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NUTRITION AND INCOMES: TIGHTLY WEDDED OR LOOSELY MESHED?

by

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FOREWORD

The Cornell Food and Nutrition Policy Program (CFNPP) was created in 1988 within the Division of Nutritional Sciences to undertake research, training, and technical assistance in food and nutrition policy with emphasis on developing countries. The Nutritional Surveillance Program (CNSP), which was formed in 1980 with support from the Agency for International Development, is part of the CFNPP.

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This lecture, which was presented by Dr. Jere Behrman is the third of six lectures planned for the Fall 1988. In this lecture Professor Behrman addresses the relationship between changes in household incomes and changes in energy and nutrient consumption and the nutritional status. Professor Behrman concludes that, although of obvious importance for the welfare of the poor, increasing incomes may result in much smaller increases in energy and nutrient intakes than previously expected. Therefore, contrary to widespread claims, efforts to alleviate poverty may not be the single most important solution to the nutrition problem.

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NUTRIENT INTAKES AND INCOMES: TIGHTLY WEDDED OR LOOSELY MESHED?

by

Jere R. Behrman[1]

Inadequate nutrition is thought to be a widespread problem in the developing world. Estimates vary, but agreement seems broad that hundreds of millions of individuals in these countries are undernourished. One widely held view is that until the economic development process generates appreciable improvement in per capita income, the situation will remain largely unchanged. The World Bank, for example, states this position forcefully: "There is now a wide measure of agreement on several bread propositions.... Malnutrition is largely a reflection of poverty: people do not have income for food. Given the slow income growth that is likely for the poorest people in the foreseeable future, large numbers will remain malnourished for decades to come.... The most efficient long-term policies are those that raise the income of the poor" (World Bank, 1981: 59).

Some recent estimates of nutrient (usually calorie[2]) intake elasticities with respect to income or total expenditure seem to support the

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[1]I thank Per Pinstrup-Andersen, the organizer for this lecture, and a number of other individuals in attendance for questions and comments that helped to improve this paper.

[2]In this lecture the term "nutrients" is used primarily to refer to calories because in many contexts undernourishment is equated with inadequate calories in the diet and because most of the empirical socioeconomic work focuses on calories, although other nutrients often also may be included.

World Bank[3] emphasis on the interrelationship between changes in income in poor populations and number of calories consumed. An elasticity of 0.8 is reported for poor households in Sri Lanka by Sahn (1988) and for rural households in Bangladesh by Pitt (1983); 0.9 was found for rural Sierra Leone households by Strauss (1982) and for rural Nigerian households by Pinstrup-Andersen and Uy (Alderman 1986a); and an elasticity of 1.2 was calculated for lower-income Moroccan households by Mateus (1985). Such estimates suggest that nutrients and income are "tightly wedded" in the sense that percentage changes are more-or-less similar in both. If this is the case, the World Bank type emphasis on the postulation that income growth plays a critical role in alleviating undernourishment in the developing world well may be justified.[4]

The estimates summarized in the previous paragraph are at the upper end of the range of recent estimates. There also are a number of estimated elasticities of calories (as well as of other nutrients) with respect to income of 0.1 or less for Nicaragua (Wolfe and Behrman 1983; Behrman and Wolfe 1984), Sri Lanka (Scandizzo and Knudsen 1980), Chile (Harbert and Scandizzo 1982), rural South India (Behrman and Deolalikar 1987a; Bhargava 1988), rural Indonesia (Pitt and Rosenzweig 1985; Ravallion 1988a), low-income households in urban Brazil (Alderman 1986a), and

[3]The World Bank is not a completely homogeneous institution in regard to beliefs about the magnitude of nutrient elasticities with respect to income. Some World Bank staff members (e.g., Reutlinger and Selowsky, 1976; Berg, 1973) seem to suggest that these elasticities are much smaller than does the above quoted statement. However, in this paper the "World Bank view" is used to refer to the position espoused in the 1981 *World Development Report*.

[4]Undernourishment may be a reflection of conditions other than just inadequate nutrient intakes, such as diseases that can prevent the body from using an adequate diet. However, sufficient nutrient intakes, which are the focus of this paper, widely are thought to be of major importance in avoiding undernourishment. This is further emphasized by the World Bank, quotation given above.

low-income households in the rural Philippines (Bouis and Haddad 1988). If such estimates are valid, nutrient intakes and income are better characterized as "loosely meshed" than as "tightly wedded." In these cases, income changes were associated with much less than equal percentage differences in nutrient intakes. Thus, contrary to what the World Bank quotation suggests, the elimination of poverty may not always be the answer to improving nutrition.

In this paper, I first review how many (most?) economists view the linkages between income and nutrient intakes. Then, I review some recent empirical evidence on these linkages. Finally, I consider the implications of these estimates.

SECTION 1. *A PRIORI* CONSIDERATION OF LINKS BETWEEN INCOME AND NUTRIENT INTAKES

Economists consider both income and nutrient intakes to be dependent on household decisions that are the outcome of maximization of household preferences[5] which are subject to constraints imposed by the household assets (human, physical, and financial), market prices, and household production functions. Household preferences are posited to depend, *inter alia*, on the health (H_i), consumption (C_i), and leisure (L_i) of each of the individuals (I) in the household:

$$(1) \quad U = U(H_i, C_i, L_i, \ldots), \quad i = 1, \ldots, I.$$

Note that I have not explicitly included nutrient intake in this preference function because nutrients are not valued directly in and of themselves but because of their effect on health (and therefore affect satisfaction through H_i) or simply because they are consumed as part of food, which directly affects satisfaction (through C_i). That is, people may gain satisfaction from the taste, variety, status value, and health provided by eating food, but not from the consumption of niacin or other nutrients per se.[6]

There are two sets of constraints on the preference maximization of the household. First, there are household production functions. Perhaps the most important of these for the purpose of this paper is the health production function that determines the health of each individual as a function of nutrient intakes (N_i), consumption of goods and services (C_i), the individual's endowments (E_i),[7] and time use of the individual (T_i, including as one element, leisure), among other determinants (e.g.

[5]Economists often assume that household preferences are maximized without explicit consideration of how individual preferences are combined to form household preferences. Some have been very critical of this assumption because it seems to ignore what appear to be bargaining processes among household members (e.g. Folbre 1984). While there have been some bargaining models developed for intrahousehold allocations, to my knowledge no empirical estimates are available that convincingly indicate that such bargaining models are preferable to the assumed maximization of unified household preferences or vice versa. The problem is that most data sets do not permit identification of the individual's bargaining power versus the value of an individual's time. Thus, attribution of the significance of a person's schooling, wage, or income in the determination of intrahousehold allocation decisions does not indicate that bargaining models are important (nor that unified preferences are a preferred assumption) despite some claims to that effect. (for further discussion of this point, see the interchange between Folbre 1984 and Rosenzweig and Schultz 1984 or the discussion in Behrman and Deolalikar 1988c or in Behrman 1988c). Because most estimates of income-nutrient relations by economists are based on household data (with a few exceptions such as Behrman and Deolalikar 1988a and Garcia and Pinstrup-Andersen 1987), in this paper I focus on household nutrient intake determinants (for a survey of estimated relations that reflect intrahousehold allocations of nutrients, see Behrman 1988c). Because available estimates do not permit a confident identification between bargaining and maximization of unified household preferences, for simplicity I write as if the latter is occurring even though the former may seem more plausible *prima facie* to many.

[6]Nothing that follows in this section explicitly depends on this assumption. However, the observation is important because presumably for many purposes our ultimate interest is in the welfare of individuals, while interests in nutrient intake occurs only to the extent that it affects welfare.

characteristics of the primary health care provider in the household, usually an adult woman):[8]

$$(2)\quad H_i = H(N_i, C_i, E_i, T_i, \ldots), \quad \text{for each } i.$$

Note that while nutrients are posited to be an important input into the maintenance of health, they are not assumed to be the only input. As a result, only under very special conditions is nutrient intake likely to be perfectly correlated with health status or vice versa.[9] It is even possible that nutrients are allocated so as to compensate for endowments and therefore are negatively correlated with health status.[10] Even though it only is a matter of semantics, it seems best to avoid using terminology that equates anthropometric, energy expenditure, clinical and disease indicators of health with nutrients alone (e.g., such as "nutritional status") because they need not even be positively and probably are not perfectly correlated with nutrient intake.[11]

A second production function of importance for the topic under discussion is that for the nutrient intakes themselves:

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[7]Endowments include genetic endowments, but also may include environmental endowments related to the household and the community of residence.

[8]All the variables can be vectors.

[9]The conditions are analogous to those described in Behrman (1987), which dealt with the case of the perfect association of child quality (or, equivalently, health) with child schooling (or, nutrient intakes).

[10]There is evidence of this in the (relatively) surplus season in rural south India (see Behrman 1988a;b).

[11]It would be equally plausible and equally confusing to equate such indicators with "consumption status," "genetic endowment status," "leisure status," "good water status" etc. because of all these factors also are related to health as reflected in anthropometric indicators, clinical measurements such as blood tests, and disease experience.

(3) $N_i = N(C_i, \ldots)$, for each i.

Obviously these nutrient intakes depend upon the consumption of food in C_i. The important point to note is that this is not likely to be a fixed coefficient relation because of variations in food preparation and wastage, both of which may vary with income and with prices. For many of the households of interest, labor productivity in own farm/firm activities and/or in paid employment may depend on health and/or on nutrient intakes. If so, there are additional production functions for own farm/firm output (Q) and for wage rates (Wi) that depend on health or nutrient intakes:

(4) $Q = Q(H_i, N_i, \ldots)$, for all $i = 1, \ldots, I$ and

(5) $W_i = W(H_i, N_i, \ldots)$, for each i.

The greater the percentage labor income is of total household nominal income, the more important are health and nutrient intakes in determining labor productivities, and the closer the association between nutrient intakes and health, the stronger is the income-nutrient relationship. This is because of the labor productivity link in addition to any connection caused through the pure demand effect of income on nutrient intake.

Second, there is a full-income constraint, which values the total resources of the household and indicates how those resources are used. The total resources of the household include the value of the total time of all of the household members ($W_i T_i^T$ summed over all I household members) plus the value of farm/firm production minus the cost of purchased inputs used in that production ($P^Q Q - P^F F$) plus the returns from physical and financial assets owned by the household other than those used in own farm/firm production (rA_n) plus net subsidies plus net transfers minus taxes ($S + Tr - Tx$). The uses of these resources include

consumption ($P^C C_i$ summed over all I household members) plus leisure ($W_i T_i^L$ summed over all household members) plus net total asset changes (ΔA):

$$(6)\ \sum_I W_i T_i^T + P^Q Q - P^F F + rA_n + S + Tr - Tx$$
$$= P^c \sum_I C_i + \sum_I W_i T_i^L + \Delta A$$

Note that full income is not what is usually used in studies concerned with the association of income with nutrients. Instead, what might be called nominal or monetary equivalent income is substituted. This differs from full income by not placing any value on leisure time. Also, note that such a measure of income is endogenous if there is any choice about how much labor time to supply versus how much time to devote to leisure activities. Because generally a large portion of total time is spent at leisure (e.g. for Philippine farmers, Behrman and Lanzona 1988 report means of over 15 hours per day for all demographic-seasonal combinations), small changes in leisure time may change labor earnings and therefore nominal income considerably.

Reduced-form relations can be derived from the maximization of preferences in equation (1) subject to the constraints in equations (2) through (6) (plus any other relevant constraints caused by other household production functions not explicitly listed above). There is one reduced-form relation for each endogenous variable in the system, including (but not limited to) household nominal income (Y) and food and other consumption (C_i), nutrient intakes (N_i), and health (H_i) for each individual household member. The right-side variables are ones that are exogenous or predetermined from the point of view of the household in the relevant time period, including (but not limited to) all of the prices (P^C, P^Q, P^F, r),[12] predetermined assets of all types (physical, financial, and human), endowments (E_i), policies (including the terms of provision of

services and tax and subsidy rates) and community characteristics.[13] These relations do not directly show the association between nominal income and nutrient intakes, although they do indicate how both nominal income and nutrient intake vary in response to a change in an exogenous variable such as the price of rice.

To estimate relations between income and nutrient intakes, economists generally calculate food or nutrient demand relations, which conceptually can be obtained from the reduced forms just described by substituting the reduced form for nominal income (or for some major component of income, such as net profits from farm/firm activities) into the reduced forms for household food or for nutrient intakes. This leads to demand equations of the following form:

$$(7)\quad C = C(P^C, Y, E_i, \ldots) \text{ and}$$

$$(8)\quad N = N(P^C, Y, E_i, \ldots).$$

The estimated association between nominal income (or net profits plus unearned income) and nutrients in equation (8) or between food consumption and income (or net profits plus unearned income) in equation (7), after food is translated into nutrient intakes using conversion factors, is interpreted to indicate how responsive nutrient intakes are to changes in

[12]In the special case in which wages do not depend on current consumption decisions through nutrition and health effects on labor productivity, the W_i also are included among these prices. If wages do depend on consumption, the local wage structure, which indicates what wages individuals receive for different labor productivities, is exogenous from the point of view of the household, though not the actual wages received by individual household members.

[13]Treating community characteristics as predetermined, as is normally done, assumes that the location is fixed and that governmental decisions that affect community characteristics are not caused by unobserved community characteristics (e.g., see Rosenzweig and Wolpin 1986).

income. Behrman and Deolalikar (1987a) refer to the direct estimation of nutrient intake elasticities in equation (8) as "direct estimates" and the estimation of nutrient intake elasticities with respect to income by applying food-to-nutrient conversion factors to the estimates of equation (7) as "indirect estimates." A number of economists (perhaps most strongly Pitt 1983, but also Strauss 1982 and Murty and Radhakrishna 1981) argue that the preferable procedure is to use indirect estimates. This is because there are a number of prior restrictions from economic theory on the coefficients of a system of relations for consumer demands for goods and services, such as in equation (7), that permit more efficient estimation; however these do not apply to equation (8) because of the joint product way in which nutrients are "produced" from food intakes in equation (3). Whichever of these approaches is taken, if there are labor productivity effects caused by current consumption or any other reasons such that income cannot be determined separately from consumption (e.g., incomplete markets, risk aversion), simultaneous estimators should be used or if income is treated as predetermined, the assumption should be tested (e.g. Pitt and Rosenzweig 1985 or Bhargava 1988) to avoid simultaneity bias.

While such an approach does allow us to predict the effect of income on nutrient intake, it does not indicate the magnitude of the effect. There are many links in the chain between income changes and nutrient intakes that offer opportunities for slippage. (1) If economic development leads to an upward shift in the wage structure caused, say by growth in productivity derived from improved technology or more capital stock, part of the increase in full income may be invested in additional leisure (if the income effect on the demand for leisure outweighs the price effect or expense of leisure). Thus, nominal income may be altered differently than full income. (2) Part of the rise in nominal income may be saved rather

than spent on current consumption of goods and services.[14] (3) A portion of increased expenditure on consumption of goods and services may go to nonfood purchases. In fact, most estimates for many societies suggest that the elasticity of expenditures on nonfood items is likely to be higher than the elasticity of expenditures on food, although there are a few exceptions documented among the ultra-poor in India, Northern Nigeria, and Sri Lanka (Deaton 1981; Poleman 1981; Lipton 1983; and Edirisinghe 1987).[15] (4) Part of the increased food expenditures may go to feed guests, friends, employees, and religious and other supplicants. Bouis and Haddad (1988), Ravallion and Dearden (1988), Rosenzweig (1986) and Behrman and Deolalikar (1987b), for example, document that such interhousehold transfers may be on an order of magnitude of one-tenth of nominal income in various Asian societies. (5) Increased expenditure on food for household members may be used to alter food composition to obtain nonnutrient food attributes such as flavor, status value, appearance, aroma, and variety. These are not necessarily highly correlated with the nutrient content of food (Lipton 1983; Shah 1983; Behrman and Wolfe 1984; and Behrman and Deolalikar 1987a). (6) In the course of food preparation more may be wasted because scarcity is less of a problem, there may be diminishing marginal satisfaction from food, and the opportunity cost of time spent in preparing and conserving food is higher.

SECTION 2. EMPIRICAL ESTIMATES

That there may be a number of slips between increases in income and nutrient intake increases does not mean that there is necessarily a

[14]This may eventually (but not immediately) lead to increased expenditure.

[15]See my comment on these estimates in Section 3 below.

loose relationship between nominal income and nutrients. The question is basically of an empirical nature. Of course there are a number of issues in making and interpreting empirical estimates. I now review six of them, and the available evidence.

Level of aggregation at which nutrient conversion factors are applied: Two alternative strategies are followed to estimate the nutrient intake demand response to income. One is the "indirect" method. The expenditure system for different food groups in equation (7) is estimated, and food-to-nutrient conversion factors are applied to the estimates to obtain nutrient elasticities with respect to total expenditure or nominal income. As noted above, some have argued that this is a superior procedure because standard restrictions derived from economic theory can be imposed or tested. The second alternative, the "direct" method, directly estimates nutrient intake response to income from equation (8). At this level of abstraction, there seems to be little to recommend one procedure over the other except for the advantage of the ability to factor in more aspects of economic theory with the first approach. In practice, however, the two approaches differ substantially in the level of aggregation at which the food-to-nutrient conversion factors are typically applied. Researchers using the food expenditure approach usually aggregate food expenditures into about ten groups[16] to keep the econometric system estimates tractable and apply the food-to-nutrient conversion factors at that level of aggregation. The direct nutrient estimates, in contrast, are usually based on application of food-to-conversion factors at a much more detailed level, often 100 food categories or more. The reason that the level of aggregation makes a difference is that the nutrient elasticity with respect to income is equal to the food expenditure elasticity with respect to

[16]For example, Sahn (1988) uses 13 food groups, Murty and Radhakrishna (1981) and Pitt (1983) use nine food groups, and Strauss (1982) use five food groups.

income minus the nutrient's average price elasticity with respect to income.[17] However, the intragroup substitutions among foods that occur when income rises and that may result in an increase in the price paid per nutrient are ignored. Therefore, if there is substantial intra-food-group substitution among foods induced by higher income, nutrient intake elasticities with respect to income are likely to be overestimated. This is more likely to be important the higher the level of aggregation at which the food-to-nutrient conversion factors are applied.

At least two types of empirical evidence are available regarding the issue of aggregation. The first pertains to the relationship between nutrient prices and income. All of the available evidence of which I am aware suggests that they are positively associated (e.g., Pitt (1983) on Bangladesh, Radhakrishna (1984) on India, Williamson-Gray (1982) on Brazil and, Behrman and Deolalikar (1988d) on cross-country estimates). The second includes estimates of nutrient intake elasticities calculated with both direct and indirect methods. Substantially lower nutrient elasticities are uniformly found with respect to income for the latter than for the former. In the case of rural south India, Behrman and Deolalikar (1987a) report estimates of about 0.8 for the indirect method, while direct estimates yielded less than half as much and were statistically insignificant for calories and a number of other nutrients. A number of other recent studies similarly report food expenditure elasticities about twice those of calorie elasticities: Garcia and Pinstrup-Andersen (1987) for rural Philippines, Greer and Thorbecke (1984) for a rural Kenyan sample, Kumar (1987) for Kerala, India, Alderman (1986b) for Karnataka, India,

[17]Although most studies that advocate the superiority of the indirect method estimate food expenditure systems, some estimate food quantity demands. In that case, the condition described here is modified and the food expenditure elasticity with respect to income is replaced by the food quantity elasticity with respect to income plus the food price elasticity with respect to income.

and Reutlinger and Selowsky (1976) and Behrman and Deolalikar (1988d) for cross-country samples.

These studies are consistent with the suggestion of Behrman and Deolalikar (1987a) that the level of aggregation significantly affects the results and that if food-to-nutrient conversion factors are applied at a high level of aggregation, such as in Strauss (1982), Pitt (1983), Sahn (1988), and Murty and Radhakrishna (1981), true nutrient intake elasticities with respect to income are likely to be overstated. Although these studies reported figures of 0.8 or higher, based on comparisons between the direct and the indirect approaches, the true elasticities are likely to be one-half or less.

Availability of nutrients versus nutrient intakes: As noted in Section 1, not all available nutrients are actually consumed by household members because a portion is always given to other individuals, is lost in preparation, and/or is wasted. Most socioeconomic data sets do not contain much of this type of information. In the rural Philippine sample, however, Bouis and Haddad (1988), found that food provided to laborers, guests and others accounted for a substantial difference between the estimated responsiveness of household nutrient availability and nutrient intakes of household members to total changes in expenditure. Their OLS estimate of the elasticity of nutrient availability with respect to total expenditure (with no control for observed leaks nor for measurement error) was 0.47. Their preferred estimate with such controls (as well as with a control for unobserved fixed effects and measurement error in calorie availability) was 0.05. They attribute, with qualifications, over one-half of this difference to errors in measuring leaks and to a failure to subtract food served to guests and laborers from nutrient availability for the 0.47 estimate. Thus, the distinction between food availability and food intake, which is not made in many studies, appears to be a very important in this

sample and quite possibly is in others as well.[18]

A further dimension to the distinction between food availability and food intake, not discussed by Bouis and Haddad, is that if expenditure surveys used to calculate estimates cover only short periods and "lumpy" purchases are made, there is the danger that further upward biases will be introduced. This problem perhaps can be best illustrated by considering a simple example. Assume that there are two poor households that are identical in all respects, except one. Both households depend on rice as the staple food, and purchase in bulk once every two months. The only difference between the households is when they purchase rice (all other food items are purchased equally every week). Household one purchases two months' worth of rice during the two-week survey reference period, accounting for five-eighths of its food expenditures and one-half of its total expenditures, but household two consumes rice left from purchases made before the reference period commenced, although it had otherwise identical expenditures. Assume further that the other food items purchased by the two households have one-half of the nutrients per rupee of expenditure that has rice. Under these assumptions, household one added 433 percent as much to its availability of nutrients as did household two, with 200 percent as much total expenditure in the reference period. Thus, one might be tempted to conclude that the elasticity of nutrients with respect to total expenditure is over two (433 percent/200 percent). But the true elasticity of nutrients with respect to total expenditure over a longer period cannot be calculated from these data and may be any value, including as low as 0.05 that Bouis and Haddad prefer for their Philippine

[18]Bouis and Haddad (1988) correctly point out that what Behrman and Deolalikar (1987a) attribute to aggregation problems may in part be caused by the availability versus intake distinction. Neither Bouis and Haddad nor Behrman and Deolalikar (nor anyone else to my knowledge) present estimates that confidently can be used to distinguish between the aggregation problem and the availability-intake distinction.

sample! I am not sure to what extent lumpy purchases can cause problems in estimating nutrient elasticities from expenditure surveys, but often such surveys have reference periods of a week or two. Sometimes they indicate that households acquired less nutrients than is thought to be necessary for survival during the reference period Thus, such a phenomenon may be important for some studies.[19]

Correlated measurement error in nutrients and in total expenditures: Bouis and Haddad (1988) also note that if available nutrients are estimated based on food expenditures, as is done in many studies, measurement error will be correlated with error in total expenditures, which implies an upward bias in the estimated nutrient expenditure association. This will probably be a more significant problem for poorer households than for richer ones because food purchases are likely to account for a larger share of total expenditures and to be more erratic (resulting in more measurement error). As noted above, Bouis and Haddad claim that measurement errors in their sample account for a substantial proportion of the upward bias in OLS estimates of the association between nutrients and total expenditure.

Simultaneity of income: If labor productivity depends on health

[19]Pinstrup-Andersen has told me that for many nutritional studies such as the cash-cropping studies of IFPRI, the practice is to ask how often food of various types is bought and how much is purchased over a reference period that is sufficiently long to assure an average. This suggests that some researchers consider the possibility of the importance of lumpy food purchases. However, ordinary consumer surveys that often are used to estimate nutrient intake elasticities with respect to expenditure (e.g., at least seven of the nine sources cited in the note to Table 9 in Alderman 1986a appear to be general purpose household surveys) generally do not adjust the reference period to reflect differences in the patterns of food purchases and thus may be subject this problem. And in some instances purchases of basic staples apparently are lump. For instance, *The Economist* (p. 49) of 15 October 1988 claims that in Algeria the coarse wheatmeal used to make couscous, the national dish and the basic staple, are not available in quantities smaller than 50 Kilo bags.

and nutrient intake, there may be a simultaneity bias in OLS estimated responses of nutrients to income because the positive impact of nutrients on income through labor productivity may bias upward the estimated effect of income on nutrient intake.[20] Several recent studies present evidence that labor productivity in poor rural populations does depend on health and nutrient intakes, even when the latter are controlled for simultaneity: Strauss's (1986) estimates for Sierra Leone, Sahn and Alderman's (1988) estimates for Sri Lanka, and Deolalikar's (1988) and Behrman and Deolalikar's (1989) estimates for rural south India. For this reason authors of many of the more recent studies tested for simultaneity or used a simultaneous estimator. Pitt and Rosenzweig (1985) and Bhargava (1988), for example, tested formally and found that simultaneity was not a problem in their estimates for rural Indonesia and India, respectively. Behrman and Deolalikar (1987a) gave instrumental estimates in their study of rural south India, but reported that these estimates did not differ very much from OLS estimates. Bouis and Haddad (1988) found that control for simultaneity substantially reduces the nutrient availability-expenditure association, but not the association between nutrient intakes (which they argue is a superior measure for reasons described above) and income or expenditure. Thus, it appears from the studies to date that simultaneity bias may not be a major problem in estimating nutrient intake responses to income.

Dynamics and permanent versus transitory effects: The approach outlined in Section 1 is for a period of an indeterminate length, but that implicitly includes a number of years. However, actual estimates of nutrient-income relations cover much shorter periods of observation,

[20]As is noted above, there may be simultaneity bias for other reasons as well, including incomplete markets or risk aversion. However, the direction of any bias in the nutrient response to income may be up or down, depending on the exact nature of the simultaneity.

usually one year or less. Because an adequate supply of various nutrients is among the most basic of necessities, plausibly nutrient intakes reflect permanent or long-run income, but fluctuate relatively little in response to transitory income changes. If so, most of the estimated nutrient-income associations may be downwardly biased because they are founded on cross-sectional data, which may be contaminated with substantial transitory income. Thus, using more permanent income measures or allowing for longer-run adjustments as income changes might lead to higher nutrient responses to income. Perhaps somewhat surprisingly, however, the available empirical evidence does not suggest that longer-run and dynamic effects cause large biases in estimated income-nutrient relations. The only study that specifies dynamics is the reexamination of the rural south Indian data set used by Behrman and Deolalikar (1987a) by Bhargava (1988). He found significant evidence of adjustments in food and nutrient demands, reporting more precise estimates of the nutrient response to income than that obtained by Behrman and Deolalikar. But the magnitude of the response that he obtained is still very small—a caloric elasticity with respect to income of about 0.1. Behrman and Deolalikar (1988a) also re-estimate nutrient demand relations for this sample with a permanent income measure based on nine years instead of current income. They find no evidence of a stronger role for permanent than for current income. While Bhagarva's study explicitly specified the dynamics and Behrman and Deolalikar's study explicitly represents permanent income, in a sense all of the studies that treat income or expenditure as simultaneously determined at least partially control for permanent income because the estimated income measure typically depends on longer-run determinants such as physical and human assets. As noted above, this generally does not seem to systematically alter the estimated income-nutrient relation.

Omitted variable biases: The reduced-form demand relations in equations (7) and (8) show that there are a number of other variables in addition to prices and income, which are usually included in estimated versions that should be included. Among these are all of the household's predetermined physical and human assets and all individual, household, and community endowments. For at least one data set extensively examined in recent studies, one variable—women's education—seems to be an important determinant of household nutrition (studies on Nicaragua by Behrman and Wolfe 1984; 1987; 1988; and Wolfe and Behrman 1983; 1987). If variables such as this one are important in a model and are correlated with income, their omission will cause omitted variable bias (most likely upward) in the estimated response of nutrient intakes to income. Most available studies do not control for this possibility. However, there is some evidence in the fixed-effect estimates for data from rural south India (Behrman and Deolalikar, 1987a; 1988a and Alderman 1986b) and from the rural Philippines (Bouis and Haddad 1988). These estimates do not show that a strong systematic bias is likely to result if unobserved fixed effects are not controlled, although in some cases, these estimates are substantially higher or lower than those made without control for fixed effects.

SECTION 3. IMPLICATIONS OF AVAILABLE ESTIMATES

Although estimates of the nutrient response to income have some problems, which were discussed in the previous section, some tentative implications still can be drawn.

First, the estimates increasingly suggest to me that nutrient elasticities for poor people in developing countries with respect to income generally are fairly low and are much lower than are food expenditure elasticities with respect to income. The problems with many of the

existing nutrient elasticities are threefold: 1) they are based on the indirect estimation method at a relatively high level of aggregation for food groups, 2) they do not distinguish between nutrients available and nutrients consumed by household members, and 3) they do not control for measurement errors. For the poorest or during times of famine (Sen 1981; Ravillion 1988b; and others) the elasticities may be higher, but I see the evidence as suggesting that this is not the case for most poor people most of the time.

The estimates by Lipton (1983) and Edirisinghe (1987) are interpreted to mean that nutrient elasticities with respect to income are very high for the ultra-poor because, for such households, in Lipton's (p. 42) words "Engel's Law does not operate" (i.e., food expenditures increase more than total expenditures) and because the composition of food consumption is relatively constant. But the evidence to date on these points is not completely persuasive for at least two reasons. First, the apparent nonoperation of Engel's Law may only reflect the lumpiness of food purchases discussed with regard to the distinction between nutrient availabilities and nutrient intakes in Section 2. The example given there, for instance, could be interpreted to illustrate the failure of Engel's Law since household two spends 60 percent of its expenditure in the reference period on food and household one spends 80 percent of its expenditure on food with a higher total expenditure. But this appearance is an artifact of the data collection procedure. For both households in fact Engel's Law may hold in that over a long enough reference period food expenditure may increase less than proportionally to total expenditures. Second, the claim about the lack of much food compositional change is based on the relative stability of the share of cereals or cereals plus root crops in total food expenditures. But substantial compositional changes that affect average nutrient prices can and apparently do occur within the cereal plus

root crops food category which change from broken to whole grains, from less to more processed grains, from root crops to cereals, from "inferior" to superior grains, etc. Thus, even for the ultra-poor, nutrient elasticities with respect to income may be a lot smaller than is often assumed.

Second, if nutrient intake elasticities with respect to income are much lower than food elasticities with respect to income, what food attributes are poor people purchasing? Possibilities are many, including flavor, appearance, level of processing, status value, and variety. Most data sets, however, do not provide much information that could be used to answer this question. Several do permit the estimation of elasticities of various nutrients with respect to income, and these suggest that the elasticities for some nutrients are higher than are those for calories. Thus, to a certain extent, low calorie intake elasticities may reflect compositional choices made to obtain more of certain other nutrients when incomes increase. However, the intake elasticities of other nutrients, while greater than those for calories, are not as high as are those for food elasticities. Therefore, compositional choices among nutrients as income increases only can explain part of the low calorie elasticities with respect to income. Most large socioeconomic data sets do not permit representation of the other possible food attributes that could help cause the low nutrient elasticities. However, Behrman and Deolalikar (1988b) and Behrman, Deolalikar, and Wolfe (1988) argue that food variety in itself may be desirable and may be purchased as income arises.[21] They suggest three dimensions of food preferences that might underlie a taste for food variety and that are illustrated in a very stylized way in Figure 1. (1) At very low income levels, there may be a minimum survival constraint that indicates minimal calories needed to survive, as represented in the figure by the line SS′ on which preferences collapse (so the preference curves are

[21]Lipton (1983) makes the same suggestion.

represented by dashed lines below SS$'$) since there is no tradeoff of interest between the two types of food below survival. Note that such a constraint means that if income increases from an initially very low level, which implies concentration on consumption of the basic staple such as at point A, initially all of the additional income is spent on purchasing food variety by buying the nonstaple without any additional calories obtained by moving along the survival constraint to a point such as B.[22] (2) Above the survival constraint, there is a question of how "central" are the preference curves, with increasing taste for variety as income increases being reflected in reference curves that move away from the staple food axis as income increases so at given relative food prices, food consumption is increasingly less concentrated on the staple, moving from points such as D to E in the figure. (3) Also, above the survival constraint, an increasing taste for variety may be reflected in preference curves of increasingly sharp curvature so that more food variety is consumed for a range of relative prices rather than concentrating on the relatively cheaper food as occurs at lower income levels (e.g. preference curve U5 versus U3 in the figure). Behrman and Deolalikar (1988b) developed an empirically tractable model to estimate the last two of these elements of taste for variety and, using international data, found evidence that both are significant. Thus, a taste for food variety may be part of the explanation for the low nutrient intake elasticities with respect to income.

[22]The slope of the budget line is steeper than that of the survival constraint if the staple food is the cheapest source of nutrients needed for survival. If there were no survival constraint, initially a point C with greater food variety would be selected. Given relative prices, as incomes rise, the optimal combination of foods moves down the survival constraint (with no change in nutrients, but greater variety) until the income constraint is tangent with the preference curve on the survival constraint. Further, income increases move the optimal choice away from the survival constraint and boost nutrient intake.

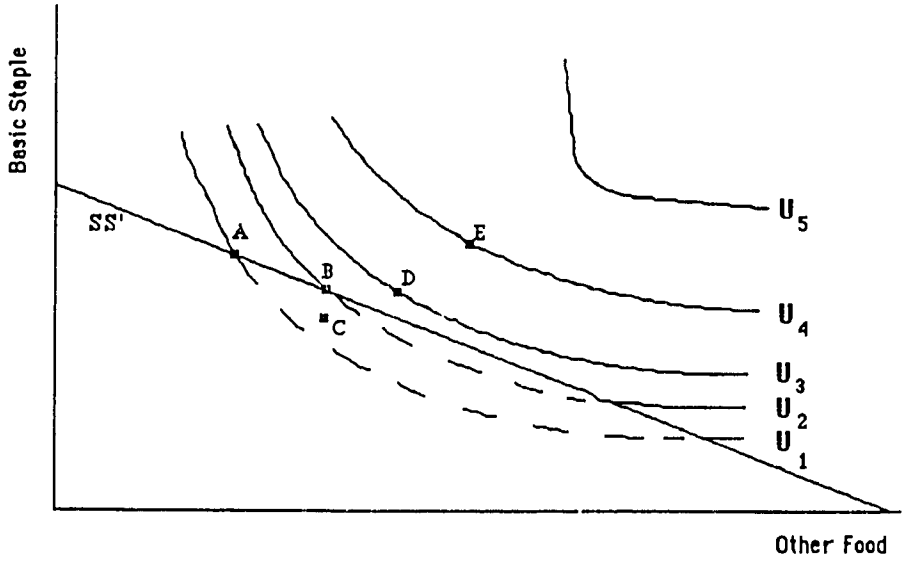

Figure 1. Three dimensions of tastes for variety that may imply low nutrient elasticities with respect to income.

Third, if nutrient intake elasticities are really as low as is indicated in many estimates, perhaps the people being studied are not as much in deficit regarding nutrient intakes as is supposed. If such deficits really existed, it would seem likely that marginal food expenditures would be used to boost proportionally nutrient intakes by buying and consuming more of the same food rather than changing the composition of the diet.[23] Thus, in a sense, the low nutrient intake elasticities with respect to income support revisionist nutritionists and economists who suggest that standard approaches overstate malnutrition (e.g., Payne 1988; Srinivasan 1981; 1988; and Sukhatme 1982). Of course there is a possibility that the poor people under study group do not understand the relation between their

[23]Lipton (1983: 44) similarly observes that diversification away from "cheap foods" that accompanies expenditure increases "must indicate that poverty is perceived as non-threatening to nutrition, at least by comparison with the threat to other needs."

particular food choices and nutrient intake, in which case lack of education may be a critical problem. However, to this observer, it does not seem that a lack of information can wholely explain low nutrient intake elasticities. Most people probably perceived that increasing the quantities consumed of the same foods would more or less increase nutrient intake proportionately, while changing to more expensive foods, including shifts, for example, from broken to whole grains, might not appreciably alter nutrient intake.

Fourth, if direct nutrient responses to income are as small as I believe, the correct interpretations of current estimates suggest, that the World Bank emphasis on income increases as the key to lessening nutrient deficits is somewhat overstated and potentially misleading. Other methods, such as appropriate pricing policies and education, may be equally or more useful. However, a qualification is that even if the direct effects of income on nutrient intake are fairly limited, there may be externalities to having a more nourished population along the lines suggested in recent growth modeling by Lucas (1988), Romer (1986), and Azariadis and Drazen (1988). But available cross-country estimates (Behrman and Deolalikar, 1988d; and Reutlinger and Selowsky 1976) do not suggest a strong nutrient-development association, even after the inclusion of macro effects and externalities.

Fifth, of ultimate interest is not the nutrient intake of poor people, but their welfare. Even if it is the case that income growth does not boost nutrient intakes because other food attributes are purchased in place of additional nutrients; that does not signify that income increases are unimportant.

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