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I. Introduction

A growing body of literature has examined the interaction between nutrient intake, household income, and nutritional status in LDCs and has made policy recommendations on how to improve nutrition based on empirical studies of food expenditure systems at the household level. Recent studies include those by D. F. McCarthy, K. N. Murty and R. Radhakrishna, J. Strauss, M. M. Pitt, and J. R. Behrman and A. B. Deolalikar.[1] The recommendations derived from their analysis depend critically on the definition of nutrition used in those studies.

In this article, we suggest that the definitions used in the above studies are unsatisfactory and in Section II we propose an alternative definition. This is followed by a comparison of the implications of the different definitions for the income elasticity of nutrition in Section III, for nutrition standards and malnutrition in Section IV, and for policies designed to improve nutrition in Section V. We intend hereby to further elucidate the nature of the relationship between nutrition, nutrient intake, income, and other variables discussed below. The policy implications are found to differ significantly for urban and rural areas. Section VI is the conclusion.

II. Definition of Nutrition

The studies of Murty and Radhakrishna, Strauss, and Pitt estimate food expenditure systems for a small number of food aggregates. They generally obtain income elasticities of nutrients somewhat smaller than but not significantly different from one. These are derived indirectly by estimating the income elasticities of food expenditures (also found to

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be close to one) and by assuming constant nutrient-to-food conversion factors.[2]

The constant nutrient-to-food conversion factors imply the following relation between food expenditures, nutrient intake, and non-nutrient food attributes in those studies:

$$n = \alpha F, \; q = (1 - \alpha)F, \tag{1}$$

where F = food expenditures, n = nutrient intake, q = non-nutrient food attributes, and α is a constant between zero and one.

If n and q are vectors, then

$$n_i = \alpha_i F, \; q_j = \gamma_j F; \; \Sigma_i \alpha_i + \Sigma_j \gamma_j = 1, \tag{1'}$$

and α_i, γ_j are non-negative constants.

Then, denoting the elasticity of X with respect to income, Y, by ϵ_{XY}, and given their finding that $\epsilon_{FY} = 1$, these studies conclude that $\epsilon_{nY} = \epsilon_{FY} = 1$, since $\epsilon_{\alpha Y}$ is assumed to be zero (i.e., since the nutrient-to-food conversion factor is assumed not to vary with income). It also follows that $\epsilon_{qY} = 1$.

In their article "Will Developing Country Nutrition Improve with Income? A Case Study for Rural South India," Behrman and Deolalikar examine the impact of income on nutrition. However, their findings on nutrition, N, are based on an empirical analysis of the income elasticity of nutrient intake, ϵ_{nY}, rather than of nutrition, ϵ_{NY}.

The implicit assumption of equality of ϵ_{nY} and ϵ_{NY} is that nutrition is directly proportional to nutrient intake and is not affected by other food or nonfood attributes; that is,

$$N = \beta n, \tag{2}$$

where N = nutrition and β is a positive constant.

By grouping 120 foods into six food aggregates, Behrman and Deolalikar replicate the methodology of studies that derive ϵ_{nY} indirectly from ϵ_{FY} as well as derive ϵ_{nY} more directly from the nutrient content of these 120 foods. They find that ϵ_{FY} for the six food aggregates is close to one (0.8 or higher), while for nine nutrients the elasticities ϵ_{nY} are close to and not significantly different from zero. According to equation (2), this implies $\epsilon_{NY} = 0$. Their explanation is that α in equation (1) does not remain constant as income and expenditure on food increases but, rather, that it falls. 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 that save time in their preparation, and others. Similar results were obtained for Pakistan by McCarthy, who finds that as

income rises, increases in food expenditures are allocated mostly to quality rather than quantity.[3]

We believe that neither definition is appropriate (except perhaps as a special case, as explained below). The nutrition level or nutritional status, N, of a household depends only in part on its nutrient-intake level, n. It also depends on other privately and publicly provided goods and services. In other words, the concern about nutritional status should be with the nutrition-output level, N, rather than with the level of nutrient inputs, n, which enter the nutrition production function, N.

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

$$N = N(n, q, p, k, H; S, A, L), \epsilon_{Nn}, \epsilon_{Nq}, \epsilon_{Np}, \epsilon_{Nk}, \epsilon_{NH} > 0, \quad (3)$$

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,
A = 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.

We argue that nutrition depends not only on nutrient intake, n, but also on non-nutrient food attributes, q, on nonfood privately and publicly provided inputs, p and k, and on health status, H.[4]

The non-nutrient food attributes q that may affect nutrition, N, are the freshness of the food products purchased, their cleanliness, their storability or shelf-life, and so forth. The privately provided inputs, p, which may affect N are the time and care to prepare food, including cleaning, cooking, boiling water, and other inputs (refrigerator) that ensure that the food does not get contaminated or spoiled. The publicly provided inputs, k, would include sewerage, potable water, electricity, nutritional information, and so on.[5] The absence or low level of q, p, and k may cause food products to become spoiled or contaminated. This may lead to some reduction in the degree of absorption of nutrients or, worse, to gastrointestinal and other diseases (a fall in H) accompanied by drastic reduction in the degree of nutrient absorption and thus to a reduction in the nutritional status, N (for a given level of nutrient intake, n).[6] Finally, a fall in H due to causes other than a fall in n, q, p, or k (say, because of a reduction in medical services) will result in a fall in N.[7]

We also posit that as the level of nutrient intake, n, falls to very

low levels, the impact of nutrients, n, in raising nutrition, N, becomes increasingly important while the impact of non-nutrients on N falls; that is,

$$\partial^2 N/\partial n^2 < 0 \text{ and } \partial N/\partial x \to 0 \text{ as } n \to 0 \text{ for } x = q, p, k. \qquad (3')$$

In other words, in a famine (and for a level of cleanliness of food and water such that nutrients are absorbed) the impact of non-nutrients on nutrition would tend to zero, and only an increase in nutrients, especially the basic ones (calories and proteins), would have a significant impact on nutrition, N. Thus, equation (2) is a special case of equation (3) that is valid only in the extreme case of famine, with β being an upper limit of $\partial N/\partial n$ for very low levels of n, and declining as n increases.[8]

In the case of famine, all food expenditures will thus be allocated to nutrients, and equation (1) [or (1')] is valid in this case, with α (or $\Sigma\alpha_i$) equal or close to one. Consequently, equation (1) or (1') as well as equation (2) are only valid approximations in the case of famine. And in that case, $\epsilon_{nY} = \epsilon_{NY} = \epsilon_{fY} = 1$.[9]

In a broader sense, the variable of concern is the welfare or well-being of the households in question. An important component of household welfare is the health status, H, of its members, which depends in part on their nutritional status, N. The health production function can be represented by

$$H = H(N, p, k, m; S, A, L), \epsilon_{HN}, \epsilon_{Hp}, \epsilon_{Hk}, \epsilon_{Hm} > 0, \qquad (4)$$

where m is a vector of current and lagged values of additional inputs affecting health, such as medical services, information on hygiene and child care, 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.

III. Income Elasticity

Behrman and Deolalikar have established that even at low-income levels $\epsilon_{nY} \cong 0$. Equation (3) implies that the income elasticity of nutrition, N—ϵ_{NY}—depends not only on the impact of income on n, but also on its impact on q, p, k (and H), and on the impact of those variables on N. From equation (3), ϵ_{NY} is:

$$\epsilon_{NY} = \epsilon'_{Nn}\epsilon_{nY} + \epsilon'_{Nq}\epsilon_{qY} + \epsilon'_{Np}\epsilon_{pY} + \epsilon'_{Nk}\epsilon_{kY} + \epsilon_{NH}\epsilon_{HY} \quad (5)$$
$$\equiv A + \epsilon_{NH}\epsilon_{HY},$$

and from equation (4) the income elasticity of health status is

$$\epsilon_{HY} = \epsilon_{HN}\epsilon_{NY} + \epsilon'_{Hp}\epsilon_{pY} + \epsilon'_{Hk}\epsilon_{kY} + \epsilon'_{Hm}\epsilon_{mY} \equiv \epsilon_{HN}\epsilon_{NY} + B, \quad (6)$$

where ϵ' is a row vector.

Solving for ϵ_{NY} and ϵ_{HY} from equations (5) and (6), we obtain:

$$\epsilon_{NY} = \frac{A + \epsilon_{NH}B}{1 - \epsilon_{NH}\epsilon_{HN}}, \quad \epsilon_{HY} = \frac{B + \epsilon_{HN}A}{1 - \epsilon_{NH}\epsilon_{HN}}. \quad (7)$$

We postulate that $\epsilon_{qY}, \epsilon_{pY}, \epsilon_{kY}, \epsilon_{mY} > 0$; that is, an increase in income will tend to be accompanied by an increase in the demand for food quality such as freshness, cleanliness, and taste of the purchased foods, q; in care in preparing food and in use of household appliances such as refrigerators, p; and increased availability of sewerage systems, electricity, potable water, and so forth, k.[10] Also, richer households will use more medical and other health-related services and may provide better health-related child care, m. Thus, $A > 0$ and $B > 0$, which implies:

$$\epsilon_{NY} > 0, \epsilon_{HY} > 0.^{11} \quad (8)$$

Consequently, if nutrition is interpreted according to equation (3), then the impact of income on nutrition, N, may be significant, even though nutrient intake, n, remains unchanged or increases only slightly. 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 H may be quite important. If $\epsilon_{nY} = 0$ and $\epsilon_{IY} = 1$, it follows that $\epsilon_{qY} > 1$. The fact that $\epsilon_{qY} > 1$ implies that nonnutrient food attributes are luxuries at those income levels. However, whether ϵ_{NY} and ϵ_{HY} are larger or smaller than one must await empirical analysis.[12] Clearly, if the functions N and H differ according to individual characteristics such as sex and age, so will ϵ_{NY} and ϵ_{HY}, and these factors should be accounted for in the estimation of income elasticities. Furthermore, since income affects q, p, k, and m, and since N and H depend also on the lagged values of these variables, ϵ_{NY} and ϵ_{HY} will tend to be larger in the long run than in the short run.

IV. Individual Preferences, Standards, and Malnutrition

Even in poor regions such as rural India, C. H. Shah and, more recently, J. R. Behrman and A. B. Deolalikar found that as income

increases, households demand a wider variety of food products with a larger quantity of non-nutritive attributes (e.g., freshness, taste, processing, cleanliness, etc.).[13] The actual increase in nutrient intake associated with increases in household income is not significantly different from zero. This could lead one to believe that increases in income will not lead to improvements in household nutrition. This is, in fact, the interpretation of Behrman and Deolalikar, as reflected in equation (2). They view the lack of increase of nutrient intake in the face of rising income as a problem to be resolved by policy.

Such interpretation overlooks the fact that households have the choice of spending increments in food expenditures on nutrients, n, but prefer to spend it on other food attributes, q. Subject to the existing policy and informational constraints, and starting at very low income levels, households choose to spend additional income on non-nutrient food attributes, q, rather than on nutrients, n.[14] This would seem to indicate that, rather than suffering from a lack of nutrients, they prefer even at very low income levels to spend their money on non-nutrient food attributes. In fact, depending on which elements of q are chosen, their choice (of q rather than n) might even lead to an increase in nutrition, N, or health, H.[15]

It has become common practice to estimate the number of the hungry and the undernourished by comparing caloric and other nutrient intake with requirement norms. For instance, Behrman and Deolalikar characterize their sample households as being malnourished because they tend on average to consume 80% of the recommended daily allowance of nutrients (as in C. Gopalan, et al.).[16] However, as noted above, imposing nutrient-intake standards to measure nutritional status, N, implies that, in addition to ignoring the impact of inputs q and p on nutrition, N, no weight is given to household preferences. Moreover, nutritional requirement standards have been questioned by several authors.

For instance, P. V. Sukhatme and later T. N. Srinivasan argue that the use of average nutrient requirements as the criterion for classifying a person as undernourished cannot be justified, while T. T. Poleman argues that measurement and methodological problems lead to underestimating nutrient availability and overestimating nutrient requirements.[17] This is confirmed by S. Bhalla.[18] Bhalla used the data from a Health and Nutrition Examination Survey of over 20,000 people conducted by the U.S. Department of Health, Education, and Welfare in April 1971 and June 1974 to show that, according to FAO/WHO norms, 67% of U.S. males and 80% of U.S. females have a calorie intake below requirements!

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 for 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 food attributes. Only in the extreme case of famine, with all income spent on the cheapest foods (starchy staples), would the level of nutrient intake, n, be a relevant measure of nutrition, and raising that level would become the social priority.

V. Policy Implications

Behrman and Deolalikar conclude that in order for income to have an impact on nutrition, policies must be designed to raise the income elasticity of nutrient intake, ϵ_{nY}. It would seem to us that a more important policy objective would be to raise the level of nutrition, N (or health, H) and, in case of famine, to raise the nutrient-intake level, n, of the poorer households.

McCarthy and others have suggested that policies directed at improvement in nutritional status could in fact be based on these quality effects, given that as income increases, much of the increase does not go to increased quantity. His suggestion is to tax the high-priced varieties within the various food groups (i.e., varieties with high q content) and subsidize the low-priced varieties within the same food groups. A problem with such a prescription is that it assumes that ϵ_{Nq} in (3) above is close to zero. What the net effect of such a proposal on N will be is an empirical question. It depends on ϵ_{Nq} and ϵ_{Nn}, and a priori there is no reason to expect that the net effect on N will be positive.

Education may play an important role in the nutrient-intake level, n. One might also expect the nutrition-related and health-related child care to improve with the level of the mother's education. P. Padmanabha finds that infant mortality falls both in rural and urban areas as the literacy and formal educational level of the mother increases.[19] The evidence, though, may not be entirely conclusive, as income may be positively correlated with the mother's education and was not controlled for. As for the impact of education on nutrition, M. Garcia and P. Pinstrup-Andersen find that the mother's education strongly affects the food consumption and nutritional status of preschoolers.[20]

If the concern is with the production of health, H, and taking infant mortality as one indicator of H, P. Padmanabha 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 T. Castañeda for Chile.[21] Thus, governments may have to increase the level and quality of k and m in order to have a lasting impact on nutrition and health.

Providing information and education on hygiene and child care may also be effective ways of raising nutrition, N, as well as health, H (by raising q, p, and m). For instance, provision of information via television has been very successful in raising p and m in Chile where the literacy level and TV availability is high. Where literacy level or the availability of TV is lower, direct demonstration may be necessary.

Also, policies have been designed to raise the nutrient content of some foods or food ingredients, such as food fortification programs (e.g., vitamins added to wheat flour, iodine added to salt, etc.). These programs lead to an increase in the level of nutrition, N, by raising n.

In order to devise effective policies designed to raise the level of nutrition and health for the poorer households, research efforts should be directed at the empirical estimation of the production functions N and H and thereby of the effectiveness of the various programs at the government's disposal, as well as estimation of the costs of those programs.

Finally, one would expect that the parameters of the N and H functions differ according to age, sex, income class, and rural and urban characteristics. The estimation of those parameters is part of the research agenda. But the rural/urban distinction could raise a particularly complex policy issue. For governments to provide m and k in urban areas is probably considerably less expensive than to provide it for rural areas.[22] On the benefits side, the effect on N and H of increasing the level of m and k is probably higher in urban areas, considering that the lower population densities in rural areas would reduce the need for publicly provided sewers, drinking water, and other such services.

Thus, if the low levels of N and H are a social concern, raising those levels in urban areas by increasing expenditures on k and 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 m. What then is the prescription for rural areas, if the implication is that their nutritional and health status will then largely depend on the levels of p and q, which are provided by the households? These levels depend on income, so that raising rural households' income can raise their nutritional and health status. We have come back then to the long-debated question of how best to raise farm income. One way would be to reduce the taxation of agricultural production caused by both sector-specific and economy-wide policies in LDCs.[23] Another would be to increase expenditure on those factors that raise farm and labor productivity.

VI. Conclusion

We have argued (1) that the variable to be concerned with is not nutrient-intake level, n, but nutritional status, N, or health status, H, and

that N and H depend only in part on n and will tend to increase with income, even if n does not; (2) that in the absence of extreme corner solutions (e.g., famine and starvation), findings such as $\epsilon_{nY} \cong 0$ and n being below some nutrient standard are not necessarily a sign of malnutrition but, rather, may be reflections of household preference;[24] and (3) that raising ϵ_{nY} may not be as important as raising the level of N and H for the poorest households by adding nutrients to the foods that they consume most; by providing them with nutritional information that will raise n and some of the privately provided inputs, p; by providing them with k (sewerage, electricity, potable water) and m (medical services, information on hygiene and child care, and other health-related inputs); and by raising the mother's level of education.

Behrman and Deolalikar, McCarthy, Strauss, Shah, and others have examined the relation between income, Y, and nutrients, n. Additional research aimed at determining the nature of the production functions N and H, of the relationship between Y and privately provided inputs, p and q, and of the costs of raising k and m, should help authorities identify and select cheaper and more efficient programs designed to raise the nutritional and health status of their poorer households.

This article presents a framework to help in the evaluation of public investment programs designed to raise N and H. The empirical estimation of the N and H functions for the various groups (by location [rural/urban], age, sex) in different countries is a logical next step. Such research design should consider explicitly the privately provided inputs, p and q, as well as the state of the publicly provided inputs, k and m.

Health and nutrition public intervention programs often aim at raising m and k. The parameters from the N and H functions are necessary to estimate the benefits of raising the various elements of m and k, including the benefits of the changes in the privately provided inputs, p, q, and n, as a result of the higher levels of m and k. The costs associated with those changes also should be estimated.

The costs and the benefits of raising m and k could vary significantly between rural and urban areas. We might expect that providing additional k and m (such as sewerage, drinking water, and health-related information and services) would be more costly per person in rural areas because of the lower population density, and the benefits could be considerably lower (e.g., see n. 5 above). Thus, the efficient policy for rural areas might be to reduce the rate of taxation of agriculture, a policy found in most developing countries. This would not only improve intersectoral resource allocation but, by raising income in the agricultural sector, it would lead to increases in p and q and thus in N and H.[25]

Notes

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1. Desmond F. McCarthy, "Food Consumption, Income Distribution and Quality Effects," *Food Policy* 2, no. 1 (February 1977): 79–82; K. N. Murty and R. Radhakrishna, "Agricultural Prices, Income Distribution and Demand Patterns in a Low-Income Country," in *Computer Applications in Food Production and Agricultural Engineering*, ed. Robert E. Kalman and Jesus Martinez (Amsterdam: North-Holland, 1981); John Strauss, "Determinants of Food Consumption in Rural Sierra Leone: Application of the Quadratic Expenditure System to the Consumption-Leisure Component of a Household-Firm Model," *Journal of Development Economics* 11 (December 1982): 327–53; Mark M. Pitt, "Food Preferences and Nutrition in Rural Bangladesh," *Review of Economics and Statistics* 65 (February 1983): 105–14; and Jere R. Behrman and Anil B. Deolalikar, "Will Developing Country Nutrition Improve with Income? A Case Study for Rural South India," *Journal of Political Economy* 95, no. 3 (June 1987): 492–507.

2. McCarthy found the income elasticity of food expenditure to be somewhat lower than one in Pakistan, and to fall with income for urban households but not for rural households. Other studies found the elasticity to be larger than one at very low levels of income (and only at those levels), implying that Engel's law is violated at those income levels (Michael Lipton, "Poverty, Undernutrition and Hunger," Working Paper [Washington, D.C.: World Bank Staff, 1983]).

3. However, in the case of proteins, McCarthy found low values for the income elasticity of demand for vegetable proteins but high values for animal proteins. For instance, in the case of the poorest 40% of the population, the urban elasticity was 1.48 for animal protein and 0.06 for vegetable protein, while the corresponding figures for rural areas were 2.41 and 0.24, respectively.

4. Distinguishing between the concept and an operational definition of malnutrition, N, is even analytically very difficult. As a proposition, for the analysis in this paper, it can be stated that the absence of malnutrition implies that an individual is able to maintain good health, physical activity, and energy balance over extended periods of time. There is widespread acceptance of using anthropometric indicators to assess the nutritional status of children, such as weight for age, height for age, weight for height, and weight at birth (World Health Organization [WHO], "Measurement of Nutritional Impact," WHO/FAP/79.1 [Geneva, November 1979]). However, there is still some uncertainty about the best method to evaluate nutritive status of adults (G. B. Spurr, "Physical Activity, Nutritional Status, and Physical Work Capacity in Relation to Agricultural Productivity," in *Energy Intake and Activity*, ed. E. Pollit and P. Amante [New York: Alan R. Liss, 1984]).

5. In rural areas, potable water may be provided privately.

6. Thus, p and k may affect N directly or may affect N through their impact on H.

7. Some elements of q and p are substitutes (a product purchased in a clean place will require less cleaning), and some elements of p and k are substitutes (there will be no need to boil water before cleaning food if potable water is available).

8. Behrman and Deolalikar are of course not the only ones equating nutrition with nutrient intake. For instance, in an excellent recent empirical study of

Morocco's food subsidy system and the impact of fiscally cheaper policies on consumer real income and nutrition, Laraki restricts his analysis to calorie intake even though the lower deciles in Morocco would not be considered to be in a state of famine (K. Laraki, "The Welfare, Nutritional and Budgetary Effects of Price Reform in Developing Countries: The Case of Food Subsidies in Morocco," Living Standards and Measurements [Washington, D.C.: World Bank, March 1988, mimeographed]). H is not included explicitly in equation (3'). However, when n tends to zero, N falls considerably and, consequently, so does H (see eq. [4]), and any increase in n will raise both N and H.

9. In an excellent survey dealing mostly with their work on the impact and determinants of nutrient intake, Behrman, Deolalikar, and Wolfe examine the reasons behind their findings on nutrient elasticities and present some interesting testable hypotheses both for households below the nutrient subsistence level and for those above it (Jere R. Behrman, Anil B. Deolalikar, and Barbara L. Wolfe, "Nutrients: Impacts and Determinants," *World Bank Economic Review* 2, no. 3 [September 1988]: 299–320).

10. Higher income families, especially in urban areas, live in better neighborhoods where sewerage and potable water are available, so that they have a higher level of k.

11. The denominator in eq. (7) must be positive for the system to converge.

12. That depends on the values of the other elasticities in eqq. (5) and (7).

13. Behrman and Deolalikar (n. 1 above); and C. H. Shah, "Food Preference, Poverty, and the Nutrition Gap," *Economic Development and Cultural Change* 32 (October 1983): 121–48.

14. Informational constraints about the nutrient content of various foods will probably tend to be minor for the basic nutrients (calories and proteins) but may be more important for the other nutrients.

15. N will be lower if, rather than n, they choose taste only. If they choose food freshness, cleanliness, or shelf life (as well as other nonfood nutrition inputs, p), then N and H might be higher.

16. C. Gopalan, B. V. Rama Sastri, and S. C. Balasubramanian, *Nutritive Value of Indian Foods* (Hyderabad: National Institute of Nutrition, 1971).

17. P. V. Sukhatme, "Malnutrition and Poverty," Ninth Lal Bahadur Shastri Memorial Lecture, New Delhi, January 29, 1977; T. N. Srinivasan, "Hunger: Defining It, Estimating Its Global Incidence, and Alleviating It," in *The Role of Markets in the World Food Economy*, ed. D. Gale Johnson and G. Edward Schuh (Boulder, Colo.: Westview Press, 1983), pp. 77–108; and Thomas T. Poleman, "World Hunger: Extent, Causes, and Cures," in Johnson and Schuh, eds., pp. 41–75.

18. Surjit Bhalla, "Measurement of Poverty: Issues and Methods" (Washington, D.C.: World Bank, 1980, mimeographed).

19. P. Padmanabha, "Mortality in India: A Note on Trends and Implications," *Economic and Political Weekly* (Bombay) 17 (August 7, 1982): 1285–90.

20. M. Garcia and P. Pinstrup-Andersen, *The Pilot Food Price Subsidy Scheme in the Philippines: Its Impact on Income, Food Consumption, and Nutritional Status*, IFPRI Research Report no. 61 (Washington, D.C., August 1987).

21. Tarcisio Castañeda, "Determinantes del Descenso de la Mortalidad Infantil en Chile, 1975–1983" (Determinants of the decrease in child mortality in Chile, 1975–83), *Cuadernos de Economia* (Santiago) 22, no. 66 (August 1985): 195–214. He finds that the major factors in the 82% decline in infant mortality between 1955 and 1983 are the increase in the household coverage of

potable water and of sewerage, in the frequency of health controls for pregnant women, and in the availability of subsidized milk for pregnant women, but that milk to infants and preschoolers is not a major factor.

22. In rural areas, sewers, drinking water, and information (e.g., direct demonstration) would have to be provided over large areas, which would make the provision of such services per household very costly.

23. An analysis of the impact of those policies for 18 developing countries is provided in A. O. Krueger, M. Schiff, and A. Valdes, "Agricultural Incentives in Developing Countries: Measuring the Effect of Sectoral and Economywide Policies," *World Bank Economic Review* 2, no. 3 (September 1988): 255–71.

24. Behrman, Deolalikar, and Wolfe recognize that possibility in their 1988 article (n. 9 above).

25. First, the relative costs and benefits of raising k and m in urban and rural areas (as well as the functions N and H) require empirical verification. Second, reducing the rate of taxation of agriculture (either direct, sector-specific taxation or indirect taxation due to overvaluation of the real exchange rate or industrial protection) will raise income for agriculture as a whole since the sector is a net seller of agricultural products. However, the income effect on small farmers who are net buyers of food is ambiguous, as the higher food price accompanying reduced taxation would raise the cost of their food purchases on the one hand but, on the other hand, would raise the demand for their labor.