the conclusions drawn from these studies, whatever they are, have been based on certain statistical analyses. As the observed relationship between per capita income and various indicators of the standard of living appeared to be non-linear, estimation and testing of some non-linear functional forms was the basis of analysis in majority of these studies. The functional forms used in these studies include logistic, log-linear, semi-log and inverse functions. The common characteristic of all these non-linear functional forms, except the inverse form, is that after some transformation of the variables, they become linear and hence can be estimated using OLS method. But there was no reason to suppose that the relationship had to be of such a non-linear form that would become linear after transformation. To defend their specifications, moreover, these studies considered only high R^2 and t-values, without going into any specification testing method. Thus, in none of these studies was the choice of the functional form determined through a consistent methodological approach. It seems that the common objective of all these studies was to get a 'good' estimate of some particular parameter, which is often referred to as "data-mining". In policy research of this kind, however, the objective should be to find out a model that adequately approximate the "true" model. Since inferences drawn from a misspecified model can have serious consequences on policy choices, knowledge of the "true" data-generating process is crucial in this situation. Another drawback of all these studies was that they assumed constant parameters for each country which was unrealistic.

Under such a circumstances, where the relationship between the variables are non-linear , the question of specification of the model can be looked into properly by following an alternative methodological approach viz. the nonparametric approach. In the parametric approach, the functional form of the regression model is specified through the prior assumption regarding the distribution of the variables under consideration. In the nonparametric approach, on the other hand, the density functions are estimated on the basis of actual observations. Thus, the functional form of the regression model is not prespecified in this approach.

The objective of this study is to reexamine the relationship between the standard of living and per capita income using the nonparametric regression method. We shall also consider the role of public services in this respect. In this context one important aspect is the measurement of the "standard of living" within Sen's "capability approach". This issue involves a number of problems viz. - (a) identification of relevant functionings that would be considered as constituting the standard of living, (b) measurement of certain functionings such as morbidity, undernourishment, freedom, achieving self-respect, being happy in one's job and others for which there do not exist unambiguous and comparable measure, (c) aggregation of the functionings and the corresponding weight specifications to get a composite index of capability. As these problems are yet to be resolved, in applied development economics research the practice has been to measure the standard of living of the people of a country by direct measures such as life expectancy at birth, the infant mortality rate, the adult literacy rate, the mean years of schooling etc. In fact, in support of this practice we may even quote Sen (1985,pp.37-38) "the capability approach, broadly defined, is not concerned only with checking what set of bundles of functionings one could choose from , but also seeing functionings themselves in a suitably rich way as reflecting the relevant aspect of freedom". The present study remains concerned with one of the most important dimensions of the standard of living viz. life-expectancy at birth. Per capita income is represented by real GDP per capita in terms of purchasing power parity dollars [Summers and Heston (1984)] and public services are represented by public expenditures on health. This study is based on data from 88 developing countries at two time points viz. 1970 and 1989. The data used in this analysis are collected from various publications of UNDP, World Bank and Summers and Heston (1984).

The plan of the paper is as follows. Section II reviews the methodological approaches followed by some of the empirical studies on the standard of living. Section III introduces the non-parametric methodology. Section IV discusses the findings and analysis. We conclude in section V.

II. A Review of Earlier Approaches :

Isenman (1980) estimated the following log-linear relationship between life-expectancy and per capita income for the data on 59 countries in 1975:

$$\ln Z = 3.197 + 0.132 \ln Y.$$

It appears from this study that the specification of the functional form was guided by high R^{-2} value and significant t-value since there is no theoretical reason as to why the relationship should take this particular form. By assuming constant elasticity of life-expectancy with respect to income, this specification ignores the fact that life-expectancy itself has an upper limit. Following this model, Sen (1981) observes that Sri Lanka's per capita income is expected to be $2684 in 1975 as opposed to its actual income of $130 only. This sharp difference between the expected and actual income in Sri Lanka corresponding to its achieved level of life-expectancy instigated detailed investigation. While analysing Sri Lanka's experience both Isenman (1980) and Sen (1981) argue that redistributive policies of the government made it possible for Sri Lanka to outperform many developed countries with respect to life-expectancy at birth and infant mortality rate even with a very low level of per capita income. This is challenged by Bhalla and Glewwe (1986) and Bhalla (1988) They point out that the results of Sen and Isenman are flawed because the initial conditions of the countries compared were not taken into account. Initial conditions are important because Sri

Lanka achieved an exceptionally high standard of living even before the early 1940's , the period when public expenditures on health, education, food subsidy and other welfare measures started to increase considerably in the country. After incorporating the initial conditions Bhalla and Glewwe come to the conclusion that Sri Lanka should be considered as an outlier with respect to life-expectancy at birth in 1960 and 1975. But the change in its living standard over the entire period of 1960-78 shows that the performance is not exceptional given the fact that there was a large increase in social expenditure in Sri Lanka in the post 1950's. Bhalla and Glewwe estimate two different forms, log-log and logistic, to capture both (i) the influence of income on various indicators of living standard at a point of time, and (ii) the relationship between the change in income and the change in those indicators. For some indicators they obtain implausible results, which, according to them, underscores the importance of proper specification of the functional form even though they notice that the results with respect to life-expectancy are not dependent on specific functional form. Afterwards, Bhalla (1988) comes up with a more striking result. Using a log-log form on cross-country data, he finds that Sri Lanka is not an outlier for any of the six indicators chosen including the life-expectancy at birth. It is the logistic form that makes Sri Lanka's performance appear exceptional in terms of life-expectancy and death rate. It shows how crucial the specification of the functional form is while testing hypotheses. Kakwani (1993), notwithstanding his finding that Sri Lanka's achievement stands out as a positive outlier for the periods 1971-80, 1981-90 and 1971-90, maintains his reservation against the assertion that the exceptional performance of Sri Lanka could be entirely attributed to high proportional welfare expenditures. Another study by Anand and Kanbur (1991), which is based on time-series data from Sri Lanka for the period 1952-81, notes that growth in income and public health spending both played significant role in reducing infant mortality rate in Sri Lanka. Interestingly, Anand and Kanbur use log-linear functional form which had been rejected earlier by Bhalla (1988) since it produced implausible results. In an influential study by Anand and Ravallion (1993) the central theme again is the relative importance of private incomes and public services in promoting human development in poor countries where human development is taken to be some aggregate indicators of individual capabilities such as life-expectancy at birth, literacy rate, and so on. For each such indicator, they define the dependent variable as the proportionate reduction in shortfall of the indicator from an asymptotic limit and estimate a log-linear relationship between the transformed dependent variable and GNP per capita. The regression coefficient turns out to be significant with a positive sign. The specification, however, seems to be arbitrary since no explanation has been provided. Subsequently in the same paper, Anand and Ravallion introduce two additional explanatory variables viz., a poverty index and public health expenditure per capita. With the introduction of these two variables the coefficient of GNP per capita reverses to negative sign but turns out to be not significant. This phenomenon they observe for all the indicators except literacy. On this basis they conclude that there are mainly two channels, reduction of poverty and improvement in public health services, through which economic growth promotes human development in poor countries. Their entire analysis is based on the evidence that the sign of the coefficient of GNP per capita reverses on adding two other variables to the regression. But this could well be an indication of multicollinearity, a sure test of which would be to verify if a high simple correlation between each pair of the explanatory variables exists (Kennedy, 1990). And it is indeed the case since the correlation coefficient between log of public health spending per capita and log GNP per person in their study is found to be 0.91 (significant at 1% level). The rule of thumb, which is often used to detect multicollinearity, is that the estimated R^2 is less than the square of the simple correlation coefficient between the independent variables. However, multicollinearity is not so serious and can be ignored if all the estimated t-statistics are greater than 2 (Kennedy, 1990). Following this criterion we observe that multicollinearity is serious in the study by Anand and Ravallion since the estimated t-statistics for log GNP per person is 1.34. In presence of multicollinearity estimates are unbiased but not precise. Murray et.al (1994) observe that per capita public health expenditure could be explained by per capita income if one examined a large sample of countries, as they did. They find that the income elasticity of per capita public health expenditure is 1.43.

Some early studies also examined cross-country relationship between life-expectancy and income per capita. Preston (1975) estimated a logistic function since the scatter plot of his data revealed an asymptotic limit to the upper end[2] . He found that the growth in income accounted for only 10 to 25 percent of the growth in life expectancy during the study period. Rodgers (1979) experimented with various alternative functional forms for some indicators of mortality, income per capita and Gini coefficient for distribution of income for 56 countries. 'Best' results were obtained from the non-logarithmic formulations such as the inverse and inverse quadratic. One that produced high R^2 value, significant t-values and a reasonable value for the asymptote was considered to be the best! This is akin to the notorious practice of 'data-mining'. Furthermore, choice of a functional form from several alternative non-linear models should not be based on the criterion of

2. It is interesting to note that while considering 112 countries including both the developed and developing countries we also observed that the relationship appears to be logistic both in 1970 and 1989.

highest R^2 for two main reasons : (i) R^2 for different non-linear forms are not comparable and (ii) a functional form having a good fit within the sample may produce large forecast errors when used for prediction outside the sample (Studenmund, 1992). Even the same functional form fitted on different sets of data may produce absurd results. Kakwani (1993), for example, finds that the estimated α, which represents the highest standard of living that can be achieved with infinite income, is negative in one case. In another, the estimated value of the asymptotic limit of life-expectancy at birth turns out to be as high as 123.

In a recent study by Pritchett and Summers (1996) significant effect of per capita income on life-expectancy has been found from cross-country time-series data for the period 1960-1985. To identify the pure income effect, they use instrumental variable estimation method instead of OLS. The income elasticity of infant mortality in the developing countries turns out to be -0.2. Their study also suggests that the relationship is causal and not merely incidental. As stated by the authors this study uses log-linear relationship because of the convenience of easy interpretation of the estimated coefficients. The same criticism, therefore, applies to this study too as we had for Isenman (1980). The importance of the study by Kakwani (1993) lies in its explicit treatment of some of the methodological problems implicit in the existing studies. Instead of following a purely data-driven approach to specification he starts with a set of axioms and derive deductively an index for measuring achievement in living standard. An index for measuring improvement is then derived as a difference between 'achievement levels' according to the achievement function which is convex in the indicators of the standard of living viz, life-expectancy at birth, infant mortality rate and so on. Convexity follows from the view that "as the standard of living reaches progressively higher limits, incremental improvement would represent much higher levels of achievement than similar incremental improvements from a lower base”. He deploys the achievement function to explain the non-linear relationship between the standard of living and per capita income in 80 developing countries between 1971 and 1990. He observes that economic welfare as measured by logarithm of per capita GDP is an important determinant of the standard of living but the elasticities, in absolute term, decrease monotonically with income. So he notes that the standard of living is more responsive to per capita income in the poorer countries than that in the richer ones. Moreover, he observes that improvement in the standard of living is significantly influenced by the level as well as change in economic welfare. A few comments, however, are in order. To capture the non-linear relationship between the social indicators and per capita income he estimates a linear function between the achievement index and average welfare measured by the logarithm of per capita GDP. Thus, in effect, he estimates a semi-log function between achievement and per capita income. He argues that the use of the achievement index as the dependent variable adequately captures the non-linearity. For our sample of countries, however, the relationship between the achievement function and logarithm of GDP per capita appears to be non-linear, as discussed later. We also observe a non-linear relationship between Kakwani’s improvement index and the level of and change in welfare, which is assumed to be linear by Kakwani (1993).

III. Methodology

In this section we describe briefly the nonparametric regression technique which we shall apply to our problem. The regression relationship can be modeled as :

$$Y = m(x) + u = E(Y|X=x) + u$$

where Y is the dependent variable, m(x) is the regression function, u is the disturbance term and X is the vector of regressors. If the joint density f(y,x) exists then m(x) can be calculated as

$m(x) = \int y \frac{f(y,x)}{f_1(x)} dy$ where $f_1(x) = \int f(y,x)dy$ denotes the marginal density of x. In parametric approach, m(x) is given by the prior specification of the data generating process i.e. the joint density function of the variables under consideration. For example, whenever m(x) is linear the underlying assumption is that f(y,x) is normally distributed. However, it is a well-known fact that if there exists any misspecification in the functional form of the regression equation we get inconsistent estimates of the regression coefficients and the test performed on the basis of such estimates may not be reliable. One way to get around this problem is to follow the nonparametric approach, which is a distribution-free method. In this approach, the density functions are estimated on the basis of actual observations.

Density estimation can be done by various methods. Pagan and Ullah (forthcoming) presents an exhaustive discussion on all such methods. These methods apply a smoothing technique viz. the"local averaging procedure". This technique, for a given value of $X=x_i$, considers a small neighbourhood around x_i (denoted by h, which is known as 'window width' or 'bandwidth' or smoothing parameter') and takes the average of all the corresponding observations on y. Then the resulting curve for $\widehat{m}(x)$ becomes smooth. Formally, this procedure can be defined as $\widehat{m}(x) = n^{-1}\sum_{i=i}^{n} w_{ni}(x)y_i$ where $[w_{ni}(x)]_{i=i}^{n}$ denotes the weight sequence which depends on the vector $\{Xi\}_{i=1}^{n}$. The particular method we adopt in our analysis is called the kernel smoothing. Here the observations closer to x_i are given higher weights and the weight decreases as the observations lie far from x_i.

The shape of the weight function w_{ni} (x) is represented by a density function known as kernel function [k(u)] which adjusts the size of the weights.[k (u)] has the properties that it is a continuous, bounded and symmetric real function which integrates to unity. Silverman (1986) and Hardle (1990) give a detailed discussion on kernel density estimators. Out of this class of kernel estimators we choose the Nadaraya-Watson estimator where the weight sequence is defined as :

$$w_{ni}(x) = k\left(\frac{x_i - x}{h}\right) / n^{-1} \sum_{i=i}^{n} k\left(\frac{x_i - x}{h}\right)$$

The shape of the kernel weight is determined by the kernel function k(u), whereas the size of the weight depends upon the window-width, h. Kernel functions may be of various shapes viz., parabolic, uniform, normal, canonical etc. But it is observed that any kernal is optimal for large samples (Pagan and Ullah, forthcoming)[3] . Therefore, for practical problems the choice of kernel is not a major issue provided the sample is large enough. In our analysis, we use the normal kernel. However, the choice of window-width, h, is very crucial. As h increases, variance decreases because a large number of points are used in the estimation of density. But it results in an over-smoothed density which increases the bias. Therefore, the choice of h involves a trade-off between bias and variance. The guiding principle is to choose h such that the integrated mean square error of the estimated density is minimized. It is achieved when $h \propto n^{-1/(4+q)}$ where q is the number of explanatory variables[4] . In our analysis, since

q = 1, we use $h = s_x n^{-1/5}$ where s_x is the standard deviation of X.

---

3. For a discussion on the optimality properties of the kernel function see Hardle (1990) and Scott (1992).

4. For further details on the choice of h, see Pagan and Ullah (forthcoming), Ullah (1989) and Hardle (1990).

Similar to m(x), conditional variance of Y at a given X, i.e. v(Y|X=x) can also be estimated by nonparametric methods. The estimate is given as :

$$\hat{v}\,(y|x) = \sum_{i=i}^{n} w_{ni}(x)\, y_i^2 - \sum_{i=i}^{n} w_{ni}\,(x)\, y_i$$

Finally, the response coefficients, at a given value of X =x, are obtained from the estimated slope of $\hat{m}$ (x) as:

$$\hat{\beta}_j\,(x) = \frac{\delta\, \hat{m}\,(x)}{\delta\, x_j} \quad \text{where } j = 1, 2 \,.......q$$

$$\simeq \frac{\hat{m}\,(x + \frac{h}{2}) - \hat{m}\,(x - \frac{h}{2})}{h}$$

where $\hat{m}\,(x \pm \frac{h}{2}) = \hat{m}\,(x_1, x_2, ...x_j \pm (h/2), ... x_q)$

Asymptotic properties of $\hat{\beta}$ are discussed in detail by Pagan and Ullah (forthcoming).

Section IV : Findings and Analysis

From 1970 data, it appears that life expectancy increases at a more or less constant rate with GDP per capita (fig.1). But the relationship for the same group of countries in 1989 (fig.2) shows that life expectancy was increasing but at a decreasing rate. The relationship, thus, appears to be almost linear in 1970 whereas in 1989 it appears to

Fig. 1. NP Regression of Life Expectancy on GDP : Developing Countries - 1970

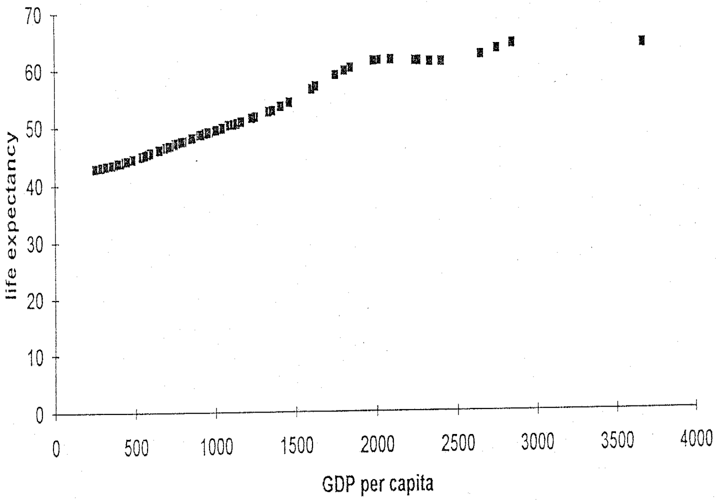
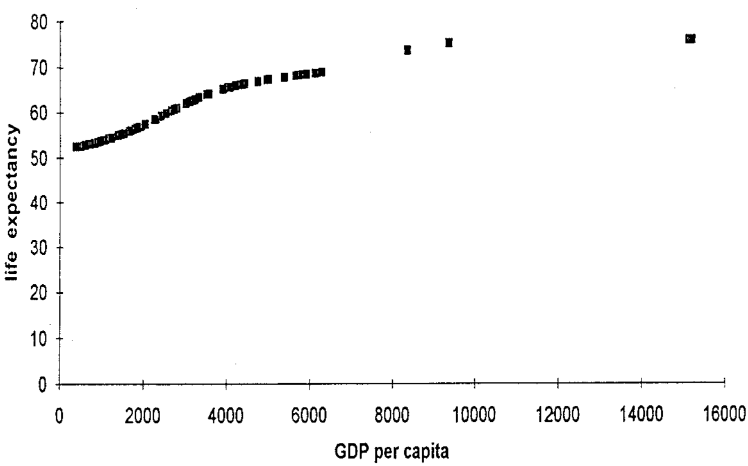


Fig. 2. NP Regression of Life Expectancy on GDP : Developing Countries - 1989



be quadratic. So, the relationship changed over time[5] . This finding identifies a misspecification problem in the existing studies based on the parametric method. It is already discussed that the existing studies, based on the data from developing countries, estimated different

Fig. 3. NP Regression of life Expectancy on GDP : Developed Countries - 1970

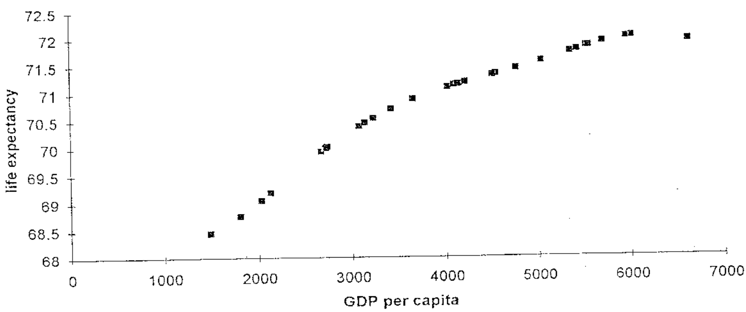
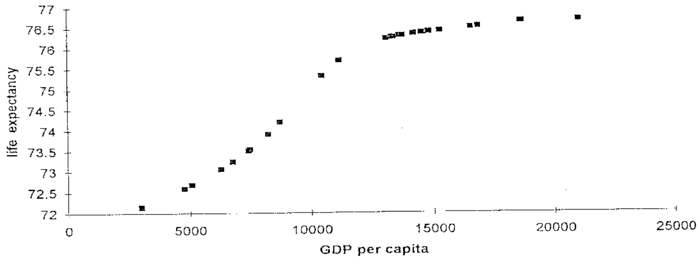


Fig. 4. NP Regression of life Expectancy of GDP : Developed Countries - 1989



---

5. It is to be noted that the relationship changed not only over time but also across different categories of countries viz. developed and developing countries. For a group of 32 developed countries we observed that the relationship was almost quadratic in 1970 (fig.3) but became a logistic one in 1989 (fig.4). From these observations one should not rush to the conclusion that the relationship between the two variables follows a particular evolutionary path over time. The fact that in 1970 for the developed countries the relationship is observed to be quadratic and for the developing countries the same relationship holds in 1989 is not meant to support any convergence theory.

non-linear functional forms, e.g. reciprocal, log-linear, logistic, which seem to be inappropriate in the light of the nonparametric method.

The response coefficient(ß) appears to be significant both in 1970 and 1989 in all the developing countries with a few exceptions only (figs.5 and 6). The estimated response coefficients for all countries for 1970 and 1989 are presented in Table 1. This table also identifies the countries with significant response coefficients(ß). We mentioned that

Fig. 5. BETA 1970 : Developing Countries

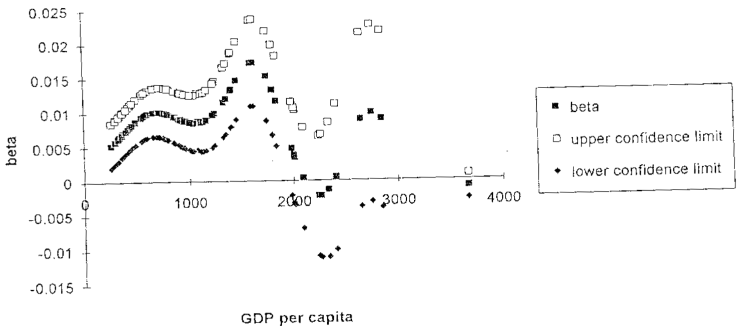
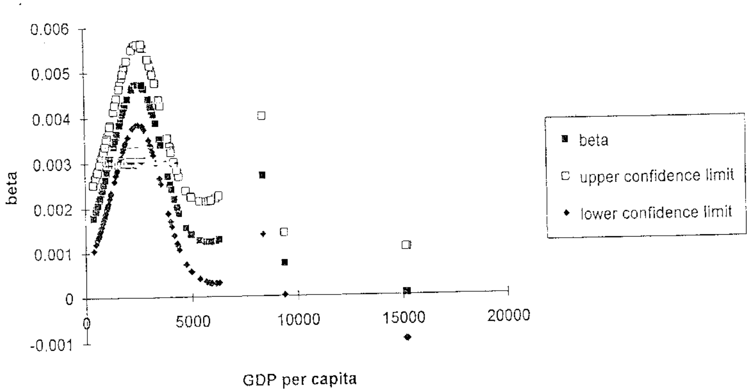


Fig. 6. BETA 1989 : Developing Countries



following the parametric method, some of the earlier studies too observed significant positive effect of income on life-expectancy. But the important fact that emerges from our findings is that the response coefficient changes across countries (figs. 5 and 6). This finding is a significant development over the existing studies because they estimated fixed parameter models on the assumption of a constant response coefficient (ß) for all the countries. The existing studies observed ß's to be either significant or insignificant over the whole range of per capita income. But we find that these coefficients are significant for countries belonging to a certain range of per capita income. It appears from Table 1 that income has significant effect on life-expectancy in countries having per capita income less than $4500 in 1989. The similar group of countries in 1970 are those having per capita income below $1810 approximately, with a few exceptions. Exceptional countries include Lesotho($320), Malawi($257), Mali($253), Rwanda($290) and Myanmar($320) where the response coefficient was not significant though their per capita income was much less than $1810 in 1970. This result is justified because wealthy nations have already reached a high level of life-expectancy and hence any further increase in the average income has no impact on life-expectancy which itself has an upper limit. For the low income countries, however, variability of life-expectancy is considerably high whereas for the high income countries it is low both in 1970 and 1989(figs. 7 and 8). This indicates that for the low income countries there are certain factors other than income that play a role in improving the standard of living. This brings into focus the role of direct public action in raising the standard of living of the poor countries , as pointed out by Sen(1981) and others. It is interesting to note that with an increase in real per capita income between 1970 and 1989, variability of life-expectancy reduced in 70 countries , out of a total of 88 (Table 2).

Fig. 7. Nonparametric Variability of life Expectancy - Developing Countries: 1970

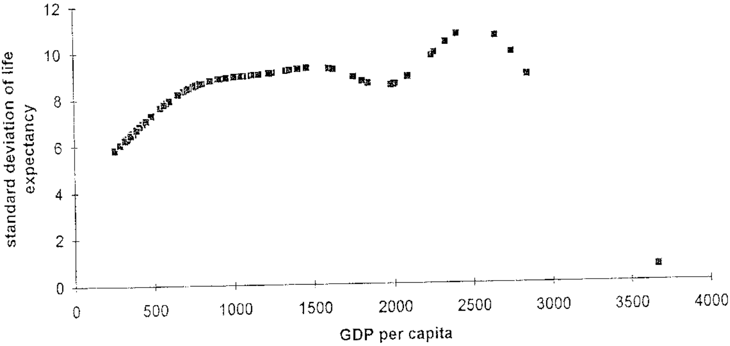
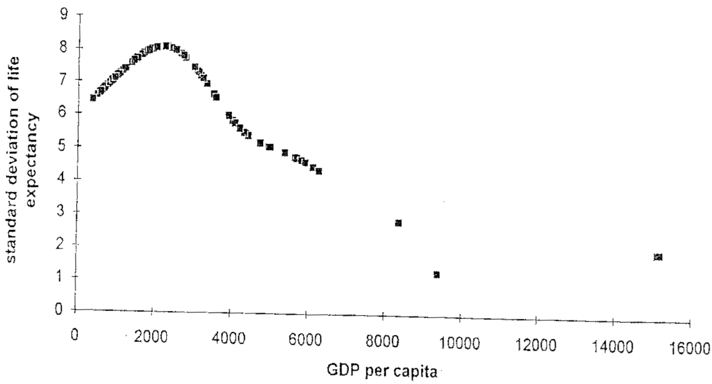


Fig. 8. Nonparametric Variability of life Expectancy - Developing Countries: 1989



It is evident from figs.7 and 8 that variance of life expectancy is not constant across countries which signifies the presence of heteroscedasticity. But some of the earlier studies viz., Anand and Ravallion (1993), Rodgers (1979) and Preston (1975) were based on the assumption of homoscedasticity since they used OLS estimation technique. Use of OLS method in the presence of heteroscedasticity has serious consequences. Under this situation, estimated regression coefficients remain unbiased but the variance of the coefficients are underestimated. As a result the t-statistic is overestimated. Inferences drawn on this basis is , therefore, misleading. The only study which was aware of the presence of heteroscedasticity was Kakwani(1993) and to remedy this problem he estimated heteroscedasticity consistent t-statistic as proposed by White(1980).

The life-expectancy at birth and income both increased between 1970 and 1989 across all the countries. So one may think that improvement in longevity is influenced by the changes in income. As Kakwani(1993) points out an increase in per capita income makes available to people a larger real consumption of items affecting health viz. food, housing, medical services, education and so on. Preston (1976), on the other hand, mentioned that an increase in income may also have negative effect on health through increased consumption of goods such as alcohol, cigarettes and animal fats. Some studies further argue that the initial level of income is likely to have some influence on the rate of change of certain social indicators. For example, Preston (1975) observed negative significant relationship between the change in life-expectancy and the level of income. Interestingly enough, the same relationship was observed to be positively significant by Kakwani(1993). We too attempt to examine the relationship between improvement in life-expectancy at birth and change in income as well as the level of income in 1970. But we shall follow the nonparametric regression method unlike the earlier studies. Before estimation the question of measurement of improvement in life-expectancy at birth comes in order. Generally three alternative measures are used to represent improvement in an indicator, having asymptotic limits, over a period :(a) absolute change, (b) percentage change and (c)Sen's(1980) index, which measures improvement as the proportion of deprivation or shortfall (from an upper limit) made up through an increase in the absolute level of the indicator. It is given by $Z = \frac{(x_2 - x_1)}{(M - x_1)}$ where M is the upper limit and x_1 and x_2 are the values of the indicators at the initial and the terminal periods, respectively. But all the three methods have some limitations. The first method gives equal weight to countries having equal increment in life-expectancy, irrespective of their initial levels of life-expectancy, which is unjust because it becomes more and more difficult to increase life-expectancy as life-expectancy rises [Sen(1981) and Dasgupta(1990)]. The second method, on the contrary, gives greater weight to the countries with low life-expectancy. The third method, on the other hand, is not additive in the sense that improvement over a period measured by this method is not equal to the addition of improvements in two subperiods within the said period[6]. Kakwani(1993) developed an alternative improvement index, using axiomatic approach, which takes care of all these problems. Firstly, he developed an achievement function which is normalized to lie between 0 and 1. The achievement function is derived in such a way that it gives greater weight to an increase in life-expectancy of a country which has higher longevity level than a similar increment in life-expectancy of some other country at a lower level of longevity. Then he derived the improvement index as the difference between the achievement

6. A detailed discussion of the problems of each method, with illustration, is given by Kakwani(1993).

functions at two different periods. Kakwani(1993) derived a class of achievement functions. Out of these, the achievement function which satisfies all of his axioms is given by $f(x, M_o, M) = \frac{\ln(M - M_o) - \ln(M-x)}{\ln(M-M_o)}$ where x represents the social indicator e.g. life-expectancy and M_o and M are the lower and upper limits of the indicator, respectively. Improvement index, corresponding to the above function is derived as :

$$Q(x_1, x_2, M_o, M) = \frac{\ln(M- x_1) - \ln(M - x_2)}{\ln(M- M_o)}$$

where x_1 and x_2 are the values of the social indicator in first and second periods respectively. Following this methodology, we estimate the achievement functions for all the countries in 1970 and 1989 and then compute the improvement index. We assume, like Kakwani, the maximum and minimum values of life-expectancy as 80 years and 30 years, respectively.

The estimated nonparametric regression results are presented in Table 3. The results indicate that neither the change in income nor the level of income have significant effect on improvement in longevity. In none of the 88 countries the response coefficient appear to be significant, although they are positive in most of the cases. These results, therefore, contradict the earlier findings of Preston(1976) and Kakwani(1993). It is to be noted that two earlier studies by Arriaga and Davies(1969) and Stolnitz(1965) based on the analysis of mortality trends in some less developed countries such as Latin America, Asia, and Africa also observed a lack of relationship between the level of income and the rate of change of mortality in the post-war period. One reason for obtaining significant relationship by Kakwani(1993) as well as Preston(1976) may be due to the specification adopted. Both of these studies estimated a linear functional form between the variables. However, the nonparametric relations between the improvement index and the percentage change in income, obtained from both Kakwani's and our data, appear to be nonlinear (figs. 9 and 10)[7] . We also want to

Fig. 9. NP Regression of improvement Index on Change in GDP: Kakwant's Data Set

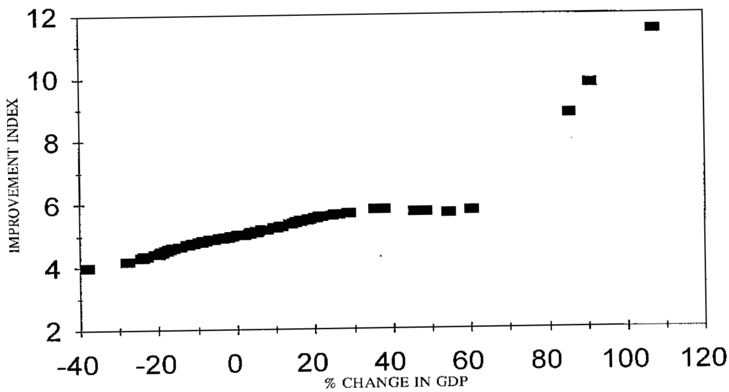
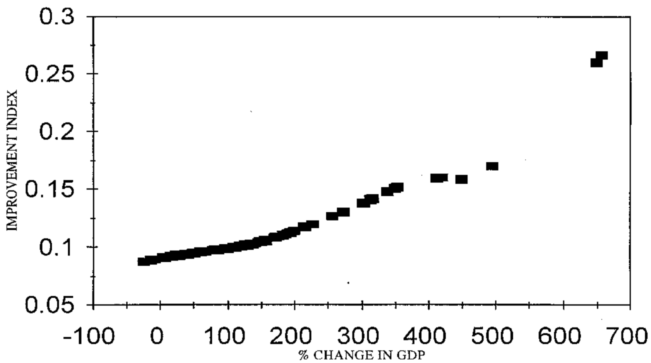


Fig. 10. NP Regression of improvement Index on Change in GDP: Our Data Set



---

7. Since only two-dimensional plot could be visualised we have considered the relationship between the improvement index and the percentage change in income and dropped the other variable viz. the level of income.

draw attention to the functional form used by Kakwani(1993) to relate the achievement index and economic welfare of a country. He argues that logarithm of GDP per capita can be considered as a measure of economic welfare of a country in the absence of data for the distribution of income for each country. Thus, essentially he estimates a linear functional form between the achievement index and log GDP per capita. Our analysis, however, detects a misspecification in this respect. We find that the relationship appears to be nonlinear both in 1970 and 1989 (figs 11 and 12).

Fig. 11. Developing : 1970

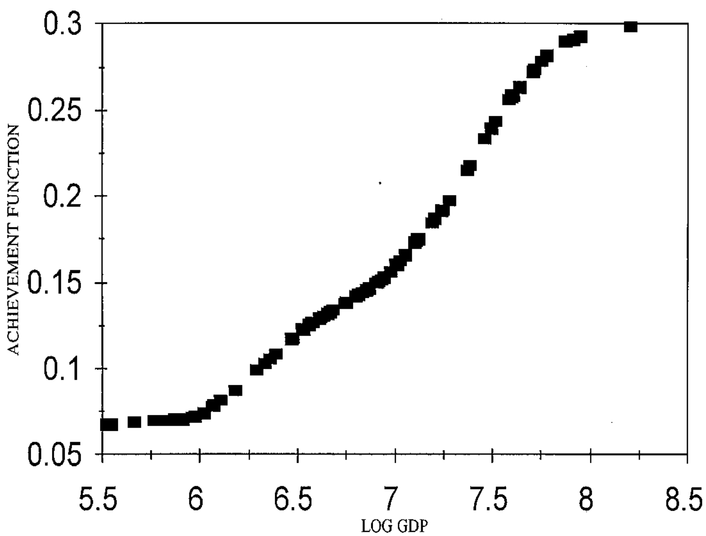
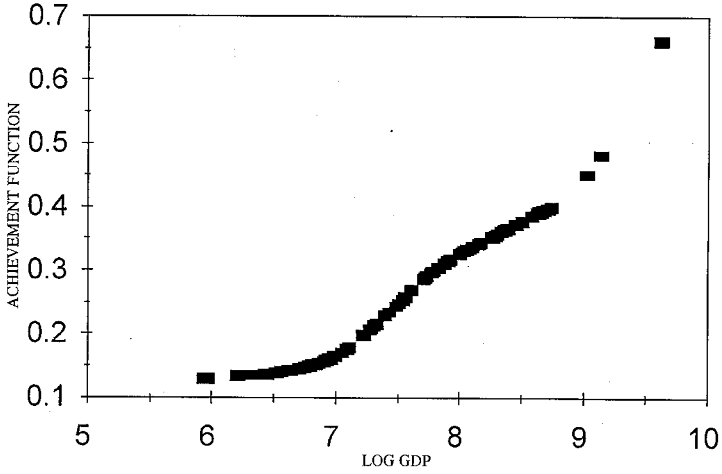


Fig. 12. Developing : 1989



Our findings show that the relationship between life-expectancy and GDP per capita was linear in 1970 and in 1989 it became quadratic. Both the variables represent aggregate measure. However, it can be proved that if the relationship between life-expectancy and personal income at the individual level is linear then the relationship would be linear at the aggregate level also. It implies that whatever be the distribution of income, life-expectancy would remain the same for a country with a given level of income. On the other hand if the relationship is quadratic at the individual level then it would result to a quadratic functional form at the aggregate level and that would depend on the distribution of income. Quadratic functional form at the individual level means life-expectancy is an increasing function of personal income but increases at a decreasing rate. It reflects diminishing returns to increases in income which is very much plausible. Under this situation since the quadratic relationship at the aggregate level depends on the distribution of income it is possible to increase life-expectancy even without changing the average income but only reducing the inequality in the distribution of income[8]. In the absence of data on distribution of income in different countries it has not been possible to include this variable in our analysis. However, from the observed quadratic relationship in 1989 it follows that it is possible to achieve larger gains in life-expectancy by any slowly-growing low-income country through well-targeted redistributive government policies as followed in Sri Lanka, China and Kerala (in India). Since we observed significant effect of income in majority of the countries it implies that public action can do well in the short-term but for sustainability long-term economic growth is important.

One important point in this context is how to measure public action. Very often public expenditure is used as a proxy for public action as for example in the study by Anand and Ravallion(1993). They conclude on the basis of data from 22 developing countries that it was not economic growth but public expenditures on social sectors and removal of poverty which played the crucial role to improve the standard of living. We already have discussed some limitations in the methodology

---

8. Suppose Y represents personal income and Z represents the corresponding level of life-expectancy. Let f(y) be the density function of income distribution with mean μ and variance σ^2. Consider two different cases with respect to the relationships between personal income and life-expectancy (i) linear and (ii) quadratic. In case (i), we have $Z = \alpha + \beta Y$. Aggregating this relation we get mean life-expectancy for the population of the country as

$$E(Z) = E(\alpha + \beta Y)$$

or, $\bar{Z} = \alpha + \beta\mu$, which shows average life-expectancy is a linear function of average per capita income. In case (ii), on the other hand, we have $\bar{Z} = \alpha + \beta Y - \gamma Y^2$. Thus, after aggregation it becomes $\bar{Z} = \alpha + \beta\mu - \gamma\mu^2 - \mu\sigma^2$. In this case, therefore, average life-expectancy depends not only on average income but also on the variance of the distribution of income such that higher is the variance lower is the average life-expectancy and vice versa.

of this study in section II. Apart from that we should consider how important is the role of public expenditure in the developing countries. Evidence shows that while the public share was 71% of the total health expenditure in the formerly socialist economies of Europe it was only 38% in Asian countries (excluding India and China), 44% in Sub-Saharan Africa, 20% in India and 11% in China (Murray et.al.,1994). A World Bank survey of household expenditures in some African countries also corroborates this view (World Bank, 1994). They reported that per capita household expenditure on health was $19 in Cote d'Ivore with a per capita GNP of $900 in 1985 whereas central government expenditures averaged $8.20 per capita. In Ghana per capita household expenditure on health was $7.30 whereas central government expenditure was about $4.20 and per capita GNP was $240 in 1986. In Nigeria, where per capita GNP was $400 in 1985-86 , average per capita household expenditures were about $15 whereas central government health expenditure were between $1-$2 per capita. Table 4 shows a comparative picture of the Sub-Saharan African countries. It is evident that the share of private expenditure in total health expenditure was comparatively much higher in these countries than the developed market economies. Private health expenditure, again, was observed to be significantly influenced by per capita income in the developing countries, elasticity being 1.03 (Murray et. al.,1994). Therefore, effect of income on life-expectancy may be through this channel of private health expenditure in the developing countries. It is to be noted that per capita health expenditure is extremely low in most of the African countries(Table 4). The only exceptions in this respect are Burkina Faso, Cameroon, Senegal and Zimbabwe. Per capita health expenditure is extremely low in Sri Lanka and China too, $18 and $11 respectively. But the coverage of health services was remarkably high in both the countries. During 1988-90, 93% of total population in Sri

Lanka had access to health services. The similar figure in China was 83% Sen(1981) also pointed out these facts about Sri Lanka in his study. Thus only increased volume of health expenditure may not necessarily raise longevity. Evidence from some of the Sub-Saharan African countries, in fact, corroborates this view. During the 1980's there was an implementation of massive international programmes to promote child health in the countries in Sub-Saharan Africa. During 1980-88, however, the rate of decline in under-five mortality was extremely low in most of these countries, the only exception being Senegal, Madagascar, Kenya and Zimbabwe (Table 4). Failure of these programmes was argued to be due to the orientation of those programmes towards curative care than preventive ones. (World Bank,1994 and Brockerhoff ,1995). It was stated that not only external assistance but also public expenditure on health in these countries was mostly meant for curative care. Countries which spent more than 60% of public health budget on curative care between 1981 and 1988 includes Kenya, Malawi, Tanzania, Uganda and Nigeria . Thus, effectiveness of public action in the developing countries depends on the coverage of public services rather than on the public expenditures, and on the nature of orientation of the programmes.

Conclusion :

The relative role of economic growth vis-a-vis public action in raising living standards in developing countries has been a point of contention for quite some time now. The arguments on both sides are usually based on some estimated relationship between indicators of living standard and other variables. A critical review of the existing studies throws up some methodological issues among which misspecification of the model is most crucial. An alternative approach, viz. the nonparametric regression method, has been shown to be superior in taking care of this problem. Analysing the data for 88 developing countries we note that per capita income has positive significant effect on the life-expectancy at birth. We have estimated the response coefficient of income on life-expectancy for each of the countries, which could not have been possible by earlier studies for their particular methodological adherence. We further observe that the assumption of homoscedasticity made in the earlier studies cannot be supported. We have not observed any relationship between the improvement in life-expectancy and the level and change in income unlike some earlier studies. This indicates that even the slowly growing low-income economies can improve their standard of living considerably, which is possible through direct public action as argued by Sen (1980). However, direct public action should not be confused with public expenditures on social sectors, as some researchers did. Public action should be interpreted as redistributive orientation of government policy, which may be reflected through its coverage of and effectiveness to the people. However, well-targeted public policies may be successful in improving the standard of living in poor economies in the short-term. But for sustainability in the long-term, growth-based strategies are necessary. Our cross-country findings corroborate this view.

REFERENCES

Adelman, I and C.T.Morris (1973), *Economic Growth and Social Equity in Developing Countries,* Stanford University Press.

Anand, Sudhir and Martin Ravallion, (1993), "Human Development in Poor Countries : On the Role of Private Incomes and Public Services", *Journal of Economic Perspectives,* 7(1).

Anand, Sudhir and S.M.Ravi Kanbur (1991), "Public Policy and Basic Needs Provision : Intervention and Achievement in Sri Lanka," in Dreze, J.P and A.K.Sen (eds), *The Political Economy of Hunger,* Vol.3, Clarendon Press, Oxford.

Arriaga, E.E. and K.Davis (1969), "The Patterns of Mortality Change in Latin America," *Demography,* 6.

Bhalla, Surjit S.(1988), "Is Sri Lanka an Exception ? A Comparative Study of Living Standards," in Srinivasan, T.N. and P.K.Bardhan (eds), *Rural Poverty in South Asia,* Columbia University Press, New York.

Bhalla, Surjit S. and Paul Glewwe(1986), "Growth and Equity in Developing Countries : A reinterpretation of the Sri Lankan Experience," *The World Bank Economic Review,* 1(1).

Brockerhoff, Martin (1995), "Child Mortality in East Africa : the Impact of Preventive Health Care, The Population Council, Research Division," Working Paper No.76.

Dasgupta, P. (1990), "Well-being and the Extent of its Realization in Poor Countries," *Economic Journal* (Supplement).

Grant, James P. (1990), *The State of the World's Children,* 1990, Published for UNICEF, New York.

Hardle,W. (1990), *Applied Nonparametric Regression,* Cambridge University Press.

Isenman, Paul (1980), "Basic Needs : The Case of Sri Lanka," *World Development,* 8.

Kakwani, N. (1993), "Performance in Living Standards - An International Comparison," *Journal of Development Economics, 41.*

Kennedy,Peter (1990), *A Guide to Econometrics,* The MIT Press, Cambridge.

Murray, C.J.L., R.Govindraj and P.Musgrove (1994), "National Health Expenditures : A Global Analysis," *Bulletin of the World Health Organization,* 72(4).

Pagan,Adrian and Aman Ullah (forthcoming)

Preston,Samuel H. (1975), "The Changing Relation Between Mortality and Level of Economic Development," *Population Studies,* July, 29(2).

Pritchett,Lant and Lawrence H. Summers (1996), "Wealthier is Healthier," *The Journal of Human Resources,* 31(4).

Rodgers,G.B. (1979), "Income and Inequality as Determinants of Mortality : An International Cross-Section Analysis," *Population Studies,* 33(2).

Scott, D.W. (1992), *Multivariate Density Estimation : Theory, Practice and Visualization,* John Wiley and Sons.

Sen, Amartya (1981), "Public Action and the Quality of Life in Developing Countries," *Oxford Bulletin of Economics and Statistics,* November, 43(4).

Sen, Amartya (1987a), *Commodities and Capabilities,* Oxford University Press.

Sen, Amartya (1987b) *The Standard of Living* - *The Tanner Lecture, 1985,* Cambridge University Press.

Sen, Amartya (1988), "The Concept of Development" in H. Chenery and T.N.Srinivasan (eds), *Handbook of Development Economics,* North-Holland, Amsterdam.

Sen, Amartya (1993), "Capability and Well-Being" in Martha C.Nussbaum and Amartya Sen (ed), *The Quality of Life,* Clarendon Press, Oxford.

Silverman,B.W. (1986), *Density Estimation for Statistics and Data Analysis,* Chapman and Hall, London.

Stolnitz, G. (1965), "Recent Mortality Trends in Latin America and Africa," *Population Studies.*

Streeten,P. and S.Burki (1978), " Basic Needs : Some Issues", *World Development,* 6.

Streeten,P., S.Burki, Mahbub ul Haq, N.Hicks and F.Stewart (1981), *First Things First : Meeting Basic Needs in Developing Countries,* Oxford University Press.

Studenmund,A.H. (1992), *Using Econometrics - A Practical Guide,* Harper Collins Publisher.

Summers, Robert and Heston, Alan (1984), "Improved International Comparisons of Real Product and its Composition : 1950-1980," *Review of Income and Wealth,* June, 30.

Ullah, Aman (ed) (1989), *Semiparametric and Nonparametric Econometrics,* Heidelberg : Physica-Verlag.

UNDP (1992), *Human Development Report,* Oxford University Press.

White, H. (1980), "A Heteroscedasticity - Consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity," *Econometrica,* 48.

World Bank (1991 and 1993), *World Development Report,* Oxford University Press.

World Bank (1994), *Better Health in Africa - Experiences and Lessons Learned.*

Table 1

Nonparametric Regression Estimates of Effects of Per Capita Income on LifeExpectancy in 1970 and 1989

Country	LE70	RGDP70	BETA70		s.e.70	LE89	RGDP89	BETA89		s.e.89	t89	t70
ALGERIA	50.7	1403	0.013182	*	0.005411	65	3088	0.004285	**	0.000892	4.803812	2.436149
BENIN	38.5	435	0.007955	*	0.003245	51	1030	0.002743	**	0.000736	3.726902	2.451464
BOTSWANA	41	723	0.010085	**	0.00359	67	3180	0.00414	**	0.000887	4.667418	2.809192
BURUNDI	38.5	329	0.006337	*	0.003179	49	611	0.002086	**	0.000725	2.877241	1.993394
CAMEROON	41	802	0.00977	**	0.003683	57	1699	0.003916	**	0.000801	4.888889	2.652729
C.AF.EMP	39	542	0.009325	**	0.003365	51	770	0.002321	**	0.000726	3.196970	2.771174
CHAD	38	434	0.00794	*	0.003244	47	582	0.002045	**	0.000725	2.820690	2.447596
CONGO	41	966	0.008737	*	0.003909	54	2382	0.004693	**	0.000876	5.357306	2.235098
EGYPT	49.9	755	0.009994	**	0.003628	60	1934	0.004276	**	0.00083	5.151807	2.754686
ETHIOPIA	38.5	336	0.006444	*	0.00318	48	392	0.001794	*	0.000732	2.450820	2.026415
GABON	38.5	2404	0.000525		0.010565	53	4735	0.001548		0.000825	1.876364	0.049692
GAMBIA	41	687	0.010115	**	0.003546	44	886	0.002504	**	0.000729	3.434842	2.852510
GHANA	41.5	1080	0.008738	*	0.004171	55	1005	0.002701	**	0.000735	3.674830	2.094941
GUINEA	38.5	689	0.010116	**	0.003549	43	602	0.002074	**	0.000725	2.860690	2.850380
IVORY COA	41	1028	0.008513	*	0.004024	53	1381	0.003361	**	0.000765	4.393464	2.115557
KENYA	49.1	431	0.007896	*	0.003242	59	1023	0.002731	**	0.000736	3.710598	2.435534
LESOTHO	43.5	320	0.0062		0.003177	56	1646	0.003828	**	0.000795	4.815094	1.951527
LIBERIA	41	860	0.009402	*	0.003755	54	937	0.002587	**	0.000731	3.538988	2.503862
MADAGASCA	40.9	647	0.010045	**	0.003497	51	690	0.002201	**	0.000725	3.035862	2.872462
MALAWI	38.5	257	0.005276		0.003186	48	620	0.002099	**	0.000725	2.895172	1.655995
MALI	37.2	253	0.00522		0.003188	48	576	0.002037	**	0.000725	2.809655	1.637390

Table 1 (Contd.......)

MAURITANI	41	650	0.010054	**	0.003501	46	1092	0.002849	**	0.00074	3.85	2.871751
MAURITIUS	63.2	901	0.009124	*	0.00381	70	5375	0.001264		0.000874	1.446224	2.394751
MOROCCO	50.4	956	0.008788	*	0.003892	61	2298	0.00465	**	0.000869	5.350978	2.257965
MOZAMBIQU	41	1007	0.008567	*	0.003982	49	1060	0.002794	**	0.000738	3.785908	2.151431
NIGER	38.5	485	0.008654	**	0.003298	45	634	0.002119	**	0.000725	2.922759	2.624015
NIGERIA	38.5	936	0.008902	*	0.003861	51	1160	0.002968	**	0.000745	3.983893	2.305620
RWANDA	41	290	0.005751		0.003176	49	680	0.002186	**	0.000724	3.019337	1.810768
SENEGAL	40	853	0.009449	*	0.003746	48	1208	0.003052	**	0.000749	4.074766	2.522424
SIERRA LE	41	580	0.009672	**	0.003413	42	1061	0.002796	**	0.000738	3.788618	2.833870
SOMALIA	38.5	362	0.006844	*	0.003191	48	861	0.002464	**	0.000728	3.384615	2.144782
S.AFRICA	49	2239	-0.00222		0.008707	62	4958	0.001404		0.000839	1.673421	-0.25497
SUDAN	46.1	750	0.010012	**	0.003622	50	1042	0.002763	**	0.000737	3.748982	2.764219
SWAZILAND	41	1044	0.008489	*	0.004058	56	2405	0.004702	**	0.000878	5.355353	2.091917
TANZANIA	41.8	394	0.007338	*	0.003211	49	557	0.002011	**	0.000726	2.769972	2.285269
TOGO	38.5	597	0.009797	**	0.003434	54	752	0.002294	**	0.000725	3.164138	2.852941
TUNISIA	51.6	1016	0.008541	*	0.004	66	3329	0.003874	**	0.000878	4.412301	2.13525
UGANDA	47.5	654	0.010065	**	0.003506	49	499	0.001932	**	0.000727	2.657497	2.870793
ZAIRE	42	413	0.007627	*	0.003226	53	380	0.001779	*	0.000732	2.430328	2.364228
ZAMBIA	43.5	722	0.010087	**	0.003588	54	767	0.002317	**	0.000725	3.195862	2.811315
AFGHANIST	37.8	365	0.006891	*	0.003193	43	710	0.00223	**	0.000725	3.075862	2.158158
BANGLADES	43.3	370	0.006968	*	0.003195	51	820	0.002399	**	0.000727	3.299862	2.180908
MYANMAR	47.5	320	0.0062		0.003177	61	595	0.002064	**	0.000725	2.846897	1.951527
CHINA	67	711	0.010105	**	0.003575	70	2656	0.004699	**	0.000893	5.262038	2.826573
HONG KONG	70	2005	0.003708		0.006886	78	15180	0.000053		0.001022	0.051957	0.538484
INDIA	47.2	450	0.008173	*	0.00326	59	910	0.002543	**	0.00073	3.483562	2.507055
IRAN	48.8	1749	0.015279	*	0.006566	63	3120	0.004237	**	0.00089	4.760674	2.326988

Table 1 (Contd.......)

IRAQ	50.2	1602	0.017172	**	0.00632	63	3510	0.003516	**	0.000864	4.069444	2.717089
JORDAN	50.7	935	0.008908	*	0.003859	67	2415	0.004705	**	0.000879	5.352673	2.308370
KOREA	65	1112	0.008576	*	0.004224	70	6117	0.001249		0.000957	1.305120	2.030303
MALAYSIA	56.7	1242	0.009774	*	0.00466	70	5649	0.00123		0.000902	1.363636	2.097425
NEPAL	40.6	359	0.006798	*	0.00319	52	896	0.00252	**	0.000729	3.456790	2.131034
PAKISTAN	47.4	564	0.009537	**	0.003393	55	1789	0.004062	**	0.000812	5.002463	2.810787
PHILIPPIN	55.6	781	0.009881	**	0.003658	64	2269	0.004631	**	0.000867	5.341407	2.701203
SINGAPORE	68	2012	0.003401		0.006916	74	15108	0.000053		0.001022	0.051957	0.491758
SRI LANKA	65.8	765	0.009954	**	0.003639	71	2253	0.00462	**	0.000865	5.341040	2.735367
SYR.ARAB.	53	1041	0.008492	*	0.004051	66	4348	0.001962	*	0.000815	2.407362	2.096273
THAILAND	55.5	791	0.00983	**	0.00367	66	3569	0.003394	**	0.000859	3.951106	2.678474
CYPRUS	70.2	2259	-0.0022		0.008922	76	9368	0.000726		0.000702	1.034188	-0.24658
TURKEY	54.4	1408	0.013311	*	0.005437	66	4002	0.002524	**	0.000826	3.055690	2.448225
BARBADOS	67.6	2333	-0.00135		0.009755	75	8351	0.002694	*	0.001307	2.061209	-0.13839
COSTA RIC	66.8	1601	0.017166	**	0.006317	75	4413	0.001877	*	0.000815	2.303067	2.717429
DOMINICAN	52.2	1113	0.008579	*	0.004227	67	2537	0.004722	**	0.000887	5.323563	2.029572
EL SALVAD	65	902	0.009118	*	0.003811	63	1897	0.004224	**	0.000825	5.12	2.392548
GUATEMALA	51.1	1133	0.008672	*	0.004283	63	2531	0.004723	**	0.000887	5.324690	2.024749
HAITI	47.7	356	0.006752	*	0.003188	55	962	0.002629	**	0.000732	3.591530	2.117942
HONDURAS	49.4	910	0.009065	*	0.003822	65	1504	0.003581	**	0.000779	4.596919	2.371795
JAMAICA	67.8	1841	0.011611		0.006579	73	2787	0.004626	**	0.000896	5.162946	1.764858
MEXICO	62.4	2005	0.003708		0.006886	69	5691	0.001228		0.000906	1.355408	0.538484
NICARAGUA	50.4	1246	0.009835	*	0.004676	64	1463	0.003508	**	0.000774	4.532300	2.103293
PANAMA	64.9	1804	0.01325	*	0.006575	73	3231	0.004053	**	0.000884	4.584842	2.015209
TRIN & TO	66.1	2847	0.008876		0.012866	71	6266	0.001282		0.000978	1.310838	0.689880

Table 1 (Contd.......)

ARGENTINA	67.4	2750	0.009774		0.012905	71	4310	0.002015	*	0.000816	2.469363	0.757381
BOLIVIA	45.3	915	0.009033	*	0.003829	54	1531	0.003628	**	0.000782	4.639386	2.359102
BRAZIL	59.4	1225	0.009533	*	0.004593	66	4951	0.001408		0.000838	1.680191	2.075550
CHILE	60.6	2090	0.000417		0.007364	72	4987	0.00139		0.000841	1.652794	0.056627
COLOMBIA	58.5	1355	0.01199	*	0.005169	69	4068	0.002404	**	0.000823	2.921021	2.319598
ECUADOR	57.2	954	0.008799	*	0.003889	66	3012	0.004392	**	0.000894	4.912752	2.262535
GUYANA	65.2	1162	0.008865	*	0.004372	64	1453	0.00349	**	0.000773	4.514877	2.027676
PARAGUAY	59	1004	0.008577	*	0.003976	67	2742	0.004656	**	0.000895	5.202235	2.157193
PERU	58	1626	0.017241	**	0.006391	62	2731	0.004717	**	0.000906	5.206402	2.697700
SURINAM	63.6	1984	0.004659		0.006805	67	3907	0.002704	**	0.000832	3.25	0.684644
URUGUAY	69.3	2648	0.008806		0.012634	73	5805	0.001225		0.000919	1.332971	0.697008
VENEZUELA	63.8	3667	-0.00093		0.001775	70	5908	0.001227		0.00093	1.319355	-0.52394
FIJI	68.1	1460	0.01465	*	0.005704	67	4192	0.002194	**	0.000818	2.682152	2.568373
INDONESIA	45	391	0.007292	*	0.003209	61	2034	0.004405	**	0.000842	5.231591	2.272359
PAP NEW G	45.1	1230	0.009602	*	0.004613	54	1834	0.004131	**	0.000818	5.050122	2.081509

Note: * represents significant at 5% level
** represents significant at 1% level.

LE 70 : Life-expectancy in 1970
LE 89 : Life-expectancy in 1989
RGDP 70 : real CDP per capita in 1970
RGDP 89 : Real CDP per capita in 1989
BETA 70 : response coefficient in 1970
BETA 89 : response coefficient in 1989

S.C. 70 : Standard error of BETA 70
S.C. 89 : Standard error of BETA 89

to 70 : t. value correspomnding to BETA 70
t 89 : t-value corresponding to BETA 89

Table 2
Comparative Figures for Conditional Variance in 1970 and 1989

Country	RGDP70	RGDP89	VAR70	VAR89
ALGERIA	1403	3088	85.523	54.17636
BOTSWANA	723	3180	71.291	52.03056
CAMEROON	802	1699	75.041	62.26943
C.AF.EMP	542	770	57.956	47.52005
CHAD	434	582	48.333	44.55348
CONGO	966	2382	79.143	65.11572
EGYPT	755	1934	72.974	64.59917
GABON	2404	4735	114.2	27.02081
GAMBIA	687	886	69.128	49.42985
GHANA	1080	1005	80.456	51.43076
GUINEA	689	602	69.256	44.86029
IVORY COAST	1028	1381	79.915	57.71151
LIBERIA	860	937	76.974	50.28383
MADAGASCAR	647	690	66.404	46.23545
MAURITANIA	650	1092	66.619	52.90625
MAURITIUS	901	5375	77.987	24.10623
MOROCCO	956	2298	78.994	65.47615
MOZAMBIQUE	1007	1060	79.676	52.36345
NIGER	485	634	52.901	45.35528
NIGERIA	936	1160	78.667	54.05833
SENEGAL	853	1208	76.773	54.86743
SIERRA LEONE	580	1061	61.189	52.38016
SOMALIA	362	861	42.108	49.01431
S.AFRICA	2239	4958	95.47	25.91556
SUDAN	750	1042	72.727	52.05767

Table 2 (Contd.......)

SWAZILAND	1044	2405	80.085	64.97832
TANZANIA	394	557	44.823	44.17363
TOGO	597	752	62.579	47.22835
TUNISIA	1016	3329	79.78	48.45507
ZAMBIA	722	767	71.236	47.47146
CHAINA	711	2656	70.602	62.4101
HONG KONG	2005	15180	72.94	3.999916
INDIA	450	910	49.76	49.83068
IRAN	1749	3120	78.796	53.43904
IRAQ	1602	3510	85.663	44.14793
JORDAN	935	2415	78.65	64.91292
KOREA	1112	6117	80.787	20.05589
MALAYSIA	1242	5649	82.493	22.77328
NEPAL	359	896	41.858	49.59643
PHILIPPINES	781	2269	74.177	65.54937
SINGAPORE	2012	15108	73.245	4.000076
SRI LANKA	765	2253	73.455	65.57851
SYR.ARAB.REP	1041	4348	80.054	29.91367
THAILAND	791	3569	74.599	42.79193
CYPRUS	2259	9368	98.028	1.671003
TURKEY	1408	4002	85.613	34.33423
BARBADOS	2333	8351	107.096	8.137312
COSTA RICA	1601	4413	85.69	29.30191
DOMINICAN REP	1113	2537	80.798	63.86715
EL SALVADOR	902	1897	78.009	64.31095
GUATEMALA	1133	2531	81.015	63.9293
HONDURAS	910	1504	78.177	59.61174
JAMAICA	1841	2787	73.772	60.34615
MEXICO	2005	5691	72.94	22.55048

Table 2 (Contd.......)

NICARAGUA	1246	1463	82.559	58.99377
PANAMA	1804	3231	75.616	50.81457
TRIN & TOB	2847	6266	79.15	19.12195
ARGENTINA	2750	4310	97.546	30.30138
BOLIVIA	915	1531	78.277	60.00945
BRAZIL	1225	4951	82.223	25.94724
CHILE	2090	4987	78.525	25.78667
COLOMBIA	1355	4068	84.601	33.32809
ECUADOR	954	3012	78.963	55.88014
GUYANA	1162	1453	81.354	58.8404
PARAGUAY	1004	2742	79.641	61.10582
PERU	1626	2731	84.936	61.28352
SURINAM	1984	3907	72.201	35.92299
URUGUAY	2648	5805	112.307	21.92337
FIJI	1460	4192	86.397	31.65116
PAP NEW GUN	1230	1834	82.301	63.74813

Note:
RCDP 70 : real GDP per capita in 1970
RCDP 89 : real GDP per capita in 1989
VAR 70 : conditional variance of life-expectancy in 1970
VAR 89 : conditional variance of life-expectancy in 1970

Table 3
Nonparametric Regression Results Estimating the Effect of the Level of Income and its change on Life-Expectance

Country	%CGDP	RGDP70	BETA 1	s.e.1	t1	BETA 2	s.e. 2	t2
ALGERIA	120.0998	1403	0.000306	0.000217	1.410599	0.000028	0.000015	1.891156
ANGOLA	-8.10200	1333	0.000163	0.000194	0.838394	0.000008	0.000013	0.610687
BENIN	136.7816	435	0.000172	0.000194	0.885170	0.000018	0.000013	1.404580
BOTSWANA	339.8340	723	0.000180	0.000528	0.341796	0.000001	0.000036	0.022409
BURUNDI	85.71430	329	0.000213	0.000172	1.239232	0.000009	0.000012	0.801724
CAMEROON	111.8454	802	0.000305	0.000189	1.611317	0.000018	0.000013	1.390625
C.AF.EMP	42.06640	542	0.000164	0.000165	0.992131	0.000010	0.000011	0.910714
CHAD	34.10140	434	0.000113	0.000162	0.694444	0.000008	0.000011	0.761468
CONGO	146.5839	966	0.000147	0.000205	0.715959	0.000020	0.000014	1.442029
EGYPT	156.1589	755	0.000177	0.000202	0.873024	0.000018	0.000014	1.321168
ETHIOPIA	16.66670	336	0.000029	0.000160	0.180738	0.000002	0.000011	0.222222
GABON	96.96340	2404	0.000197	0.000283	0.696788	-0.000005	0.000019	-0.24084
GAMBIA	28.96650	687	0.000100	0.000163	0.616615	0.000010	0.000011	0.863636
GHANA	-6.94440	1080	0.000135	0.000178	0.760540	0.000006	0.000012	0.508333
GUINEA	-12.6270	689	0.000099	0.000170	0.583382	0.000005	0.000012	0.434783
IVORY COA	34.33850	1028	0.000171	0.000171	0.997076	0.000010	0.000012	0.860870
KENYA	137.3550	431	0.000158	0.000194	0.815139	0.000018	0.000013	1.404580
LESOTHO	414.375	320	-0.00075	0.000484	-1.55259	0.000006	0.000033	0.192661
LIBERIA	8.953500	860	0.000094	0.000165	0.570133	0.000008	0.000011	0.678571
MADAGASCA	6.6461	647	0.000065	0.000163	0.399139	0.000008	0.000011	0.7
MALAWI	141.2451	257	0.000158	0.000193	0.820965	0.000019	0.000013	1.438462
MALI	127.6680	253	0.000188	0.000190	0.985294	0.000017	0.000013	1.325581
MAURITANI	68	650	0.000235	0.000165	1.431003	0.000012	0.000011	1.099099
MAURITIUS	496.5594	901	-0.00003	0.000227	-0.12180	-0.000003	0.000015	-0.20261
MOROCCO	140.3766	956	0.000149	0.000203	0.734483	0.000020	0.000014	1.452555
MOZAMBIQU	5.263200	1007	0.000108	0.000171	0.632164	0.000007	0.000012	0.637931

Table 3 (Contd......)

NIGER	30.72160	485	0.000082	0.000161	0.510229	0.000008	0.000011	0.752294
NIGERIA	23.93160	936	0.000075	0.000166	0.450992	0.000008	0.000011	0.723214
RWANDA	134.4828	290	0.000178	0.000192	0.926157	0.000018	0.000013	1.353846
SENEGAL	41.61780	853	0.000189	0.000168	1.122546	0.000010	0.000011	0.912281
SIERRA LE	82.93100	580	0.000238	0.000170	1.400353	0.000013	0.000012	1.121739
SOMALIA	137.8453	362	0.000159	0.000194	0.820341	0.000017	0.000013	1.328244
S.AFRICA	121.4381	2239	0.000149	0.000286	0.522378	0.000001	0.000019	0.041451
SUDAN	38.9333	750	0.000174	0.000166	1.048825	0.000011	0.000011	0.9375
SWAZILAND	130.3640	1044	0.00018	0.000203	0.886700	0.000021	0.000014	1.510949
TANZANIA	41.37060	394	0.000138	0.000164	0.838808	0.000008	0.000011	0.702703
TOGO	25.96310	597	0.000078	0.000161	0.482010	0.000009	0.000011	0.779817
TUNISIA	227.6575	1016	0.000087	0.000318	0.272927	0.000018	0.000022	0.855814
UGANDA	-23.7003	654	0.000055	0.000177	0.307215	0.000004	0.000012	0.325
ZAIRE	-7.99030	413	0.000061	0.000168	0.365752	0.000004	0.000011	0.353982
ZAMBIA	6.232700	722	0.000075	0.000164	0.456933	0.000008	0.000011	0.711712
AFGHANIST	94.52050	365	0.000234	0.000176	1.327469	0.000012	0.000012	1.016807
BANGLADES	121.6216	370	0.000267	0.000189	1.412480	0.000016	0.000013	1.242188
MYANMAR	85.9375	320	0.000212	0.000172	1.228937	0.000009	0.000012	0.810345
CHAINA	273.5584	711	0.000798	0.000458	1.741218	0.000002	0.000031	0.058065
HONG KONG	657.1072	2005	0.000085	0.001539	0.055086	*********	0.000104	-0.00385
INDIA	102.2222	450	0.000268	0.000181	1.477084	0.000016	0.000012	1.295082
IRAN	78.38770	1749	0.000378	0.000234	1.617622	0.000030	0.000016	1.917722
IRAQ	119.1011	1602	0.000320	0.000233	1.371674	0.000029	0.000016	1.847134
JORDAN	158.2888	935	0.000172	0.000208	0.825168	0.000019	0.000014	1.375887
KOREA	450.0899	1112	0.000007	0.000226	0.031042	*********	0.000015	-0.29605
MALAYSIA	354.8309	1242	0.000200	0.000490	0.407385	0.000014	0.000033	0.419940
NEPAL	149.5822	359	0.000179	0.000195	0.917436	0.000018	0.000013	1.371212
PAKISTAN	217.1986	564	0.000065	0.000274	0.238495	0.000014	0.000019	0.740541
PHILIPPIN	190.5250	781	0.000087	0.000227	0.383194	0.000017	0.000015	1.077922
SINGAPORE	650.8946	2012	0.000085	0.001539	0.055086	*********	0.000104	-0.00385

Table 3 (Contd.......)

SRI LANKA	194.5098	765	0.000077	0.000231	0.331029	0.000016	0.000016	1.051282
SYR.ARAB.	317.6753	1041	0.000283	0.000536	0.528929	0.000015	0.000036	0.403315
THAILAND	351.2010	791	0.000195	0.000504	0.386310	0.000002	0.000034	0.061765
CYPRUS	314.6968	2259	-0.00007	0.000541	-0.12463	0.000054	0.000037	1.473973
TURKEY	184.2330	1408	0.000156	0.000255	0.609632	0.000028	0.000017	1.612717
BARBADOS	257.9511	2333	0.000857	0.000730	1.173377	0.000054	0.000049	1.087221
COSTA RIC	175.6402	1601	0.000213	0.000268	0.794469	0.000027	0.000018	1.497238
DOMINICAN	127.9425	1113	0.000200	0.000205	0.975550	0.000021	0.000014	1.543478
EL SALVAD	110.3104	902	0.000314	0.000191	1.643269	0.000019	0.000013	1.457364
GUATEMALA	123.3892	1133	0.000251	0.000204	1.231222	0.000022	0.000014	1.572464
HAITI	170.2247	356	0.000194	0.000203	0.952779	0.000019	0.000014	1.357664
HONDURAS	65.27470	910	0.000269	0.000169	1.589835	0.000014	0.000011	1.184211
JAMAICA	51.38510	1841	0.000408	0.000245	1.663677	0.000030	0.000017	1.819277
MEXICO	183.8404	2005	0.000258	0.000348	0.740092	0.000013	0.000024	0.570213
NICARAGUA	17.41570	1246	0.000089	0.000180	0.496102	0.000010	0.000012	0.809917
PANAMA	79.10200	1804	0.000379	0.000240	1.579758	0.000028	0.000016	1.709877
TRIN & TO	120.0913	2847	0.000158	0.000314	0.502229	*********	0.000021	-0.66509
ARGENTINA	56.72730	2750	0.000171	0.000293	0.584074	*********	0.000020	-0.54545
BOLIVIA	67.32240	915	0.000268	0.000170	1.577150	0.000014	0.000012	1.2
BRAZIL	304.1633	1225	0.000441	0.000505	0.874331	0.000023	0.000034	0.674487
CHILE	138.6124	2090	0.000144	0.000288	0.499826	0.000005	0.000019	0.273196
COLOMBIA	200.2214	1355	0.000055	0.000274	0.202411	0.000027	0.000019	1.475676
ECUADOR	215.7233	954	0.000034	0.000281	0.120057	0.000018	0.000019	0.957895
GUYANA	25.04300	1162	0.000119	0.000175	0.678857	0.000009	0.000012	0.796610
PARAGUAY	173.1076	1004	0.000163	0.000220	0.742141	0.000020	0.000015	1.331081
PERU	67.95820	1626	0.000380	0.000214	1.774510	0.000028	0.000015	1.944828
SURINAM	96.92540	1984	0.000325	0.000258	1.261729	0.000021	0.000017	1.183908
URUGUAY	119.2221	2648	0.000135	0.000314	0.430118	*********	0.000021	-0.57547

Table 3 (Contd......)

VENEZUELA	61.11260	3667	0.000008	0.000171	0.043885	0.000011	0.000012	0.973913
FIJI	187.1233	1460	0.000144	0.000264	0.546349	0.000029	0.000018	1.608939
INDONESIA	420.2046	391	-0.00074	0.000450	-1.64140	0.000005	0.000030	0.154605
PAP NEW G	49.10570	1230	0.000284	0.000181	1.567881	0.000014	0.000012	1.147541

NOTE : (i) none of the beta coefficients are significant
(ii) **** represents negative but insignificant values

% CGDP : percentage change in real GDP per capita
RGDP 70 : real GDP per capita in 1970
BETA 1 : response coefficient w.r.t % CGDP
BETA 2 : response coefficient w.r.t RGDP 70
s.e.1 : standard error of BETA 1
s.e. 2 : standard error of BETA 2
t 1 : t- value corresponding to BETA 1
t2 : t-value corresponding to BETA 2

Table 4
Health Sector Characteristics in Selected Countries

Countries	Health expenditures as % of total, 1990			Total health exp. per capita,1990 (official exchange rate dollars	% of total population having access to health care services	Under-five mortality rate [per 1000 live births]		Average annual rate of reduction (%)
	Public	(%) Private	Aid Flows		1988-1990	1980	1988	1980-1988
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mozambique	21.0	25.7	53.3	5	27	258	298	-1.8
Malawi	35.0	41.7	23.3	11	80	300	262	1.7
Ethiopia	41.3	39.9	18.8	4	55	260	259	0.1
Guinea	39.7	40.3	20.0	17	32	281	248	1.6
Burkina Faso	9.8	17.9	72.3	7	49	265	233	1.6
Madagascar	29.0	49.6	21.4	7	49	216	184	2.0
Tanzania	14.4	31.6	54.0	4	80	201	176	1.7
Senegal	45.1	38.0	16.9	29	40	205	136	5.1
Uganda	13.3	53.0	33.7	8	41	187	169	1.3
Cameroon	26.4	61.7	11.9	27	41	176	153	1.8
Ghana	35.0	51.8	13.2	15	76	165	146	1.5
Zambia	65.4	30.6	4.1	17	75	146	127	1.7
Zimbabwe	40.3	48.7	11.0	39	83	132	113	1.9
Kenya	40.0	37.9	22.1	16	58	133	113	2.0
India	20.0	78.4	1.6	21	54*	180	149	2.4
China	58.5	40.9	0.6	11	83*	56	43	3.3
Sri Lanka	40.4	51.1	8.6	18	93*	58	43	3.7

Table 4 (Contd.......)

Greece	76.0	24.0	0.0	359	-	23	18	3.1
Denmark	84.2	15.8	0.0	1588	-	11	11	0.0
Norway	95.7	4.3	0.0	1835	-	10	10	0.0
Sweden	89.3	10.7	0.0	2343	-	9	7	3.1
United Kingdom	84.9	15.1	0.0	1039	-	16	11	4.7

Note :

1.* refers to the period 1985-1995 (source: Human Development Report, 1996)

2.** refers to the period 1985-87(Source: same as above)

3.- means not available

Source:

1.Cols.2,3,4,5 : Murray et.al.(1994)

2. Col.6 : World Bank(1994)

3.Cols.7,8,9 : UNICEF(1990)

CENTRE FOR DEVELOPMENT STUDIES
LIST OF WORKING PAPERS

(From 1991 onwards)

MRIDUL EAPEN Hantex: An Economic Appraisal.
September, 1991, W.P.242

SUNIL MANI Government Intervention in Commercial Crop Development: A Case of Flue Cured Virginia Tobacco.
November, 1991, W.P.243

K. PUSHPANGADAN Wage Determination in a Casual Labour Market: The Case Study of Paddy Field Labour in Kerala.
January, 1992, W.P.244

K.N. NAIR & S.P. PADHI Dynamics of Land Distribution: An Alternative Approach and Analysis with Reference to Kerala.
January, 1992, W.P.245

THOMAS ISAAC Estimates of External Trade Flows of Kerala - 1975-76 and 1980-81.
March, 1992, W.P.246

THOMAS ISAAC, RAM MANOHAR REDDY, NATA DUVVURRY Regional Terms of Trade for the State of Kerala.
March, 1992, W.P.247

P. MOHANAN PILLAI Constraints on the Diffusion of Innovations in Kerala: A Case Study of Smokeless Chulas.
March, 1992, W.P.248

R. ANANDRAJ Cyclicality in Industrial Growth in India: An Exploratory Analysis.
April, 1992, W.P.249

T.M. THOMAS ISAAC, RAM MANOHAR REDDY, NATA DUVVURY Balance of Trade, Remittance and Net Capital Flows: An Analysis of Economic Development in Kerala since independence.
October, 1992, W.P.250

M. KABIR, T.N. KRISHNAN Social Intermediation and Health Transition: Lessons from Kerala,
October, 1992, W.P.251

SUNIL MANI, P. NANDAKUMAR Aggregate Net Financial Flows to India: The Relative Importance of Private Loan vis-a-vis Foreign Direct Investments.
August, 1993, W.P.252

PULAPRE BALAKRISHNAN Rationale and the Result of the Current Stabilisation Programme.
November, 1993, W.P.253

K.K. SUBRAHMANIAN, P. MOHANAN PILLAI Modern Small Industry in Kerala: A Review of Structural Change and Growth Performance.
January, 1994, W.P.254

DILIP M.MENON Becoming Hindu and Muslim : Identity and Conflict in Malabar 1900-1936.
January, 1994 W.P.255

D. NARAYANA Government Intervention in Commodity Trade: An Analysis of the Coffee Trade in India.
January, 1994 W.P.256

K.J. JOSEPH, P. NANDAKUMAR On the Determinants of Current Account Deficits: A Comparative Analysis of India, China and South Korea.
January, 1994 W.P.257

K.K. SUBRAHMANIAN, K.J. JOSEPH Foreign Control and Export Intensity of Firms in Indian Industry.
February, 1994 W.P.258

PULAPRE BALAKRISHNAN, K. PUSHPANGADAN Total Factor Productivity Growth in Indian Manufacturing - A Fresh Look.
April 1994, W.P.259

D. NARAYANA, K.N. NAIR Role of the Leading Input in Shaping Institutions: Tendency in the Context of Irrigation Uncertainty.
May, 1994, W.P.260

G. MURUGAN, K. PUSHPANGADAN Pricing of Drinking Water: An Application of Coase Two-part Tariff.
December, 1994 W.P.261

MOHANAN PILLAI On the Mexican Crisis.
December, 1995, W.P.262

SUNIL MANI Financing Domestic Technology Development through the Venture Capital Route.
December, 1995, W.P.263

T.T. SREEKUMAR Peasants and Formal Credit in Thiruvithamcore: The State Institutions and Social Structure 1914-1940.
December, 1995 W.P.264

AMITABH Estimation of the Affordability of Land for Housing Purposes in Lucknow City, Uttar Pradesh (India): 1970-1990.
March, 1996. W.P.265

K. PUSHPANGADAN, G. MURUGAN, K. NAVANEETHAM Travel Time, User Rate & Cost of Supply: Drinking Water in Kerala, India:
June 1996. W.P.266

K.J. JOSEPH Structural Adjustment in India: A Survey of Recent Studies & Issues for Further Research,
June 1996 W.P.267

D. NARAYANA Asian Fertility Transition: Is Gender Equity in Formal Occupations an Explanatory Factor?
October, 1996 W.P.268

D. NARAYANA, SAIKAT SINHAROY Import and Domestic Production of Capital Goods from Substitution to Complementarity,
October 1996. W.P.269

NEW SERIES

W.P. 270 **ACHIN CHAKRABORTY** *On the Possibility of a Weighting System for Functionings* December 1996

W.P. 271 **SRIJIT MISHRA** *Production and Grain Drain in two inland Regions of Orissa* December 1996

W.P. 272 **SUNIL MANI** *Divestment and Public Sector Enterprise Reforms, Indian Experience Since 1991* February 1997

W.P. 273 **ROBERT E. EVENSON, K.J. JOSEPH** *Foreign Technology Licensing in Indian Industry : An econometric analysis of the choice of partners, terms of contract and the effect on licensees' performance* March 1997

W.P. 274 **K. PUSHPANGADAN, G. MURUGAN** *User Financing & Collective action: Relevance sustainable Rural water supply in India.* March 1997.

W.P. 275 **G. OMKARNATH** *Capabilities and the process of Development* March 1997

W. P. 276 **V. SANTHAKUMAR** *Institutional Lock-in inNatural Resource Management: The Case of Water Resources in Kerala,* April 1997.

W. P. 277 **PRADEEP KUMAR PANDA** *Living Arrangements of the Elderly in Rural Orissa,* May 1997.

W. P. 278 **PRADEEP KUMAR PANDA** *The Effects of Safe Drinking Water and Sanitation on Diarrhoeal Diseases Among Children in Rural Orissa,* May 1997.

W.P. 279 **U.S. MISRA, MALA RAMANATHAN, S. IRUDAYA RAJAN** Induced Abortion Potential Among Indian Women, August 1997.

W.P. 280 **PRADEEP KUMAR PANDA** *Female Headship, Poverty and Child Welfare : A Study of Rural Orissa, India,* August 1997.

W.P. 281 **SUNIL MANI** *Government Intervention in Industrial R & D, Some Lessons from the International Experience for India,* August 1997.

W.P. 282 **S. IRUDAYA RAJAN, K. C. ZACHARIAH** *Long Term Implications of Low Fertility in Kerala,* October 1997.