Food Cost and Nutrient Availability in Urban Indonesia: Estimates for Food Policy Analysis

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Abstract: Evaluating the effects of economic growth and the effectiveness of targeted government intervention requires identification of target groups and information on food and nutrient consumption patterns. A model of nutrient consumption linked to food choice behaviour is used to evaluate nutrient availability in urban Indonesia. Nutrient demand responses varied significantly across income levels.

Introduction

A recent World Bank (1986) report highlights the problem of undernourishment in low-income countries, where three quarters of the calorie undernourished people live. The report calls for sustained economic growth as a long-term solution, coupled with government intervention to guarantee food security to the most undernourished groups. Yet, several studies show that increases in income in the short run may not be effective ways of improving nutrition of the poor (e.g., Gray, 1982; and Wolfe and Behrman, 1983). Furthermore, the effectiveness of targeted government intervention requires proper identification of the target group and information on food and nutrient consumption patterns, dietary practices, and measures assessing nutritional health. The present study applies a model of nutrient consumption linked to food choice behaviour to evaluate nutrient availability in urban Indonesia and to illustrate the use of estimated nutrient demand parameters in food and nutrition policy analysis.

Several recent studies have analyzed food consumption and dietary practices in Indonesia (e.g., Timmer and Alderman, 1979; Chernichovsky and Meesook, 1984; and Johnson, Teklu, and Jensen, 1987). In these studies, expenditures on food constituted a major component of total household expenditures. Starchy staples, particularly rice, accounted for at least one third of the average food budget. While the diets of the poor were diversified, particularly among staples, the diets of those with more income contained relatively more rice. As income increased, food budget shares decreased and households shifted from consumption of starchy staples to animal products and processed foods. However, shortages of calories, protein, iron, and thiamine were evident for all income groups and regions in Indonesia, especially those in large families and the urban poor.

Chernichovsky and Meesook (1984) estimated income and region-specific nutrient demand elasticities for 11 dietary components specific to nutrient risk groups, using a single-equation, log-linear form. Their study and the earlier work by Timmer and Alderman (1979) showed that nutrient demands were responsive to changes in income, food prices, and demographic variables. The present study builds on this earlier work, with two notable differences. First, the effects of selected variables are estimated in a simultaneous framework, assuming that allocation decisions within households with respect to nutrients are made simultaneously with food choices. Second, the dietary sources of nutrients are more broadly defined: the estimation of food components are neither restricted to those derived from rice, cassava, and maize (Timmer and Alderman, 1979) nor limited to the population at nutritional risk (Chernichovsky and Meesook, 1984). The results are intended to provide additional knowledge on the linkages between socioeconomic variables, food cost, and nutrient consumption. They also provide additional information for anticipating the effects of policy changes across different socioeconomic groups.

Model

The behavioural model that governs the dietary choice problem of a household is based on a direct utility maximization process (Basiotis *et al.*, 1983). A utility function, modified to account for differences in household demographic characteristics, is defined over separable food and nonfood groups. The household maximizes the utility function subject to an income constraint. The optimal food consumption is determined in two stages. In stage one, the household determines its optimal food budget (C_f):

$$(1)\ C_f = C(P, I, Z1),$$

dependent on a vector of commodity prices (P), household income (I), and household-specific demographic variables ($Z1$). In the second stage, the household allocates the food budget, maximizing the food utility branch within the limits set by the optimal food budget. The solution in stage two gives the demand functions for food commodity i (F_i):

$$(2)\ F_i = F_i(P_f, C_f, Z2),\ i = 1, 2, ..., n,$$

conditioned on the vector of food prices (P_f), food cost (C_f), and a vector of demographic variables ($Z2$).

The optimal bundle of food commodities can be translated into nutrient equivalents using a linear transformation:

$$(3)\ N_j = \Sigma_i\, b_{ji}F_i,\ j = 1, 2, ..., m,$$

where N_j is the level of nutrient type j and b_{ji} is the quantity of the jth nutrient per unit of commodity i. The resulting derived demand functions for nutrients are dependent on food prices, food cost, and household-specific variables that influence the choice of nutrients:

$$(4)\ N_j = N_j(P_f, C_f, Z3).$$

In the empirical application of this model, joint estimation of food cost *(1)* and nutrient demands *(4)* accounts for the presence of the endogenous food cost in the nutrient demand equations. Thus, a two-stage household decision process is hypothesized: first, a choice between food and nonfood groups and, second, choices across foods that are consumed primarily for their nutrient content. An alternative approach would be to estimate food cost and food demand equations *(1)* and *(2)* and translate the estimates into nutrient equivalents using the relationship defined in equation *(3)*.

Data

Data from the 1980 nationwide household survey for Indonesia (SURGASAR) provided demographic characteristics, household expenditures, and food consumption to estimate the model. The data on consumption contained quantities of foods consumed in a household in the week prior to the taking of the survey.

Household consumption of food energy, protein, iron, and thiamine was computed from 96 food items. Results for food energy and protein are reported here.[2] Food cost was measured as the money value of food used from purchases, the household's own inventory, and transfers. The value of total household expenditures, a proxy for income, was set equal to an aggregate of food and nonfood expenditures. Prices for food (rice, vegetables and fruits, and fish and meat) were obtained from constructing geometrically weighted implicit prices at the district level, with households in a district assumed to face similar district level prices. Household composition variables included decomposition of family size into three age-sex categories: number of children under 10, number of adult males, and number of adult females. Other conditioning variables included main occupation and education of household heads.

Results

The parameters of equations *(1)* and *(4)* were estimated using a three-stage least squares procedure, and results are reported in Table 1. First, the food cost equation *(1)* was estimated, conditional on group-specific food prices, total expenditures, and household composition variables. Then, the structural coefficients of the nutrient equations were estimated to measure the marginal effect of the exogenous variables holding food cost fixed. The low values of the standard errors indicate that variables explaining food cost had significant influence on household food budgets. Prices of rice and vegetables and fruits had positive marginal effects; the price of fish and meat had a negative effect. Food cost increased with income but at a decreasing rate. Family size also had a positive effect on food allocation, but the effects varied depending on age and sex of members. Compared with adult females and children under 10 years of age, the marginal effect of additional adult males was relatively stronger.

Table 1—Parameter Estimates of Food Cost and Nutrient Availability for Urban Indonesian Households

Variable	Structural Equation Estimates: Food Cost (1)	Food Energy (2)	Protein (gm) (3)	Derived Reduced Form Estimates: Food Energy (kgal) (4)	Protein (gm) (5)
Intercept	-1,848.71 (731.88)	5,208.49 (736.23)	178.56 (20.72)	4,383.85 (879.44)	149.36 (26.03)
Rice price	9.16 (3.48)	-13.88 (3.46)	-0.44 (0.10)	-9.81 (4.11)	-0.30 (0.12)
Vegetable/ fruit price	1.42 (0.51)	-0.31 (0.51)	-0.05 (0.01)	-0.32 (0.60)	-0.03 (0.02)
Fish/meat price	-0.42 (0.17)	-1.47 (0.17)	-0.6 (0.1)	-1.66 (0.20)	-0.7 (0.1)
Food cost		0.44 (0.01)	0.02 (0.001)		
Income	0.48 (0.01)			0.21 (0.01)	0.01 (0.003)
Income squared	-0.00 (0.00)			-0.00 (0.00)	-0.00 (0.00)
Children under 10	297.37 (41.53)	759.53 (41.68)	14.83 (1.17)	891.59 (48.11)	19.52 (1.47)
Adult males	372.37 (40.81)	1,039.39 (42.01)	19.00 (1.18)	1,204.76 (46.10)	24.88 (1.47)
Adult females	301.02 (41.53)	857.03 (42.44)	17.47 (1.19)	990.71 (46.10)	22.22 (1.49)
Head's occupation		187.91 (92.66)	7.20 (2.60)	187.91 (93.08)	7.20 (2.60)
Education		-143.02 (141.30)	0.72 (3.96)	-143.02 (141.30)	0.72 (3.96)

Note: Standard errors are in parentheses.
Source: 1980 SURGASAR Data.

For the structural coefficients of the nutrient equations (Table 1, columns 2 and 3), food prices had negative marginal effects on the availability of calories and protein, with the rice price having the largest marginal effect. Food cost and family composition variables had a positive effect on consumption of nutrients. Those with at least an elementary school education consumed lower levels of available nutrients, while households in production or related physical occupations had higher levels of available nutrients.

The derived reduced-form coefficients, shown in columns 4 and 5, capture the direct and indirect (via food cost) effects of nutrient conditioning variables. For example, with family composition, both the direct and indirect effects of the respective variables reinforced each other: the marginal effects were larger for each in the long run. Indeed, variations in nutrient consumption due to household composition (age and sex) differences provide an empirical basis for the need for composition-augmented measures of household size.

Elasticity Estimates

Food cost and selected nutrient demand elasticities evaluated at sample means are given in Table 2. The absolute values of all the food cost elasticities were less than one, indicating that aggregate food demands were inelastic with respect to food prices, total expenditures, and family composition variables. Food cost was most sensitive to change in household total expenditures. Among the food prices, food cost was most sensitive to changes in the rice price, reflecting the relative insensitivity of rice demand to its own price. In short, total expenditures (as a proxy for income) followed by the rice price had the most impact on food cost.

Table 2—Food and Selected Nutrient Demand Elasticities under Fixed and Variable Food Cost Hypotheses, Urban Indonesia

Elasticities with Respect to:	Food Cost	Fixed Food Cost		Variable Food Cost	
		Food Energy	Protein	Food Energy	Protein
All households:					
Prices:					
Rice price	0.23	-0.32	-0.40	-0.23	-0.24
Vegetable/fruit price	0.05		-0.06		-0.02
Fish/meat price	-0.05	-0.16	-0.25	-0.18	-0.29
Income:					
Income	0.81			0.32	0.58
Food cost		0.40	0.71		
Household size groups:					
Children under 10	0.05	0.12	0.09	0.14	0.13
Adult males	0.09	0.22	0.16	0.26	0.22
Adult females	0.07	0.19	0.15	0.21	0.20
Lowest 40 percent income households:					
Prices:					
Rice price		-0.35	-0.47	-0.25	-0.32
Vegetable/fruit price			-0.06		-0.033
Fish/meat price		-0.17	-0.30	-0.19	-0.33
Expenditures:					
Income				0.19	0.29
Food cost		0.28	0.42		
Household size groups:					
Children under 10		0.17	0.14	0.20	0.18
Adult males		0.26	0.20	0.31	0.27
Adult females		0.22	0.19	0.25	0.24
Highest 20 percent income households:					
Prices:					
Rice price		-0.31	-0.35	-0.22	-0.24
Vegetable/fruit price			-0.05		-0.03
Fish/meat price		-0.15	-0.23	-0.17	-0.26
Expenditures:					
Income				0.48	0.65
Food cost		0.53	0.69		
Household size groups:					
Children under 10		0.07	0.06	0.09	0.07
Adult males		0.19	0.13	0.22	0.17
Adult females		0.17	0.12	0.19	0.16

Source: 1980 SURGASAR Data.

No *a priori* basis exists for predicting the signs of the nutrient demand elasticities. The short-run elasticities, which are based on the structural coefficients holding food cost fixed, are weighted sums of demand elasticities of nutrient-contributing food items; i.e.,

(5) $\varepsilon_{NjX} = \Sigma\ \alpha_{ji}\ \varepsilon_{QiX}$,

where ε_{NjX} is the observed elasticity of the jth nutrient with respect to a variable X, α_{ji} is the share contributed by the ith food to total availability of the jth nutrient, and ε_{QiX} is the demand elasticity of the ith food with respect to the variable X. The elasticities based on equation *(5)* are given in Table 2 under the fixed food cost hypothesis. When the simultaneity of food cost and nutrient demands is taken into account, the elasticities are expressed as:

(6) $\eta_{NjX} = \varepsilon_{NjX} + \varepsilon_{NjC}\varepsilon_{CX}$,

where η_{NjX} is the long-run elasticity of the jth nutrient with respect to a variable X, ε_{NjX} is the elasticity of jth nutrient with respect to a variable X under the constant food cost assumption *(5)*, ε_{NjC} is the demand elasticity of the jth nutrient with respect to food cost, and ε_{CX} is the food cost elasticity with respect to a variable X. These elasticities are presented in Table 2 when food costs were allowed to vary. The expressions of equations *(5)* and *(6)* show that nutrient elasticities reflect the combined effects of demand responses of the nutrient-source food items. Food items that are relatively important in contributing to the nutrient availability and have large demand elasticities have a significant influence on levels and signs of nutrient demand elasticities.

Both when food costs were held fixed and otherwise, the price elasticities for calories and protein were negative and less than one; i.e., changes in food prices brought about inverse changes in the quantities of calories and protein and had less than proportionate effects on nutrient consumption. The rice price was relatively more important. The negative price effects of rice and vegetables and fruits on demand for nutrients diminished when households could adjust their food budgets in response to price changes. This is true because the positive effect of these prices on food costs partially offset the negative price effect on nutrient demands.

The estimated expenditure elasticities of calories and protein were all positive and less than one (Table 2). The relatively low calorie elasticity reflects the large share of rice contributing to calories. Rice itself was the least expenditure-responsive food item. Similar to expenditure elasticities, household composition elasticities for nutrients were positive and less than one, with nutrient demands being most sensitive to an addition of adult male members to a household. Calories were more sensitive to changes in household composition than was protein. This partly reflected a shift in food consumption towards basic staple food items for large households. Nutrients derived from these staple foods are likely to show more sensitivity to change in family size and composition.

In order better to understand the income effects and to interpret the results with respect to programme targeting, the elasticities for calories and protein were evaluated at sample means for the lowest 40 and top 20 percent of households in the income distribution (Table 2). Price elasticities showed a decline in absolute value at higher income levels. Even though the differences were small, households at lower income levels appeared to be more sensitive to price effects. Calorie and protein expenditure elasticities also varied significantly at different income levels. High-income households were more sensitive to income change, as indicated by the higher expenditure elasticities, than low-income households. Similar patterns have been observed in studies on Bangladesh (Pitt, 1983) and rural Sierra Leone (Strauss, 1986). Such variations in elasticities reflected a systematic shift in the diet structure, which embodied variations in relative nutrient shares, expenditure elasticities of food components, and costs associated with these nutrient sources. A possible explanation for the Indonesian case may be a shift to income-sensitive calorie and protein sources as households experience improved income levels. These households moved to more nutritious foods.

Implications

The dietary practices of the urban Indonesian households revealed important variations across socioeconomic groups. Dietary components varied in quantity and kind, depending on income, family size, location, and occupation of the household. Increased income was associated with increased levels of consumption and a shift in composition of diets; the variations were conditioned by age and sex composition of the households. Households with low income and/or large families often account for a large proportion of nutrient-risk households.

Evaluation of calorie and protein elasticities by income groups for Indonesia using a simultaneous food decision model indicates several important implications. First, demand responses varied significantly across income levels; low-income consumers were, for example, more sensitive to changes in the rice price than high-income consumers. Food policies based on price parameters can be effectively targeted to income groups.

Contrary to previous findings on Indonesia (Chernichovsky and Meesook, 1984; and Timmer and Alderman, 1979), a positive relationship was evident between nutrient expenditure elasticities and income levels. Income as well as prices had a significant impact on household nutrient consumption; increases in income had a greater impact on available nutrients for those with higher incomes. This implies that programmes designed to change selected commodity prices may be more effective at achieving increased calorie and protein consumption by low-income households than programmes designed to change income. While changing rice prices would have the largest relative impact on available calories and protein, rice pricing policies are less effectively targeted to low-income households because rice is a preferred staple crop across all income groups. Price changes for other commodities may be better pricing policy instruments.

Notes

[1]International Food Policy Research Institute and Iowa State University, respectively. This research was conducted at the Center for Agricultural and Rural Development, Iowa State University, and supported by the Office of Nutrition, US Agency for International Development through the Office of International Cooperation and Development, US Department of Agriculture.

[2]Food items without reported nutrient values and standard quantity measures were excluded, as were foods or meals consumed away from the home.

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DISCUSSION OPENING—*Stephen J. Hiemstra* (Purdue University)

I would like to know more about the type and quality of the data analyzed. We were not given the size of the sample nor an indication of its representativeness. We were told that it was a national survey and that the data came from seven-day recall of household expenditures on food in the previous week. This type of data can be quite reliable, in my experience, but I would like to know more about the way it was collected and the time period spanned in collection. For example, is potential seasonality a problem with the data?

We were told, in a footnote to the paper, that food items without reported nutrient values and standard quantity measures were excluded from the analysis. How many foods were eliminated for these reasons? Rice is not a problem, but the data for starchy vegetables and some fruits may contain serious omissions. We found, for example, in our own study in Liberia, that many foods—vegetables, fruits, cassava, fish, and some meats—were sold in piles or by count rather than by units of weight simply because the villages had no scales. Deriving prices and implied quantities in a meaningful manner for purposes of measuring nutrient content thus becomes difficult. (Further, some of the foods we found did not have known nutrient composition.)

Since prices were derived from cross-sectional expenditure data grouped at the district level, some aggregation problems can be expected. I am surprised that the model avoided a high degree of multicollinearity. Was this problem dealt with? Cross-sectional data yield value weights rather than true prices specified in the theoretical model. Perhaps that is why the three groups selected were significant—they probably had quite different values per pound. How does one interpret the results of a price elasticity of a single commodity, such as rice, for example, on the consumption of total calories. One needs to reorient ones thinking to take account of the importance of the commodity in question in relation to the total consumption of all foods. I would prefer to see price elasticities of a commodity measured with respect to the quantities of that same commodity.

In terms of the findings, I was surprised at the low levels of the elasticities with respect to the household size groups. As I understand them, they should average near 1.0 over the three groups of people, rather than around 0.2, if people at the margin are going to eat anywhere near the average amounts of food.

Finally, I find it hard to rationalize the positive relationships between expenditure elasticities with respect to food energy and protein between the two.

GENERAL DISCUSSION—*Philippe Burny, Rapporteur* (Faculté des Sciences Agronomiques de l'État, Belgium)

In reply to the discussion opener, Jensen said that we can be confident in the data because the sample is large and the representativeness is good. The interviews were seriously undertaken and the questions were clear. However, the problem of seasonality still remains. The prices are aggregated ones.

One participant asked about the decision to study nutrient consumption instead of consumption of the different products. Jensen replied that it is a way to aggregate many commodities. What is important is to know quantities of calories and proteins consumed, whatever commodities they come from.

In conclusion, Jensen pointed out the following findings of the study: (1) low-income households are more sensitive to rice prices than higher income households, and (2) expenditure elasticities increase when income goes up (in fact, a shift from traditional staple foods towards animal products—meat, dairy products—occurs).

Participants in the discussion included I. Soliman.