INCOME DISTRIBUTION AND THE FULFILMENT OF BASIC NEEDS: THEORY AND EMPIRICAL EVIDENCE

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Abstract

Empirical studies on the impact of average income and income inequality on basic needs satisfaction have rendered rather diverse and sometimes contradictory results. Some studies find that income equalization has a positive effect on basic needs fulfilment whereas other studies show that this effect is negligible. In this paper, it is argued that the impact of (average) household income on basic needs satisfaction follows a strictly concave function. As a result, an equalization of household incomes results in a higher average level of basic needs satisfaction. This theoretical result is empirically confirmed by a regression analysis based on a cross-section data set of 54 countries. It is further shown that the contradictory results obtained in previous empirical studies are mainly caused by the fact that the specifications of the regression equations do not adequately represent the theory.

1. Introduction

In recent years a number of studies have analyzed the impacts of average income and income inequality on the fulfilment of basic needs. The level of basic needs fulfilment is postulated to be positively related to average income, since richer countries have more resources available to meet the basic needs (see, among others, Sheehan and Hopkins 1978). As the income levels of the poor are of crucial importance in meeting basic needs, it is assumed that there also exists a negative relationship between income inequality and basic needs fulfilment (see e.g. Stewart 1979).

The empirical literature on per capita income, income inequality and basic needs fulfilment is highly diverse and contradictory, as the following examples show. Sheehan and Hopkins (1978) made an exploratory analysis of the factors which explain inter-country differences in basic needs fulfilment in 1970 and the improvements between 1960 and 1970. Eleven basic needs indicators were chosen as dependent variables in the regressions. Trying various different specifications of the regression equations, they concluded that GNP per head is the most important explanatory variable of the average level of

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basic needs satisfaction. In one of their specifications, income inequality (as measured by the income share of the poorest 40 per cent of the population) and income growth were used as explanatory variables in addition to average income. For most of the basic needs indicators that were examined, the estimated coefficient of the income inequality variable did not differ significantly from zero. Hence, they tentatively concluded that income distribution is not an important determinant of average levels of basic needs performance.

A different conclusion was reached by Stewart (1979), who analysed the results of a series of country studies on basic needs performance carried out by the World Bank. She concluded that both the average income level and the skewness of the income distribution are important in explaining achievements in meeting basic needs.

Leipziger and Lewis (1980) argued that a distinction should be made between low-income and middle-income less developed countries. At low income levels, growth of income per head is necessary for progress in basic needs satisfaction. At higher income levels, once a critical level of development has been reached, distributional factors are of crucial importance in further raising levels of basic needs satisfaction. The statistical tests in their study were based on a sample of 38 developing countries for which observations during the period 1960-65 are available. The level of GNP per head of 550 dollars in 1975 was used as the division line between middle-income and low-income countries. Using simple correlation coefficients between basic needs indicators and GNP per head and income inequality (as measured by the Gini-coefficient), respectively, the authors concluded that statistical evidence provides additional support for the view that the level of GNP is important in low-income countries only, whereas income inequality matters for the group of middle-income countries.

Ram (1985) re-examined the conclusions reached by Leipziger and Lewis by using multiple regression instead of simple correlation coefficients. Furthermore, he tried to reduce the measurement errors in the data set by using more recent data (centered around 1970), and by using an average income measure based on purchasing power parities instead of exchange rate conversions. The results deviated substantially from those obtained by Leipziger and Lewis. Average income was found to be an important explanatory variable in low-income as well as middle-income countries, although its impact was found to be larger in the subgroup of low-income countries. The impact of income inequality (measured by the income share of the poorest 40 per cent), on the other hand, was found to be quite limited in both groups of countries. Only the two measures of nutrition (calorie and protein intake per capita), were found to be significantly affected by the degree of inequality in the income distribution.

After reviewing the empirical evidence, Van der Hoeven (1987: p.6) concludes that a more equal distribution does not guarantee increased satisfaction of basic needs. Hopkins and Van der Hoeven (1983: Ch.4) draw a similar conclusion from the empirical results of Sheehan and Hopkins (1978). They argue that there is no reason, a priori, to believe that the overall distribution of income will affect the average level of basic needs satisfaction. What presumably happens, in their opinion, is that the losses of the rich that result from income equalization cancel out the gains of the poor (Hopkins and Van der

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Hoeven 1983: p.101).

The purpose of this paper is to provide further evidence on the controversial relationship between basic needs fulfilment, income per capita and income inequality. It will be argued that the gains of the poor exceed the losses of the rich (because the relationship between basic needs satisfaction and income is strictly concave), so that the net effect of income equalization will be an increase of the average level of basic needs satisfaction.

In section 2 the concept of basic needs is described and its concave relationship with average income is discussed. In section 3 it is shown that when a macro-level relationship is derived from the behavior of micro-level units (as in the case of basic needs fulfilment) and the micro-level relationship is strictly convex (respectively, strictly concave), then the average value of the dependent variable does not only depend on the mean value of the explanatory variable but also on a measure of the degree of inequality (equality) in the distribution of the explanatory variable. Hence, a theoretical justification for the impact of income inequality on basic needs fulfilment is provided. In section 4 a basic needs fulfilment model based on the specifications derived in the sections 2 and 3 is estimated on the basis of a sample of 54 countries. Moreover, some alternative specifications that have been used in the literature are tested. It is found that the contradictory results referred to above are caused by deviant model specifications. Conclusions follow in the final section 5.

2. Impact of household income on basic needs fulfilment: some theoretical considerations

Basic needs fulfilment can broadly be defined as the elimination of deprivation in its two major aspects: first, the physical deprivation due to inadequate means of subsistence; and second, the associated deprivation of basic human rights (Sinha et al. 1979, p.23). Many authors have tried to define a "core" set of basic needs. For example, Hopkins and Van der Hoeven (1983: pp. 9-11) select the following components for their core set:
- food and nutrition (including drinking water)
- shelter
- clothing
- health
- education (ability to read and write; knowledge of basic health and contraceptive services)
- non-material needs (participation of the people in the decisions that affect them).

For empirical applications, a set of indicators that measure the degree of satisfaction of each component is needed. There are at least three problems involved (see Sheehan and Hopkins 1978: p.523). First, for some components of basic needs there exist no generally accepted indicators. This is true, for example, for clothing and for non-material basic needs. Second, when suitable indicators are available, data on these indicators may either be lacking or of a poor quality in many countries. And third, most of the available data is in the form of averages for a whole country (or region), without any indication of the

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distribution over the population. Such average data obscure the basic needs situation of the poorest segment of the population.

The remainder of this paper will consider only material basic needs, because problems of inadequacy of indicators and quality of the data are worst for non-material basic needs. Moreover, the relationship with economic variables is probably weakest for non-material basic needs (see Sheehan and Hopkins 1978: p.536).

The concept of basic needs is closely related to the distinction that is made in economic literature between luxury goods and necessities. Luxury goods are defined as goods with an income elasticity of demand larger than one, whereas necessities (or basic goods) are goods with an income elasticity between one and zero (see e.g. Prais and Houthakker 1955: p.90). In fact, basic needs may alternatively be defined as the demand for necessities. According to Hopkins and Van der Hoeven (1983: pp. 39-40), there are at least three objections to such an approach:

(i)   It is not the product itself but the characteristics of the product that provide satisfaction. The characteristics may change when incomes rise. A good example is maizemeal. When households obtain more income, they often buy a more refined type of maizemeal that contains less iron and vitamins and therefore has a lower nutritional value than the less refined type. Classical consumption theory is not capable of handling such changes in product characteristics, but may be adapted along lines suggested by Lancaster (1966).

(ii)   Traditional consumption theory does not take into account the possibility of external effects. In the case of education, health and food consumption, such external effects consist for example of the increased productivity of the labour force.

(iii) Not all goods and services can be bought. Some are provided by the state or community. The fulfilment of some components of basic needs depends largely on the provision of publicly-provided goods (such as safe drinking water, sanitation, public transport, and health and educational facilities) which are outside the scope of classical consumption theory.

The objections raised by Hopkins and Van der Hoeven are only partly relevant for the present study. The impact of the state or community on the satisfaction of basic needs will be captured by distinguishing private basic goods from publicly-provided basic goods. The effects on labour productivity of increased health, nutrition and education can be taken into account, for instance in the framework of a simultaneous-equations model.[0] Finally, although it is in principle possible to take into account the characteristics of goods, this will greatly complicate the analysis and is unlikely to change the major conclusions. Therefore, the characteristics will not be paid attention to here.

What does the relationship between household income and the satisfaction of a household's basic needs look like? As mentioned above, necessities or basic goods are defined as goods with an income elasticity of demand between zero and one. Empirical studies of consumption patterns, based on the so-called Engel-curve approach, have found that a semi-logarithmic or double-logarithmic specification generally provides an adequate representation of the impact of household income on the consumption of

food and other necessities (see e.g. Prais and Houthakker 1955: Ch.7, Houthakker 1957, Iyengar 1964, and Phlips 1983: Ch.IV). These findings imply that the micro-level income-necessities relationship generally follows a strictly concave pattern.

In many poor countries, governments intervene in the markets for private basic goods. A well-known example is the provision of food subsidies. Such interventions may lead to lower prices and therefore shift the income-necessities relationship, but the concave shape of the relationship is usually not affected.

The provision of "public" basic goods depends, of course, on the amount of public expenditure devoted to these items. But the actual degree of utilization partly depends on budget constraints faced by households. For example, when children go to school, a household will have to spend money on books and materials, school uniforms, tuition fees, and registration and examination fees. Moreover, the indirect costs of earnings or income forgone during schooling should also be considered a private cost of schooling (see Psacharopoulos and Woodhall 1985: Ch.5). Hence, the income of a household may surely act as a constraint on the amount of schooling received by the children in a household. Similarly, the utilization of health facilities, public transport and other publicly-provided basic goods will partly depend on the incomes received by households. As for other basic goods, the relationship between household income and the consumption of publicly-provided basic goods is likely to follow a strictly concave pattern.

The available empirical evidence is largely consistent with these conclusions. As already mentioned, strictly concave curves are generally found in household budget studies of necessities. Similarly, macro-level studies of the impact of average income on the satisfaction of basic needs have commonly found that the relationship follows a strictly concave pattern (see e.g. Hicks and Streeten 1979: pp.572-574, Larson and Wilford 1979, and Goldstein 1985).

3. Aggregation of strictly concave micro relationships

The purpose of this section is to show that when a micro-level relationship between two variables is strictly convex or strictly concave (as in the case of basic needs fulfilment and income) the average value of the dependent variable not only depends on the mean of the explanatory variable but also on a term that reflects the degree of (in)equality in the distribution of that variable.

Assume that a population consists of n micro-level units (individuals, households, and so on). Let the relationship between the dependent variable Z and explanatory variable X be

$$Z_i = f(X_i) + e_i \qquad i = 1, 2, \ldots, n$$

(1)

$E(e_i)=0, \quad E(e_i^2)=\sigma_i^2, \quad E(e_i e_j)=0 \; for \; i \neq j.$

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where e_i is a random disturbance term.

Equation (1) expresses that the micro-level relationship between the variables X and Z is identical for all micro-units, except for an additive random disturbance term [2].

Averageing of (1) over the total population ($i = 1,....,n$) gives:

$$\frac{1}{n}\sum_{i=1}^{n} Z_i \; = \; \frac{1}{n}\sum_{i=1}^{n} f(X_i) \; + \; \frac{1}{n}\sum_{i=1}^{n} e_i$$

$$= f(\bar{X}) \; + \; \frac{1}{n}\sum_{i=1}^{n}\{ f(X_i) - f(\bar{X}) \} \; + \; \frac{1}{n}\sum_{i=1}^{n} e_i \; ,$$

or

$$\bar{Z} = f(\bar{X}) \; + \; V_f(X) \; + \; \bar{e} \; ,$$

with

$$V_f(X) = \frac{1}{n}\sum_{i=1}^{n}\{ f(X_i) - f(\bar{X}) \} \; ,$$

(2)

$$\bar{Z} = \frac{1}{n}\sum_{i=1}^{n} Z_i \; , \quad \bar{X} = \frac{1}{n}\sum_{i=1}^{n} X_i \; , \quad \bar{e} = \frac{1}{n}\sum_{i=1}^{n} e_i \; , \quad E(\bar{e}) = 0 \; , \quad E(\bar{e}^2) = \frac{1}{n^2}\sum_{i=1}^{n} \sigma_i^2 \; ,$$

$$X = (X_1, X_2,....,X_n).$$

This result shows that, when a micro-level relationship between two variables is identical for all micro-nits except for a random disturbance term, then the macro-level variable $\bar{Z}$ is equal to the value of $\bar{X}$ under the same function f plus the value of a bias term $V_f(X)$ (and a disturbance term $\bar{e}$ with zero expectation). $V_f(X)$ will be termed the 'nonlinearity bias'. When f is a linear function, the value of $V_f(X)$ equals zero. For nonlinear functions, however, its value will generally differ from zero.

Next it will be shown that the nonlinearity bias $V_f(X)$ that corresponds to continuous and strictly convex functions satisfies the four basic properties that, according to Shorrocks (1988), an inequality measure should satisfy. These properties are:

a. Principles of transfers:

Let $M(X) = M(X_1, ..., X_n)$ be the inequality measure, and let $X^* = (X_1^*, ..., X_n^*)$ be derived from X by

$X_i^* = X_i$ for all $i \neq j, k$ $(i = 1, ..., n)$, $\qquad X_j^* = X_j + d$, $X_k^* = X_k - d$

with $X_k > X_j$, $d < 0.5(X_k - X_j)$;

then the measure M satisfies the principle of transfers, if $M(X^*) < M(X)$.

b. Normalization:

If $X_1 = X_2 = ... = X_n = \bar{X}$, then $M(X) = 0$.

c. Symmetry:

If $W = \Pi(X)$, Π being any permutation of X, then $M(W) = M(X)$.

d. Continuity:

$M(X)$ is continuous.

The principle of transfers captures the most fundamental defining characteric of an inequality measure. According to this principle, any progressive transfer d must lessen the degree of inequality.[3]

Theorem:

For every continuous and strictly convex function f, $V_f(X)$ as defined in (2) satisfies the principle of transfers, and the normalization, symmetry and continuity conditions.

Proof:

a. Principle of transfers.[4]

Let X and X^* be as specified under a. above. Then $\bar{X}^* = \bar{X}$. Define μ_j respectively μ_k by

$$\mu_j = 1 - \frac{d}{X_k - X_j}, \qquad \mu_k = \frac{d}{X_k - X_j},$$

It can easily be seen that $0.5 < \mu_j < 1$, $0 < \mu_k < 0.5$, and $\mu_j + \mu_k = 1$. Since f is a strictly convex function, it follows that

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$$f(X_j^*) + f(X_k^*) = f\{\mu_j \ X_j \ + \ (1-\mu_j)X_k\} + f\{\mu_k \ X_j \ + \ (1-\mu_k)X_k\}$$

$$< \ \mu_j \ f(X_j) \ + \ (1-\mu_j) \ f(X_k) \ + \ \mu_k \ f(X_j) \ + \ (1-\mu_k) \ f(X_k) = f(X_j) + f(X_k) \ .$$

Therefore

$$V_f(X^*) = \frac{1}{n}\sum_{i=1}^{n} \ \{f(X_i^*) - f(\bar{X}^*)\} = \frac{1}{n}\sum_{\substack{i=1 \\ i \neq j,k}}^{n} f(X_i) + f(X_j^*) + f(X_k^*) - \frac{1}{n}\sum_{i=1}^{n} \ f(X_i)$$

$$< \frac{1}{n}\sum_{i=1}^{n} \ \{f(X_i) - f(\bar{X})\} = V_f(X) \ .$$

b. Normalization.

Follows directly from the definition of $V_f(X)$.

c. Symmetry.

Let $W = (W_1,....,W_n)$ be obtained from $X = (X_1,....,X_n)$ by $W_i = X_i$ for all $i \neq j,k$ $(i=1, ..., n)$, $W_j = X_k$, $W_k = X_j$.

Then

$$\sum_{i=1}^{n} f(W_i) = \sum_{i=1}^{n} f(X_i) \ , \ \bar{W} = \bar{X} \ .$$

By (2), it follows that $V_f(W) = V_f(X)$. The notion that any permutation Π of X can be obtained from X by interchanging two elements of X a finite number of times, completes the proof of the symmetry condition.

d. Continuity.

Follows directly from the continuity of function f.□

<u>Corollary:</u>

For every continuous and strictly concave function f, $W_f(X) = -V_f(X)$ satisfies the principle of transfers, and the normalization, symmetry and continuity conditions.

The nonlinearity bias $V_f(X)$ that corresponds to continuous and strictly convex functions f will be referred to as an <u>inequality measure</u>. For continuous and strictly concave functions f, on the other hand, $W_f(X) = -V_f(X)$ may be called an inequality measure (and $V_f(X)$ an <u>equality measure</u>).

As mentioned in the preceding section, the impact of household income on the consumption of food and other necessities can usually adequately be modelled by a semi-logarithmic function. This functional relationship will be applied in the empirical analysis in the next section. The nonlinearity bias that corresponds to it will be written as $V_{log}(X)$.

From the definition of $V_f(X)$ in equation (2) it follows that

$$V_{log}(X) = \frac{1}{n} \sum_{i=1}^{n} \{log\ (X_i) - log\ (\bar{X})\} = \frac{1}{n} \{log\ (\prod_{i=1}^{n} X_i) - log\ (\bar{X}^n)\} = log\ (G_x) - log\ (\bar{X}) = log\ \frac{G_x}{\bar{X}}$$

where G_x is the geometric average of $X_1,..., X_n$.[5]

4. Empirical Results

In the present section, the relationship between basic needs fulfilment, average income and income inequality will empirically be tested on the basis of a cross-national data set of 54 countries. The sample consists of those countries for which nationwide income distribution estimates based on the same income concept (total available household income) are available. The year of observation differs from country to country, because the surveys providing information on income distributions are held in different years. Data on the other variables are gathered for the same year as the year of observation on income distribution.

The sample comprises countries at all levels of economic development. It contains 15 low-income countries (per capita real income < 1,000 US$ of 1975), 21 middle-income countries and 17 high-income countries (per capita real income > 4,000 US$ of 1975). Seven countries are located in Africa (six in Sub-Saharan Africa), 11 countries in Latin-America and 15 in Asia. The remaining countries are located in Europe (16 countries), Ocenia (three countries) and North-America (two countries). All but four OECD-countries are included, but there is only one CMEA-country in the sample. More information on the composition of the sample and data sources can be found in the appendix.

A first problem that has to be faced in an empirical analysis of basic needs fulfilment is the choice of appropriate basic needs indicators. A useful distinction, that is often made in the literature, is that between input and output measures (see e.g. Streeten 1981: pp. 78-79, and Hopkins and Van der Hoeven 1983: pp. 12-13). Input indicators measure the supply of basic goods and services. Examples are the number of doctors or hospital beds per thousand inhabitants, or the number of schools per thousand children of school-going age. The values of these indicators depend to a large extent on the public

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expenditure on basic goods and services. Output or performance indicators measure the actual performance in the field of basic needs. In other words, they measure the state of the population instead of how this state is arrived at. Examples are the adult literacy rate, life expectancy at birth, or calorie consumption per capita. It will be clear that input measures should not be used as dependent variables in the regression analysis, since they do not measure the actual degree of satisfaction of basic needs. For this reason, only output measures will be used as dependent variables below. The present study differs in this respect from the empirical studies mentioned in the introduction which use both input and output indicators.

Which output indicators should be used in the analysis? Using the availability and quality of the data and the suitability of the indicators as criteria (see the discussion on indicators in section two), the following indicators have been selected:
- Health: Life expectancy at birth, infant mortality rate.
- Food and nutrition: Calorie supply per capita, protein supply per capita.
- Education: Adult literacy rate, primary school enrolment ratio, combined primary and secondary school enrolment ratio.
For two other basic needs, clothing and shelter, no suitable indicators of sufficient quality are available.

As argued in section 2, the impact of household income on basic needs fulfilment is likely to follow a strictly concave pattern. A semi-logarithmic functional form is assumed to give a reasonable approximation of the income-basic needs relationship. Therefore the following specification has been chosen for the regression models.

$$BNI_i = c_1 + c_2 \log(YH_i) + c_3 V_{log}(YH)_i + c_4 IS_i + u_i, \text{ for } i = 1, .., 54 \text{ (or 52)} \qquad (9.1)$$
where BNI stands for the basic need indicators EO, IMR, CAL, PRT, LIT, ENR1, ENR12.

EO	=	Life expectancy at birth;
IMR	=	Infant mortality rate;
CAL	=	Supply of calories per capita per day (x 100);
PRT	=	Supply of proteins (in grammes) per capita per day;
LIT	=	Adult literacy rate (as a percentage of the population aged 15 and over);
ENR1	=	Primary school enrolment ratio (as a percentage of the primary school age population);
ENR12	=	Combined primary and secondary school enrolment ratio (as a percentage of the primary and secondary school age population);
YH	=	Real gross domestic product (in $1000 of 1975) per household;
$V_{log}(YH)$	=	Measure of equality of total available household income, as measured by $V_{log}(X)$.
IS	=	Percentage of the population with Islamic religion;
u	=	Disturbance term with standard properties.
$c_1,..,c_4$	=	Unknown parameters.

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The choice of the basic need indicators that serve as dependent variables has already been discussed. Two further remarks should be made. First, the two indicators of health (EO and IMR) are measures of mortality rather than health. It may be tried to use measures that exclusively focus on health (such as number of days spent in hospital, or average length or weight of the population), but these measures are subject to severe problems of data availability and quality. Moreover, health and mortality are so closely related that indicators of mortality are probably the best universally available indicators of health at the moment. Second, the choice of two different school enrolment ratios may seem a bit strange. From a theoretical point of view, the primary school enrolment ratio is the best of these two indicators, since primary schooling is much more a basic need than secondary schooling. But for a comparison over countries, this indicator has two basic weaknesses (see McGranahan et al. 1985: pp. 67-70). In the first place, the length of schooling differs from country to country; it depends on the schooling system in each country. In the second place, many of the enrolled children are older or younger than the official age range. As a result, enrolment ratios can be larger than 100 percent. When secondary schools become generally available in low-income countries and educational systems develop, this source of error usually becomes smaller and primary school enrolment ratios decline. According to McGranahan et al. (1985: p.70), these weaknesses are less marked when the combined primary and secondary school enrolment ratio is used.

Only 52 observations are available for ENR1 and ENR12. The deviant schooling systems in Switzerland, 1978 and Germany, 1974 make their data on primary and secondary school enrolment ratios incomparable with those of the other countries in the sample.

Average income is represented by real gross domestic product per household (YH). The term 'real' reflects the fact that purchasing power parities instead of exchange rates are used for converting estimates expressed in local currencies into a common currency (see also Ram 1985).

The degree of (in)equality in the income distribution is measured by applying $V_{log}(X)$, as defined in section 3, to the distribution of available household incomes. The resulting measure is called $V_{log}(YH)$. In principle, the coefficients for $log(YH)$ and $V_{log}(YH)$ should be equal. In the present application, however, the coefficients are expected to differ from each other for a number of reasons:

- The income concepts underlying YH and $V_{log}(YH)$ are not the same. Differences exist for example in the treatment of foreign earnings, taxes and government services in the two income definitions.
- Measurement errors are likely to differ between these variables, because the data come from different sources. Moreover, the purchasing power parities used for estimating YH may contain measurement errors.
- There may exist additional explanatory variables, (e.g. public expenditure on basic needs), that have been omitted from the regression equation. When these variables are correlated with $log(YH)$ and/or $V_{log}(YH)$, this will affect the coefficient estimates.

For these reasons, the restriction $c_2 = c_3$ has not been imposed.

As discussed above, the impact of average income and income equality on basic needs fulfilment is

expected to be positive. For infant mortality (IMR), this means that the coefficients of the two income variables should be negative. For the other basic need indicators, positive signs are expected.

The percentage of the population having Islamic religion (IS) has been added as an explanatory variable to the equations, because the restricted access of females to education and the limited female autonomy in Islamic countries is likely to have a negative impact on the average levels of education and the satisfaction of other basic needs in these countries.

It would have been desirable to add an extra explanatory variable, representing public expenditure on basic needs, to the regression equations. Unfortunately, data on such expenditures are lacking for most countries in the sample, so inclusion of such a variable is not possible. It may be argued that the (per capita) amount of public basic needs expenditure depends on the average income level of a country and possibly also on the degree of (in)equality in the income distribution. So, the omission of public basic needs expenditure from the regression equations implies that the estimated coefficients for $\log(YH)$ and $V_{\log}(YH)$ will not only reflect the direct impact of these variables on the fulfilment of basic needs, but also the indirect impact running through the amount of public expenditure on basic needs.

The main results are given in Table 1. With one exception, the estimated coefficients for the two income variables, $\log(YH)$ and $V_{\log}(YH)$, have the expected signs and differ significantly from zero in all equations. The only exception is the coefficient for $V_{\log}(YH)$ in the equation for primary school enrolment. In the equation for the combined primary and secondary school enrolment ratio (which is a better indicator of education, see above), the estimated coefficient does have the expected sign and differs significantly from zero. It seems therefore justified to conclude that the results are in agreement with the hypothesis that an equalization of household incomes leads to a higher average level of basic needs satisfaction in a population.

Table 1: Regression results for seven basic need indicators, ordinary least squares

EXPLANATORY VARIABLES	BASIC NEED INDICATORS									
	EO (1)	IMR (2)	CAL (3)	CAL (4)	PRT (5)	PRT (6)	LIT (7)	ENR1 (8)	ENR1 (9)	ENR12 (10)
log (YH)	10.4 (13.2)	-48.7 (-9.31)	5.00 (8.02)	5.17 (8.83)	17.3 (6.60)	17.9 (7.30)	24.4 (10.7)	18.8 (6.39)	17.4 (6.04)	20.7 (8.86)
V_{log}(YH)	14.5 (4.40)	-81.3 (-3.72)	10.7 (4.14)	10.7 (4.13)	38.3 (3.51)	38.1 (3.51)	28.5 (2.99)	-21.2@ (-1.72)	.	18.8 (1.93)
IS	-0.10 (-4.67)	0.56 (3.89)	-0.01@ (-0.86)	.	-0.05@ (-0.77)	.	-0.32 (-5.16)	-0.12 (-1.55)	-0.13 (-1.56)	-0.16 (-2.52)
R^2	.88	.80	.72	.72	.64	.64	.83	.54	.51	.74
Number of countries	54	54	54	54	54	54	54	52	52	52

@ = Not significant at 10 percent level, or wrong sign.
(t-statistics between brackets)

The estimated coefficients for V_{log}(YH) suggest that when household incomes are equalized such that V_{log}(YH) increases by 0.17 (the standard deviation across the sample), the life expectancy at birth increases by 2.5 years and the number of infant deaths per thousand decreases by 14 while the daily supply of calories increases by 180 and the daily supply of proteins by 6.5 grammes. For the measures of education, the effect would be an increase of 4.9 percentage points in the adult literacy rate, and an increase of 3.2 percentage points in the combined primary and secondary school enrolment ratio. When, on the other hand, average household income increases by $ 2,130 (the antilog of the standard deviation of log(YH)), then the life expectancy would go up by 8 years, the number of infant deaths per thousand infants would decrease by 37, the calories supply would increase by 380, and proteins supply would increase by 13.1 grammes. As regards education, the effect would be an increase of the adult literacy rate by 18.4 percentage points, and an increase of the combined primary and secondary school enrolment ratio by 15.6 percentage points.

The regression results further suggest that Islamic religion has a negative impact on the satisfaction of two of the three basic needs that are examined, namely health and education. The third basic need, nutrition, is not significantly affected, as indicated by the low values of t-statistics for IS in the equations for CAL and PRT. When the variable IS is deleted from these two equations, the results for the other two variables are only marginally affected (see columns (4) and (6) in Table 1).

The regression results raise the question why previous empirical studies have reached such deviating conclusions with regard to the impact of income (in)equality on basic needs fulfilment. In order to answer this question, a number of extra regressions have been made which are based on the

specifications that were used in the studies by Sheehan and Hopkins (1978) and Ram (1985).

The main difference between the present study and the study by Sheehan and Hopkins lies in the specification of the average income variable. The latter study uses income per capita instead of the logarithm of average household income. As discussed in section 2, the impact of (average) income on basic needs satisfaction is very likely to be nonlinear. Moreover, average income should be expressed per household instead of per head, since the household is the relevant decision unit with regard to decisions on the consumption of basic goods and services. The second difference lies in the use of input indicators as dependent variables in the study by Sheehan and Hopkins. As discussed above, input indicators do not measure the actual performance on basic needs and should therefore not be used as dependent variables.

The data set for the 54 countries also contains information on one input indicator, viz. population per physician (DOC). This variable is added to the list of basic need indicators that are used as dependent variables. The specification used by Sheehan and Hopkins reads as follows:[6]

$$BNI_i = c_1' + c_2' YPC_i + c_3' V_{log}(YH)_i + u_i' \quad \text{for } i = 1,...,54 \text{ (or 52)}$$

where BNI stands for the basic need indicators EO, IMR, CAL, PRT, LIT, ENR1, ENR12, DOC, respectively

DOC   = Population per physician (in thousands);

YPC'   = Real gross domestic product (in $1000 of 1975) per capita;

u_i' = Disturbance term with standard properties.

$c_1',...,c_3'$ = Unknown parameters.

Again, average income and income equality are expected to have a positive impact on basic needs fulfilment. This means that the coefficients of YPC and $V_{log}(YH)$ should be negative in the equations for IMR and DOC, and should be positive in the other equations. The regression results are given in Table 2.

Table 2: Regression results for the first alternative specification, ordinary least squares

BASIC NEED INDICATORS

EXPLANATORY VARIABLES	EO (1)	IMR (2)	CAL (3)	PRT (4)	LIT (5)	ENR1 (6)	ENR12 (7)	DOC (8)
YPC	0.39	-1.86	0.20	0.72	0.94	0.59	0.77	0.26
	(8.38)	(-7.03)	(8.53)	(7.88)	(7.33)	(4.38)	(6.77)	(-4.97)
$V_{log}(YH)$	3.93@	-30.9@	4.54	14.3@	2.93@	33.1@	-1.14@	12.1@
	(0.66)	(-0.92)	(1.53)	(1.23)	(0.18)	(-1.97)	(-0.08)	(1.81)
R^2	.67	.61	.71	.67	.60	.28	.55	.33
Number of countries	54	54	54	54	54	52	52	54

@ = Not significant at 10 percent level or wrong sign.
(t-statistics between brackets).

The regression results lead to a totally different conclusion. For 6 out of 7 indicators, the estimated coefficient for $V_{log}(YH)$ is either not significantly different from zero or has the wrong sign. Only in the equation for calorie supply per capita, the estimated coefficient is positive and significant on a 10 percent level. The fit of the equations, as indicated by the values of the R^2, is lower than the fit of the equations based on the original specification (see table 1). In other words, when a specification similar to the one used by Sheehan and Hopkins (1978) would have been used for the regressions instead of equation (3), the results would have suggested to reject the hypothesis that an equalization of incomes leads to a higher average level of basic needs satisfaction.

The second alternative specification that is tested is based on Ram (1985). In that study, the sample is confined to less developed countries, and two subgroups are distinguished: low-income and middle-income countries. The intercepts and slopes are allowed to differ between these two subgroups. This gives the following 'piecewise linear' specification:[7]

$$BNI_i = c_1'' + c_2''DUMR_i + c_3''YPC_i + c_4''YPC_i.DUMR_i + c_5''V_{log}(YH)_i + c_6''V_{log}(YH)_i.DUMR_i + u_i''$$
for i = 1, ..., 32

where BNI stands for the basic need indicators EO, IMR, CAL, PRT, LIT, ENR1, ENR12, DOC respectively

DUMR	=	Dummy variable (one for countries with per capita real income < $1000, zero otherwise).
u_i''	=	Disturbance term with standard properties.
$c_1'',...,c_8''$	=	Unknown parameters.

The purpose of this specification is to test the hypothesis that average income is important for low-income countries only, whereas income equality matters for the satisfaction of basic needs in middle-income countries only. So, positive signs ae expected for the coefficients of YPC, YPC.DUMR and $V_{log}(YH)$, while the coefficients of $V_{log}(YH)$.DUMR are expected to be negative. In the equations for IMR and DOC, the coefficients are again expected to have the reverse signs.

Table 3: Regression results for the second alternative specification, ordinary least squares.

EXPLANATORY VARIABLES	BASIC NEED INDICATORS							
	EO (1)	IMR (2)	CAL (3)	PRT (4)	LIT (5)	ENR1 (6)	ENR12 (7)	DOC (8)
YPC	0.22@	-0.69@	-0.00@	0.51@	0.38@	-0.12@	-0.04@	-0.05@
	(1.24)	(-0.56)	(-0.03)	(1.29)	(0.66)	(-0.21)	(-0.08)	(-0.23)
YPC.DUMR	1.87	-10.3	0.30@	0.18@	5.65	4.00	4.59	-3.36
	(3.05)	(-2.46)	(1.22)	(0.14)	(2.88)	(2.00)	(2.77)	(-4.87)
$V_{log}(YH)$	15.4	-113	6.71	25.8	32.2@	17.1@	32.2	0.94@
	(1.76)	(-1.90)	(1.93)	(1.35)	(1.15)	(0.60)	(1.36)	(0.10)
$V_{log}(YH)$.DUMR	-7.63@	107@	-5.23@	-34.6@	20.3@	-56.0	-40.1@	6.16@
	(-0.60)	(1.23)	(-1.04)	(-1.25)	(-0.50)	(-1.35)	(-1.17)	(0.43)
R^2	.72	.55	.66	.42	.60	.52	.55	.68

Sample size is 32 (low and middle-income countries only)
@ = Not significant at 10 percent testing level (t-statistics between brackets)

The results are given in table 3. The estimated coefficients for YPC do not differ significantly from zero in all equations, and the same result is found for the coefficients of $V_{log}(YH)$.DUMR in seven out of eight equations. On the other hand, the coefficients for YPC.DUMR are found to differ significantly from zero in all equations except the ones for CAL and PRT. And the coefficients for $V_{log}(YH)$ differ from zero in five out of eight equations. For two of the three education indicators, the values of the t-statistics for $V_{log}(YH)$ are below the critical values at the 10 percent level.

On the basis of these results, one would be tempted to conclude that income equality has a positive impact of health and nutrition but not on education, while average income is important only for eduation and health in low-income countries. Again, these conclusions differ substantially from the conclusions that were reached on the basis of equation (3).

In conclusion, these two exercises have shown that the specification of the explanatory variables is of crucial importance for testing the impact of income equality on basic needs satisfaction. In particular,

when a linear or piecewise linear specification (instead of a strictly concave function) is used for average income, and average income is expressed per capita instead of per household, the results of the regressions suggest incorrectly that income redistributions either have no impact on basic needs satisfaction or have an impact on a few components only (and that changes in average income levels have no impact on the fulfilment of basic needs in middle-income countries).

5. Conclusions

It has been argued in this paper that an equalization of household incomes leads to a higher average level of basic needs satisfaction in a population. This proposition is based on the strict concave form that is usually found for Engel curves of necessities. When household incomes are equalized, low-income households will consume more and high-income households less basic goods and services. But the strict concavity of the Engel curve implies that the gains of the poor households exceed the losses of the rich households. As a result, the average level of basic need satisfaction increases.

The empirical results of this paper support the hypothesis. This raises the question why most previous empirical studies reached different conclusions. It is shown that the main reason lies in the fact the specification of the regression equations in previous studies does not adequately represent the theory. In particular, a (piecewise) linear specification is used for average income instead of a nonlinear specification, and average income is expressed per head instead of per household in these studies. When similar specifications are used in the present analysis, the regression results do not confirm the hypothesis either. This result shows that consistent aggregation of the underlying micro-level relationships is of fundamental importance for the derivation of the regression equations to be used in empirical macro studies of the impact of income (in)equality on basic needs fulfilment.

Notes:

0. Heerink (1991) has estimated a simultaneous-equations model of population growth, average income, income inequality and basic needs satisfaction. The regression results for the basic needs equations are only slightly different from the OLS regression results.

1. When the analysis concentrates on the characteristics of products, the basic conclusion that the impact of household income on basic needs satisfaction follows a strictly concave pattern is unlikely to be changed. Indeed, examples may be found of food products that are replaced by more expensive variants of a lower nutritional value. The consumption of processed rice by richer households instead of the brown, short grain variety provides an additional example (see e.g. Streeten 1981: pp.35-36, and Behrman and Deolalikar 1986).

   Behrman et al. (1988) argue that when income increases and food expenditure increases almost proportionally, at the margin people will concentrate on food attributes other than nutrients (tastes, appearance, odor, degree of processing, variety, status). This explains why the income elasticity of

food expenditure is of the order of magnitude of 0.7 to 0.9 in poor societies, but the income elasticities of nutrients are only 0.3 or less for most nutrients. Evidence from Nicaraguan data indicates that there exists a statistically significant inverse association between per capita income and the income elasticity of nutrients (see Behrman et al. 1988: pp.307-309). These findings indicate that the impact of household income on nutrition follows a strictly concave pattern, although the relationship is weaker than that between household income and food expenditure (see also Gillis et al. 1987: pp.241-243).

2. When the relationship is not identical for all micro-units (that is, the function f depends on i), a different aggregation problem arises (see e.g. Theil 1971: Ch.11, and Van Daal and Merkies 1984).

3. Some of the inequality measures that have been proposed in the literature do not even satisfy these four basic conditions. For example, the relative mean deviation and the variance of the logarithms of the X_i's violate the principle of transfers. Moreover, the standard deviation of logarithms increases as a result of progressive transfers at levels of $X_i > Ge$, where G is the geometric average of the X_i's and e is the base of the natural logarithm (see e.g. Kakwani 1980: pp.79-80, 87-88).

4. An alternative proof of the principle of transfers may be derived by following the proof of Lemma 5.2 in Kakwani (1980: pp.67-68) or the proof of Theorem 3 in Shorrocks (1980: p.619).

5. Observe that $W_{log}(X) = -V_{log}(X)$ is equal to Theil's second or population-weighted entropy index (Theil 1967, pp. 126-127). In addition to the properties already discussed, it can easily be shown that $W_{log}(X)$ has a number of additional properties which are usually considered to be desirable for inequality measures. These are the properties of population size invariance, sign preservation, additive decomposability and scale invariance and the principle of equal additions (see e.g. Kakwani 1980, ch.5, Eichhorn and Gehrig 1982, pp.681-683 and Shorrocks 1988, pp. 433-435 for definitions). Of these, the first three conditions are met by all inequality measures $W_f(X) = -V_f(X)$ that correspond to continuous and strictly concave functions (see Heerink 1991: Ch.2 for details).

6. Observe that $V_{log}(YH)$ is an equality measure instead of an inequality measure.

7. The variable IS is omitted from the regression because Sheehan and Hopkins do not use a variable representing Islamic religion. Income equality is measured by $V_{log}(YH)$ instead of the income share received by the poorest 40 percent, which has been used by Sheehan and Hopkins. These two simplifications have no impact on the conclusions that are drawn from the analysis.

8. Just like Sheehan and Hopkins (1978), Ram uses the income share of the poorest 40 percent households to measure income equality. The criterion that is used in Ram's study for dividing developing countries into low-income and middle-income countries is the level of $400 of conventional GDP per capita in 1970.

APPENDIX: DATA SOURCES.

The sample that is used for the regression analyses consists of the following
54 countries and years:

1. Kenya 1976	20. Taiwan 1971	37. Italy 1977
2. Tanzania 1969	21. Hong Kong 1980	38. Ireland 1973
3. Malawi 1967-68	22. Mexico 1968	39. United Kingdom 1979
4. Zambia 1976	23. Honduras 1967	40. Netherlands 1977
5. Sierra Leone 1967-69	24. El Salvador 1976-77	41. Germany, Fed. Rep. 1974
6. Sudan 1967-68	25. Costa Rica 1971	42. Belgium 1978-79
7. Egypt 1974	26. Panama 1970	43. France 1975
8. Turkey 1973	27. Trinidad and	44. Switzerland 1978
9. Iran 1973-74	Tobago 1975-76	45. Denmark 1976
10. India 1975-76	28. Venezuela 1970	46. Sweden 1979
11. Nepal 1976-77	29. Peru 1972	47. Norway 1970
12. Bangladesh 1973-74	30. Brazil 1972	48. Finland 1977
13. Sri Lanka 1969-70	31. Chile 1968	49. Japan 1979
14. Thailand 1975-76	32. Argentina 1970	50. New Zealand 1981-82
15. Malaysia 1973	33. Israel 1979-80	51. Australia 1975-76
16. Indonesia 1976	34. Yugoslavia 1978	52. Canada 1977
17. Philippines 1970-71	35. Portugal 1973-74	53. United States 1971
18. Fiji 1977	36. Spain 1973-74	54. Hungary 1982
19. Rep. of Korea 1976		

The data come from the following sources (variables ranked alphabetically):

CAL= Supply of calories per capita per day (x 100).
Sources:
- F.A.O. Production yearbook (various years).
- Taiwan 1971: Estimated from data for 1970 and 1974 in World Bank, World
  development report (various years) and World Bank (1980).
Data refer to 3-years averages.

DOC= Population per physician (x 1000).
Sources:
- World Bank (1984: Volume II).
- Taiwan 1971: Estimated from data for 1970 and 1976 in World Bank, World
  development report (various years).

DUMR= - 1, for countries with per capita real income < $1000;
       - 0, for other countries in the sample.
Equals one for countries nos. 1-7, 10-14, 16, 17 and 23; the variable YPC
serves as the criterium.

ENR1= Primary school enrolment ratio (as a percentage of the primary school
       age population).
Sources:
- UNESCO, Statistical yearbook (various years): Table 3.2.
- Taiwan 1971: World Bank, World development report (various years).

ENR12= Combined primary and secondary school enrolment ratio (as a percentage
        of the primary and secondary school age population).
Sources: See ENR1.

EO= Life expectancy at birth.
Sources:
- United Nations (1982).
- Bangladesh 1973-74: United Nations, Demographic yearbook (various years).
- Taiwan 1971: DGBAS (1983: Table 19).

IMR= Infant mortality rate (= number of deaths to infants under one year of
     age per thousand live births).
Sources:
- United Nations Secretariat (1982)
- United Nations, Demographic yearbook (various years).
- Taiwan: DGBAS (1983: Table 19).

IS= Percentage of the population with Islamic religion.
Source: Kurian (1979: p.48).
The data refer to the early 1970s.

LIT= Adult literacy rate (population aged 15 and over).
Sources:
- World Bank (1984: Volume II).
- Taiwan 1971: Estimated from data for 1960 and 1974 in World Bank (1980) and
  World Bank, World development report (various years).

PRT= Supply of proteins (in grammes) per capita per day.
Sources:

- World Bank (1984: Volume II).
- Taiwan 1971: Kurian (1979: p.306).
Data refer to 3-years averages.

VLOGYH= Equality of total available household income, as measured by $V_{log}(Y^h)$.
Estimates of the distribution of total available household income come from
Van Ginneken and Park (1984: table 1 and table Al) for 33 countries. These are
countries nos. 1-2, 4-7, 9-13, 17-19, 22-23, 25-32, 34, 36, 38-39, 41, 43,
45-46, and 53. In order to enlarge the sample, income distribution estimates
were taken from the World Bank, World Development Report (various years) for
another 21 countries. The income concept in this series is the same as the one
used by Van Ginneken and Park.
When income distribution estimates have been published for more than year in
the World Development Reports, the most recent year (but not later than 1980)
for a country has been chosen. The value of the equality measure $V_{log}(Y^h)$ has
been estimated by fitting the Lorenz-curve that corresponds to the lognormal
distribution to these income distribution estimates (see chapter 2 in Heerink
1991 for a description of this method).

YH= Average household income (= real gross domestic product per household), in
    $1000 of 1975.
Calculated by multiplying YPC and average household size.
Sources for estimates of average household size:
- United Nations, Compendium of housing statistics 1975-77.
- Taiwan 1971: Own estimate, based on data for 1966 in United Nations, Demo-
  graphic yearbook 1968 and trend in HHSIZE in the Rep. of Korea.

YPC= Income per capita (= real gross domestic product per capita), in $1000 of
    1975.
Sources:
- Summers and Heston (1984).
- New Zealand 1981-82 and Hungary 1982: Own estimates, based on estimates for
  1980 in Summers and Heston (1984) and growth rate of per capita GDP in
  constant prices in I.M.F., International financial statistics (various
  years).
Purchasing power parities are used for converting incomes in local currencies
to US dollars. The estimates are results of the United Nations Income Compari-
son Project (ICP).

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