Policy, Research, and External Affairs

WORKING PAPERS

Trade Policy

Country Economics Department
The World Bank
November 1990
WPS 536

The Link Between Poverty and Malnutrition

A Household Theoretic Approach

Maurice Schiff
and
Alberto Valdés

Past studies have identified nutrition exclusively with nutrient intake. A better definition of nutrition (as the one used here) would critically affect the link between poverty and malnutrition and would affect the implications for policies designed to improve the nutritional status of the poor.

Policy, Research, and External Affairs

WORKING PAPERS

Trade Policy

WPS 536

This paper — a product of the Trade Policy Division, Country Economics Department — is part of a larger effort in PRE to study the impact of agricultural pricing and trade policies, and is a by-product of the Comparative Study of the Political Economy of Agricultural Pricing Policies in Developing Countries. Copies are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Sheila Fallon, room N10-025, extension 37947 (15 pages).

A household's nutrition level or status depends only partly on its nutrient intake (calories, protein, vitamins, and the like). It is also a function of:

- Non-nutrient food attributes that affect nutrition, such as the freshness, cleanliness, and storability of foods purchased.

- Privately provided inputs such as the time and care taken to prepare food to ensure that it is not contaminated or spoiled.

- Publicly provided inputs, such as potable water, sewerage, electricity, nutritional information, and the like.

No matter how closely related, food adequacy (measured by nutrient intake) and nutrition level are not the same thing. The problem of food adequacy may or may not reveal itself as a nutrition problem; and a nutrition problem may or may not be the result of an inadequate supply of food.

The fact that nutrient intake does not increase with income is not itself a cause of concern, though it is viewed that way by some who identify nutrition exclusively with nutrient intake. Such a view overlooks the fact that households have the *choice* of spending increments in food expenditures on nutrients but prefer to spend it on other food attributes. It also ignores the fact that these other food (and nonfood) attributes may also contribute to nutritional status (for example, food freshness and cleanliness, refrigeration, and so on).

In urban areas, nutritional and health status can probably best be raised through the provision of publicly provided inputs (sewerage, potable water, and so on).

In rural areas, nutritional and health status depend largely on household inputs — which depend on income. So raising the rural household's income can raise its nutritional and health status.

One of the best ways to raise farm income is to reduce taxes on agricultural production; another is to increase public spending on factors that raise land and labor productivity in rural areas. Schiff and Valdés argue that agricultural export-led growth has real potential for creating jobs, reducing poverty, and thereby contributing to improvements in the nutritional status of the poor.

Produced by the PRE Dissemination Center

THE LINK BETWEEN POVERTY AND MALNUTRITION

Introduction

That malnutrition is a function of poverty is self-evident. Only in recent years has the problem of malnutrition been viewed not only as a consequence of underdevelopment, but also as a contributory factor to it. In their pioneering study, Reutlinger and Selowsky (1976) identify two distinctive features of the problem of malnutrition. One is that nutrition is one of the main determinants of health, and as distinguished from the general objective of improving economic welfare, society regards health as a desirable end in itself; thus most societies strive for a minimum standard of health and nutrition for all its citizens, although the same society may have no minimum standard of income for all its citizens. The second is that health and nutritional interventions have an impact on human capital formation, through their impact on schooling and labor productivity, and have implications for the future earnings of individuals and the growth in gross national product.

This last consideration is crucial. Solidarity with the conditions of the poor based on non-economic considerations supplies a clear justification for implementing policy interventions to provide for specific groups' minimum adequate consumption of food, health, education and shelter, beyond the levels resulting from market demand and supply. This is a basic need policy. However, since specific investment policies in nutrition and health increase the endowment of human capital of the poor by increasing their earning capacity, such programs do not necessarily imply a trade-off between economic growth and poverty alleviation. Thus the argument for making a special sustained economic effort towards such basic needs programs is reinforced by the implications of economic growth. The question before us is then how to design or adjust current programs to make them more effective.

In assessing the relative merits of various public policies to deal with malnutrition among the poor in developing countries, we will submit that a better understanding of the household behavior is the natural starting point. The decisions on health and nutrition are basically made by individuals and households in which they live, given their income, the price structure they face, and the level of services and infrastructure in the community, and the nutrition and health production technology. It is in this context that public policies must be designed, i.e., they must take into account the fact that households make the ultimate decision concerning the family's expenditures on nutrition and health. Otherwise, public policies might not be effective.

Rather than to talk about the millions of malnourished people living in developing countries, which usually becomes a call for more food aid to nations and families, we believe it is far more useful at this stage to try to relate explicitly household behavior patterns with the public policy options. In this study the focus is on the

relationship between households income and their nutritional and health status. This paper presents what in our opinion is striking new evidence on these interactions and suggests a framework for the analysis of the interactions between income transfers, the publicly provided inputs, and the household's response, as reflected in the effect on nutrition and health. Such framework can be applied in the evaluation of public policies designed to reduce malnutrition (and improve the health status) among the poor in urban and rural areas.[1]

On the Relationship of Nutrition and Income: The Statistical Evidence

In the last fifteen years, a growing body of literature has examined the interaction between nutritional status in developing countries and nutritional intake and household income, and has made recommendations on how to improve nutrition based on parameters from empirical studies of food expenditure systems at the household level. Recent surveys of such studies include Behrman and Deodalikar (1988), Alderman (1989), and Schiff and Valdés (1990b). It is found, however, that the policy recommendations derived from the analysis depend critically on the definition of nutrition and, more broadly, on the conceptual framework used. In particular, critical elements of the pathway from changes in income to its effect on nutritional status are still questioned. Showing that nutrient intakes are unresponsive to changes in income even at very low income levels such as rural South India, recent studies have questioned whether developing country nutrition will improve with income (for example in Behrman and Deodalikar 1987).

While not attempting to survey this vast field, which is already well documented in Behrman and Deodalikar (1988), it is useful to highlight some fundamental findings on which there is a fair degree of agreement. For a small number of food aggregates, estimates from food expenditure systems obtain income elasticities of nutrients (ϵ_{ny}) somewhat smaller than but not significantly different from 1.0. These are derived indirectly by estimating the income elasticities of food expenditures (also close to 1.0) and by assuming constant nutrient-to-food conversion factors.

More recently, in a re-estimation of these demand systems, such as for example for rural South India, Behrman and Deodalikar (1988) find that the expenditure income elasticity of food for the six food aggregates (120 foods grouped into 6 aggregates) is close to one. However, the elasticity is significantly lower for the more disaggregated food groups. For the major nine nutrients, the income elasticities ϵ_{ny} are close to and not significantly different from zero. Cross-country estimates confirm the microeconomic results regarding the

---

[1] Malnutrition is a multifactorial issue and there are general deficiencies of nutrients (calories, proteins) and specific deficiencies (iron, iodine, etc.). Although emphasis is given to the former type, this paper also addresses some measures to deal with the latter.

low-income elasticity of calorie demand. As income increases, a larger proportion of food expenditures is spent on non-nutrient food attributes such as diversity of products consumed, freshness, taste, convenience foods which save time in their preparation, and others. Similar results are found for low-income households in Pakistan by McCarthy (1977), who finds that as income rises, increases in food expenditures are allocated mostly to quality rather than quantity of food (i.e., ϵ_{ny} close to zero). Several other studies on consumption patterns among low-income households have produced similar results. The evidence shows that when their income rises, the poor elect to consume few nutrients at the margin. Behrman and Deolalikar (1987) conclude that raising income will have little impact on nutrition, if any. However, if it can be shown that nutrition is not to be identified exclusively with nutrient intake, then the policy implications might be strikingly different. This is a major objective of the present paper.

The Framework

The decisions on the consumption of health and nutrition are basically made by individuals or by the households in which they reside, given their assets, the level of the community's infrastructure, the prices that they face, and the technology for producing nutrition and health.

If transfer programs and other policies aimed at poverty alleviation are promoted as likely to have major nutritional impacts, we need to improve our understanding of the interactions among the income transfers, the publicly provided inputs, and the household's response among the poorest segments of the target population. The design of welfare policies should depend on the social costs and benefits of the alternative public policies, where benefits relate to the response in terms of production of nutrition and health.

In the "production" of nutrition and health, the issue of the complementarity of the publicly provided inputs and of those inputs provided by the household are crucial and, we would argue, largely unknown. Understanding this relationship better, as well as the nature of the production functions, is a central theme of this paper.

The starting point is that the nutrition level or status (N) of a household depends only in part on its nutrient intake (n). It also depends on other privately and publicly provided goods and services.[2]

At the household level, we can think of a process of "producing" nutrition (a nutrition production function), where the nutrition status (N) is a function of (1) the inputs of nutrients (calories, protein, vitamins, etc.) which we call n, (2) the input of non-nutrient food attributes which affect nutrition (N), such as freshness of the foods

---

[2] A formal development of this framework is summarized in the Appendix.

purchased, their cleanliness, their storability, which we call q, (3) the privately provided inputs which may affect nutrition (N), such as the time and care to prepare food including cleaning, cooking, boiling water, and other inputs (refrigeration) that ensure that the food does not get contaminated or spoiled, which we call p, and (4) the publicly provided inputs which would include potable water, sewerage, electricity, nutritional information, etc., which we call k. Given the level of nutrient intake n, the absence or low level of the last three types of inputs may cause food products to become spoiled or contaminated. This may lead to a reduction in the absorption of nutrients, or worse, to gastro-intestinal and other diseases accompanied by a drastic reduction in the degree of nutrient absorption, and thus a reduction in the nutritional status (N). Finally, the production of nutrition (N) is also partly determined by the individuals' health status, as well as by age, sex, and location (rural or urban). A fall in health due to causes other than a fall in (n), (q), (p), or (k) above -- say, because of a reduction in medical services -- will result in a fall in nutrition status (N). We posit that this nutrition production function depends on the effect of current as well as lagged values of those variables.

Only in the extreme case of famine (that is, as nutrient intake approaches zero), would all food expenditures be allocated to nutrients (n), and the impact on N of the other variables, particularly non-nutrient food attributes q, would tend to zero and only an increase in nutrients (basic ones, calories and proteins) would have a significant impact on nutrition (N). In that case, ϵ_{ny} would be expected to be close to one. However, the vast majority of the population in developing countries does not fall under this extreme case of famine.

In a broader sense, the variable of concern is the well being of the households in question. An important component of the household's welfare is the health status (H) of its members, which depends in part on their nutritional status. As with nutrition, at the household level we can think of a process of producing health (a health production function, H), which is a function of the nutritional status (N), privately provided inputs (p), publicly provided inputs (k), and a variable (m) of current and lagged values of additional inputs affecting health. In fact, the variable m consists of both privately provided inputs (amount and quality of child care, hygiene, etc.), and of publicly provided inputs (medical services, information on hygiene and child care, and other). Finally, the production of health is also a function of age, sex, and location (rural or urban) of the individual. Thus, health depends on privately and publicly provided inputs directly, as well as indirectly through their effect on nutrition (N).

Since we expect that the functions N and H to vary according to sex, age, location and other individual characteristics, we also expect the impact on N and H of changes in each determinant n, q, p, k, and m to vary according to those characteristics.

This framework allows us to further elucidate the question of whether income gains in low-income communities could reduce malnutrition (raise N), even when they only have a very marginal effect on nutrient intake at the household level. In their 1987 paper, Behrman and Deodalikar argue that raising nutrient intake of the poor cannot be achieved by increases in income, because empirically it has been found that even among very low income households (for example, in rural India in their study) the nutrient elasticity with respect to income may be close to zero. They state:

> "... the World Bank (1981)-type optimism about the nutrient improvement to be expected with income gains in communities such as the ones under examination (rural South India), seems fundamentally misleading," since "... increases in income in the present context will <u>not</u> result in substantial improvements in nutrient intakes." (p. 505).
>
> And from this they suggest that developing country nutrition is unlikely to improve with income.

The questions before us are:

(a) Is the level of the nutrient intake a good proxy for the health and nutrition benefits derived from food consumption under circumstances other than the extreme case of famine?

(b) Is the level of the various nutrients the relevant nutrition (N) variable, and if not, how does this affect the relationship between changes in income and nutrition? and

(c) Is the income elasticity of nutrient intake a relevant criterion to assess the merits of education and other welfare programs aimed at improving nutrition?

As mentioned in the introduction, nutrition is one of the main determinants of health, and health is now regarded as a desirable end in itself, distinct from the general objective of improving economic welfare. How these two variables (N and H) respond when income gains occur among low-income households is then the central concern in this section.

From the production function of nutrition (N) defined above, we can derive the income elasticity of nutrition:[3]

$$\epsilon_{Ny} \equiv A + \epsilon_{NH}\, \epsilon_{Hy}$$

where N = level of nutrition
H = level of health

---

[3] See the Appendix for details.

y = household's income
ϵ = income elasticity

and where A is the partial elasticity of N with respect to income (for a given health status) and includes the impact of income on n, k, q and p.

Similarly with health status, given the production function of health described above, we derive the income elasticities, namely

$$\epsilon_{Hy} \equiv \epsilon_{HN}\,\epsilon_{Ny} + B$$

where B groups the terms including the income elasticities of privately provided inputs ϵ_{qy}, of publicly provided inputs ϵ_{ky}, and of the other variable ϵ_{my} affecting health (such as medical services, information on hygiene and child care, and others)

Solving for ϵ_{Ny} and ϵ_{Hy}, we obtain:

$$\epsilon_{Ny} = \frac{A + B\,\epsilon_{NH}}{1 - \epsilon_{NH}\,\epsilon_{HN}}$$

and

$$\epsilon_{Hy} = \frac{B + \epsilon_{HN}A}{1 - \epsilon_{NH}\,\epsilon_{HN}}.$$

We postulate that ϵ_{qy}, ϵ_{py}, ϵ_{ky}, $\epsilon_{my} > 0$, that is, increases in household's income will tend to be accompanied by an increase in the demand for food "quality" -- e.g., freshness, cleanliness, level of processing, and taste of purchased foods (q) -- in the care in preparing food, and in the use of household appliances such as refrigerators (p), and in more income spent on potable water, electricity, and sewerage systems (k). Also richer households will use more medical and other health related services, and may provide health-related child care (m). The positive income elasticities for q, p, k and m imply that $A > 0$ and $B > 0$, which in turn implies that $\epsilon_{Ny} > 0$ and $\epsilon_{Hy} > 0$. Consequently, the impact of income on nutrition (N) may be significant, even though nutrient intake remains unchanged or increases only slightly with income. What we are trying to emphasize here is that to assess the impact of income on nutrition, one should not simply examine the impact on the input n, but should look at the entire production function N. Furthermore, if the ultimate concern is with improving the health status H (N being one input in the production of H), then again the impact of income on health status H may be quite important. The fact that the nutrient income elasticity is close to zero ($\epsilon_{ny} = 0$) and the food expenditure elasticities are close to 1.0 ($\epsilon_{Fy} = 1$) implies that the demand for non-nutrient food attributes (variety, storability, cleanliness, taste) is high at those low income levels ($\epsilon_{qy} > 1$).

This framework is consistent with the finding, for example by Shah (1983) in rural India, and more recently Behrman and Deodalikar (1987), that even at such a low level of family income, as income increases, households demand a wider variety of food products with a larger quantity of non-nutritive attributes (freshness, taste, processing, etc.), while the actual increase in nutrient intake associated with increases in the households income is not significantly different from zero. Thus, families have a choice of spending increments in food expenditures on nutrients (n), but choose to spend their additional income on other food attributes (q), rather than on nutrients. And this choice, depending on which element of q are chosen (say, freshness rather than taste), might even lead to an increase in nutrition (N) or health (H).

Thus, the common practice of estimating the number of hungry and undernourished by comparing calorie and other nutrient intake with requirement standards implies that, in addition to ignoring the impact of inputs of non-nutrient attributes (q) and privately provided inputs (p) on nutrition (N), no weight is given to household preference. No matter how closely related, food adequacy (measured by nutrient intake) and nutrition level are not the same thing. The problem of food adequacy may or may not reveal itself as a nutrition problem; and a nutrition problem may or may not be the result of an inadequate supply of food.[4]

The problem with interpreting the estimates of the millions of malnourished people based on the intake/requirements relationship are now well recognized. For instance, Sukhatme (1977) and later Srinivasan (1983) and Poleman (1983) concluded that the use of average nutrient requirement as a criterion for classifying a person as undernourished cannot be justified. However, even if the figures about the millions of undernourished were cut by a half or a third, the magnitude of the malnutrition problem in LDCs remains alarming. But the fact that nutrient intake does not increase with income is not in itself a cause of concern. Rather, the opposite may be true as it may indicate dietary adequacy in the sense that these households can increase their intake of nutrients but prefer to spend additional income on other items, including non-nutrient food attributes. The extreme case of famine is different. Under such condition, one expects that all income is spent on the cheapest foods (starchy staples) and thus raising calorie intake then becomes the social priority.

Policy Implications

If, as is usually the case in estimates of malnutrition using general deficiencies in terms of intake/requirement ratios, nutritional status (N) is measured as (n), then N is not responsive to y, given that nutrient consumption has been found to be rather unresponsive to changes

---

[4] Of course, in the extreme case of famine, malnutrition is the result of inadequate food supply.

in income. Thus, transfer programs will be ineffective means to improve nutrition. Similarly, as argued by Alderman (1989), a weak link between income and nutrition implies that nutrition is to some degree buffered from the downswings in the local economy. Under such scenario, and given that definition of N, for income to have an impact on nutrition, policies must be designed to raise the income elasticity of nutrient intake (ϵ_{ny}); some analysts have argued that raising the mother's education could be another way to do it.

Thus, it would seem that such a focus on food intake (n) to improve nutrition (N) is too restricted, failing to capture the complementarity between the privately and publicly provided inputs in the production of health and nutrition, and the substitution between various private inputs (n and q).

If, instead, the most important policy objective is to raise the level of nutrition (N) or health (H), the approach developed above suggests that, except in the case of famines, there is a variety of alternative policy instruments available and their relative merits may change according to location (rural or urban), initial conditions of infrastructure, etc. It also suggests that income will affect nutrition N (and health H) through its impact on q, p, and h (and m), even if it has little or no impact on nutrient intake n.

Education undoubtedly plays an important role in the process of raising nutrition. Not only can it raise the level of food intake but one might also expect the nutrition-related and health-related child care to improve with the level of the mother's education. In his study for India, Padmanabha (1982) finds that infant mortality falls both in rural and urban areas as the literacy and formal educational level of the mother increases. The evidence may not be entirely conclusive as income may be positively correlated with the mother's education and was not controlled. García and Pinstrup-Andersen (1987) in their study on the Philippines find that the mother's education strongly affects the food consumption and nutritional status of pre-schoolers.

If the concern is the production of health, and taking infant mortality as one indicator of health (H), Padmanabha (1982) argues that in rural areas in India, the main causes of death are tetanus, pneumonia, dysentery, and typhoid, which are mainly conditioned by the absence or availability of basic facilities of reliable water supply, sanitation (k), and basic child care services (m), so that nutrient intake does not seem to be the major factor. This confirms the results obtained by Castañeda (1989) for Chile, where he finds that the most important variable explaining the remarkable reduction of infant mortality in Chile from 107 per 1,000 in 1965 to 19.4 per 1,000 in 1986 was the increase in urban coverage of potable water and sewerage. Differences in such coverage were found to be statistically more important than the positive impact of the available nutritional programs addressed to mothers (which in turn appeared to have more impact than child oriented programs). Thus, governments may have to increase the

level and quality of publicly provided inputs (k and m above) in order to have a lasting impact on nutrition and health.

Providing information and education on hygiene and child care (m and p) may also be effective ways of raising nutrition N and health H. Direct demonstration in the rural areas such as the Iringa Integrated Nutrition Program in Tanzania, or the provision of information via television, which has been very successful in raising privately provided inputs (p) and (m) in Chile, are logical approaches to exploit the complementarities in the production of health and nutrition. Here, we refer to the private component of m, but as mentioned earlier in the text, there is also a public component of m.

Also, policies designed to raise the nutrient content of some food ingredients, such as food fortification programs, lead to an increase in the level of nutrition N by raising n.

Conceptually, the framework presented above can help in the evaluation of public investment programs to raise health (H) and nutrition (N) for the poorer households. However, in order to devise effective policies to raise H and N, research efforts should be directed at the empirical estimation of i) the technological production functions of N and H, to know the impact of p, q, k, and m on N and H, ii) the behavioral relationships indicated in ϵ_{py}, ϵ_{qy}, ϵ_{ky}, and ϵ_{my}, in order to compare the effectiveness of raising N and H through y, and through k and m (public components) --or a combination of both, and iii) the costs of providing the services, in order to identify and select cheaper and more efficient programs designed to raise the nutritional and health status of the poorer households.

One would expect that the parameters of these functions N and H differ according to age, sex, income class, and rural and urban characteristics. The estimation of these parameters is, in our opinion, part of the research agenda.

The Distinction between Urban and Rural Populations

The distinction between urban and rural households could raise a particular complex issue. For governments to provide medical services (m) and drinking water and sewers (k) in urban areas is probably considerably less expensive than to provide it for rural areas. Given the lower population density in the latter, the cost per household scattered over large areas would be considerably higher. On the benefits side, they are probably lower in rural areas, considering that the lower population densities in rural areas would reduce the need for publicly provided sewers, drinking water and other such service.

Thus, if the low levels of N and H are the social concern, raising those levels in urban areas by increasing expenditures on k and on public components of m may be an efficient public policy. However, this may very well not be the case for rural areas because of higher costs and lower benefits of providing k and the public components of m. What

then is the prescription for rural areas? One important implication is that in rural areas the nutritional and health status will then largely depend on the levels inputs (p and q and the private components of m), which are provided by the households. These levels depend on income, so that raising rural household's income can raise their nutritional and health status. For example, it may be easier to make a significant impact on incomes in a rural community through a variety of agricultural programs and policies than it is to appreciably increase the provision of sewerage or of health care delivery. We are back then to the long-debated question on how to best raise farm income. One way would be to reduce the taxation of agricultural production caused by sector-specific and economy-wide policies in LDCs.[5] Another would be to increase public expenditure in those factors which raise land and labor productivity. Anticipating that in real life these two components are complementary to each other, in principle both are necessary and the right balance between them is an empirical question to be addressed on a country by country basis.

Concluding Comments

While food is continuously referred to in this paper, little is said about agriculture. There is, however, a strong link with agriculture implied by the above analysis which suggests that in rural areas the nutritional and health status will largely depend on the levels of private inputs (p, q and the private components of m) provided by the households. These levels depend on income, so that raising rural income can raise their nutritional and health status.

The evidence suggests that the development strategies since World War II in most developing countries grossly undervalued the potential contribution of agriculture to economic development. The origins of the then pessimistic attitude towards agriculture and agricultural exports in particular can be found in the perception at the time that a more outward orientation would lead to a continuation of colonial patterns -- a high dependence on a very narrow range of exports, confined to a slow rate of growth, in products subject to a great variability in supply, and with low elasticity of supply. Even in cases where export growth had been substantial, there was a general perception that agricultural exports had not acted as a propulsive sector for the rest of the economy, in the sense of not having a sustained and widespread stimulating effect through its links with the rest of the economy.

However, one of the lessons of the various trade strategies for the industrial sector since the 1960s is that their impact on overall economic growth performance has been more successful under export-oriented strategies. Although we do not yet have a systematic empirical analysis of agriculture at hand, as we have for the industrial sector,

---

[5] An analysis of the impact of those policies for 18 developing countries during 1960-84 is provided in Krueger, Schiff, and Valdés, 1988.

it will be submitted that agricultural export-led growth has real potential in a variety of settings. Such a strategy has enormous potential as part of an employment generation and thus anti-poverty program, in addition to the contribution to export revenues. This potential is reinforced by recent evidence showing that agricultural exports are heavily taxed in most LDCs -- as a result of the combined effect of sectoral and economywide policies (from industrial protection and macroeconomic policies) -- and by the evidence of the strong response of agricultural exports to incentives, as was shown, for example, in Sub-Saharan Africa (Balassa 1988).

Preliminary estimates for 18 LDCs show that in most of these countries, the agricultural sector 'lost' approximately one-fourth of agricultural GDP during 1960-84, as a result of the sectoral and economy-wide price interventions (Schiff and Valdés 1990a). The cumulative effect over time of such a transfer of income out of agriculture must have had enormous repercussions in aggravating poverty in rural areas. According to the conceptual link between income, nutrition, and health developed earlier, this evidence on income transfers suggests that these domestic economic policies probably had a very detrimental effect on nutritional and health status of the poorest segments of the population. Policy reform destined to decreasing taxation on agriculture in the developing countries should have important repercussions in alleviating rural poverty in developing countries.

APPENDIX

We propose the following alternative definition for the nutrition production function:

$$N = N\,(n, q, p, k, H; S, E, L),\ \epsilon_{Nn}, \epsilon_{Nq}, \epsilon_{Np}, \epsilon_{Nk}, \epsilon_{NH} > 0, \qquad (1)$$

where

n = vector of inputs of nutrients,
q = vector of inputs of non-nutrient food attributes,
p = vector of other privately provided inputs,
k = vector of publicly provided inputs,
H = health status,
S = sex,
E = age,
L = urban or rural location, and

where n, q, p, and k are lag polynomials in those variables, reflecting the effect of current as well as lagged values of those variables.

A health production function can be defined as:

$$H = H\,(N, p, k, m; S, E, L),\ \epsilon_{HN}, \epsilon_{Hp}, \epsilon_{Hk}, \epsilon_{Hm} > 0, \qquad (2)$$

where m = vector of current and lagged values of additional public and private inputs affecting health, such as medical services, information on hygiene and child care, private provision of child care and hygiene, and other. Health depends on p and k directly, as well as indirectly through their effect on N.

Since N and H depend positively on current as well as lagged values of their arguments, the long-run elasticities will tend to be larger than the short-run elasticities. Also, the functions N and H may vary according to sex, age, location, and other individual characteristics, so that the elasticities of N and H with respect to their arguments may also vary according to those characteristics.

Finally, in terms of income elasticities:

$$\epsilon_{Ny} = \epsilon'_{Nn}\epsilon_{ny} + \epsilon'_{Nq}\epsilon_{qy} + \epsilon'_{Np}\epsilon_{py} + \epsilon'_{Nk}\epsilon_{ky} + \epsilon_{NH}\epsilon_{Hy} \equiv A + \epsilon_{NH}\epsilon_{HY} \qquad (3)$$

and from equation (2) the income elasticity of health status is

$$\epsilon_{Hy} = \epsilon_{HN}\epsilon_{Ny} + \epsilon'_{Hp}\epsilon_{py} + \epsilon'_{Hk}\epsilon_{ky} + \epsilon'_{Hm}\epsilon_{my} \equiv \epsilon_{HN}\epsilon_{Ny} + B, \qquad (4)$$

where ϵ' is a row vector.

Solving for ϵ_{Ny} and ϵ_{Hy} from equations (3) and (4), we obtain:

$$\epsilon_{Ny} = \frac{A + \epsilon_{NH}B}{1 - \epsilon_{NH}\,\epsilon_{HN}}$$

and

$$\epsilon_{Hy} = \frac{B + \epsilon_{HN} A}{1 - \epsilon_{NH}\, \epsilon_{HN}}. \qquad (5)$$

We postulate that

$$\epsilon_{qy},\ \epsilon_{py},\ \epsilon_{ky},\ \epsilon_{my} > 0,$$

that is, an increase in household's income will tend to be accompanied by an increase in the demand for food "quality," e.g. freshness, cleanliness, and taste of purchased foods (q), in the care in preparing food, and in the use of household appliances such as refrigerators (p), and in more income spent on potable water, electricity, sewerage systems, etc (k). Also richer households will use more medical and other health-related services, and may provide health-related child care (m). Thus, $A > 0$ and $B > 0$. Since for stability,

$1 - \epsilon_{NH}\epsilon_{HN} > 0$, this implies that:

$\epsilon_{Ny} > 0$ and $\epsilon_{Hy} > 0$.

REFERENCES

ALDERMAN, H. (1989). "Poverty and Malnutrition: How Closely Linked?" Paper Cuadernos de Economia, Agosto 1990.

BALASSA, BELA (1988). "Incentives Policies and Agricultural Performance in sub-Saharan Africa," World Bank Policy, Planning, and Research Working Paper 77, Washington DC, Processed.

BEHRMAN, J.R. and DEODALIKAR, A.B. (1987). "Will Developing Country Nutrition Improve with Income: A Case Study for Rural South India," Journal of Political Economy, 95 (3), 452-507.

BEHRMAN, J.R. and DEODALIKAR, A.B. (1988). "Health and Nutrition," In: Handbook of Development Economics, Vol. I, Chenery, H. and Srinivasan, T.N. (Eds.), North Holland, Amsterdam.

CASTAÑEDA, T. (1989). Innovative Social Policies for Reducing Poverty: Chile in the 1980s, The World Bank, August, the J. Hopkins University Press, (en prensa).

GARCIA, M. and PINSTRUP-ANDERSEN, P. "The Pilot Food Price Subsidy Scheme in the Philippines: Its Impact on Income, Food Consumption, and Nutritional Status," IFPRI Research Report, No. 61, (August 1987).

KRUEGER, A.O., SCHIFF M. and VALDES, A. (1988). "Agricultural Incentives in Developing Countries: Measuring the Effects of Sectoral and Economy-wide Policies," World Bank Economic Review, 2, No. 3, 255-271.

MCCARTHY, D. (1977). "Food Consumption, Income Distribution and Quality Effects," Food Policy, 2 No. 1 (February), pp. 79-82.

PADMANABHA, P. (1982). "Mortality in India: A Note on Trends and Implications," Economic and Political Weekly, 17 (7 August), Bombay: 1285-1290.

POLEMAN, T. T. (1983). "World Hunger: Extent, Causes, and Cures," in: The Role of Markets in the World Food Economy, Johnson, D. G. and Schuh, G.E. (Eds.), Westview Press, Boulder, Colorado, 41-75.

REUTLINGER, S. and SELOWSKY, M. (1976). Malnutrition and Poverty: Magnitudes and Policy Options, The Johns Hopkins University Press, Baltimore.

SCHIFF, M. AND VALDES, A. (1990a). The Economics of Agricultural Price Interventions in Developing Countries. Volume 4. Submitted for publication to the Johns Hopkins University Press.

SCHIFF, M. AND VALDES, A. (1990b). "Nutrition: Alternative Definitions and Policy Implications," Economic Development and Cultural Change, 38, No. 2 (January), pp. 281-292.

SHAH, C.H. (1983). "Food Preference, Poverty, and the Nutrition Gap," Economic Development and Cultural Change. October (1983), 121-148.

SRINIVASAN, T. N. (1983). "Hunder: Defining It, Estimating Its Global Incidence, and Alleviating It," in: The Role of Markets in the World Food Economy, Johnson, D.G. and Schuh, G.E. (Eds.), Westview Press, Boulder, colorado, 77-108.

SUKHATME, P. V. "Malnutrition and Poverty," 9th Lal Bahadur Shastri Memorial Lecture, New Delhi, India, January 29, 1977.

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS510	Public Expenditure Reviews for Education: The Bank's Experience	Antoine Schwartz Gail Stevenson	October 1990	C. Cristobal 33640
WPS511	The Macroeconomic Underpinnings of Adjustment Lending	Fred Jaspersen Karim Shariff	October 1990	A. Oropesa 39075
WPS512	Social Security Reform: The Capital Accumulation and Intergenerational Distribution Effect	Patricio Arrau	October 1990	S. King-Watson 31047
WPS513	The Business Cycle Associated with Exchange-Rate-Based Stabilization	Miguel A. Kiguel Nissan Liviatan	October 1990	E. Khine 39361
WPS514	Restrictive Labor Practices in Seaports	Alan S. Harding	October 1990	A. Joseph 33743
WPS515	Stock Markets in Developing Countries: Key Issues and a Research Agenda	Mansoor Dailami Michael Atkin	October 1990	M. Raggambi 37657
WPS516	International Capital Mobility and the Costs of U.S. Import Restraints	Jaime de Melo David Roland-Holst	October 1990	S. Fallon 37947
WPS517	Do Wage Distortions Justify Protection in the U.S. Auto and Steel Industries?	Jaime de Melo David Tarr	October 1990	S. Fallon 37947
WPS518	Industrial Organization and Trade Liberalization: Evidence from Korea	Jaime de Melo David Roland-Holst	October 1990	S. Fallon 37947
WPS519	Taxes, Outward Orientation, and Growth Performance in Korea	Irene Trela John Whalley	October 1990	A. Bhalla 37699
WPS520	Trade Reform, Policy Uncertainty, and the Current Account	Sweder van Wijnbergen	October 1990	M. Stroude 38831
WPS521	World Bank Treatment of the Social Impact of Adjustment Programs	Helena Ribe Soniya Carvalho	October 1990	M. Abiera 31262
WPS522	A Survey of the Costs of World Sugar Policies	Brent Borrell Ronald C. Duncan	October 1990	A. Kitson-Walters 33712
WPS523	EC Bananarama 1992	Brent Borrell Maw-Cheng Yang	October 1990	S. Lipscomb 33718
WPS524	The Kuwaiti NGOs: Their Role in Aid Flows to Developing Countries	Nural Abdulhadi	October 1990	R. Grimm 31129
WPS525	School Effects on Achievement in Secondary Mathematics and Portuguese in Brazil	Marlaine E. Lockheed Barbara Bruns	October 1990	C. Cristobal 33640

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS526	Rural Poverty in India, 1973-86	Nanak Kakwani Kalinidhi Subbarao	October 1990	B. Rosa 33751
WPS527	Voluntary Choices in Concerted Deals: Mechanics and Attributes of the Menu Approach	Ishac Diwan Ken Kletzer	October 1990	S. King-Watson 31047
WPS528	Monetary Policy Instruments for Developing Countries	Gerard Caprio, Jr. Patrick Honohan	October 1990	W. Pitayatona-karn 37666
WPS529	The Sectoral Structure of Poverty During An Adjustment Period: Evidence for Indonesia in the Mid-1980s	Monika Huppi Martin Ravallion	October 1990	C. Spooner 30464
WPS530	The Menu Approach to Developing Country External Debt: An Analysis of Commercial Banks' Choice Behavior	Asli Demirguc-Kunt Ishac Diwan	November 1990	S. King-Watson 31047
WPS531	The World Bank's Role in Shaping Third World Population Policy	Fred T. Sai Lauren A. Chester	November 1990	L. Bruce-Diggs 31091
WPS532	Privatization in Turkey	Sven B. Kjellström	November 1990	T. Nana-Sinkan 36026
WPS533	Government Revenue from Financial Repression	Alberto Giovannini Martha de Melo	November 1990	A. Bhalla 37699
WPS534	Risk Facing U.S. Commercial Banks	Menahem Prywes	November 1990	J. Israel 31285
WPS535	Shared Investment in General Training: The Role of Information	Eliakim Katz Adrian Ziderman	November 1990	V. Charles 33651
WPS536	The Link Between Poverty and Malnutrition: A Household Theoretic Approach	Maurice Schiff Alberto Valdés	November 1990	S. Fallon 37947