A Review of Consumer Demand Theory and Food Demand Studies on Indonesia

Tesfaye Teklu and S.R. Johnson

Staff Report 86-SR 7
April 1986

A Review of Consumer Demand Theory and Food Demand Studies on Indonesia

by Tesfaye Teklu and S. R. Johnson

Staff Report 86-SR7
April 1986

Center for Agricultural and Rural Development
Iowa State University
Ames, Iowa 50011

The authors are postdoctoral research associate, and professor and administrator, Center for Agricultural and Rural Development, Iowa State University.

This report is part of a research project funded by the United States Agency for International Development, Bureau for Science and Technology, Office of Nutrition, under the technical supervision of the Nutrition Economics Group, Office of International Cooperation and Development, United States Department of Agriculture.

Contents

Project Staff

S.R. Johnson, Professor of Economics
William H. Meyers, Professor of Economics
Helen Jensen, Assistant Professor of Economics
Tesfaye Teklu, Research Analyst
Mohammad Wardhani, Research Assistant

Report Plan

This research report has three main parts: first, a review of basic consumer demand theory, second, a discussion of extensions of the theory; and third, a summary of selected food demand studies for Indonesia.

Part one reviews alternative approaches to consumer demand theory. Aspects discussed are the basic demand restrictions of the theory and their implications for estimation of demand systems. Also surveyed are the commonly used empirical demand models and their implications for demand structure and parameters.

Part two presents three extensions of the basic consumer demand theory. Included is a discussion of the share analysis model that incorporates commodity consumption interactions. This is followed by a survey of techniques for introducing demographic variables in estimated demand systems. Part two concludes by reviewing "new" approaches to consumer demand theory that allow production as an integral component of the demand system. These approaches are then specialized for farm household production and nutritional analyses.

Part Three reviews selected food demand studies for Indonesia. The goals of this review are twofold: first, to show the variation among these studies according to their data bases, commodity coverages and aggregations, demand model specifications, estimation procedures; and second, to present selected parameter estimates from these studies for use in food and nutrition policy analysis. The lessons learned from these studies and the review of the theory are used as a basis for the proposed empirical work for the project.

INTRODUCTION

Food-pricing policy, for rice in particular, is central to the Indonesian development strategy for agriculture. The rice-pricing policy has the dual roles of providing incentive to producers to regulate production and moderating consumer demand. This policy and the effective administration of the associated pricing scheme have important implications for Indonesia, especially since the policy has been extended in recent years to other staple and secondary food crops (PALAWIJA).

Changes in relative food prices can have significant impacts on the economy through direct or indirect influences on production, employment of resources, income, consumption, and external trade. These impacts are particularly important for Indonesia since food expenditure shares are high and a large proportion of the population is engaged in agriculture. Of course, complete economic assessment of the impact of rice-pricing policies would require a general equilibrium framework. This project, which focuses on food consumption and nutrition, abstracts from these complex economic interrelations by using a partial equilibrium framework to evaluate particular aspects of the rice-pricing policy.

Our partial equilibrium analysis of the impacts of pricing policy on food consumption and nutritional status requires information on food demand and nutrient consumption. This includes basic descriptive information on food consumption patterns and nutritional status. Also, demand parameters can be used to evaluate policy performance and the incidence of policy effects. The availability of this descriptive information and the demand parameters is critical to effective policy design in Indonesia, where a few crops dominate food consumption and the majority of the population have low income levels.

The existing food demand parameters for Indonesia are inadequate for comprehensive food policy analysis. First, most of these estimates are from ad hoc demand models and lack consistency with and information from the theory of consumer demand. This lack of congruency with the theory limits the basis for comparability. Second, the demand parameters are largely restricted to estimates of expenditure elasticities for rice, cassava, and potatoes. Price elasticity estimates are absent or highly tentative. Third, the majority of Indonesians are farmers who produce partly for their own consumption. But, the existing demand parameter estimates have not recognized and incorporated the interdependency of household consumption and production decisions. A more plausible approach is to estimate demand parameters for these households with income endogenous. Finally, the existing demand parameters are for food commodities, and no systematic linkages to nutritional status have been developed.

The intent of this project is to contribute to information available for food policy analysis in Indonesia. Our more specific goals are fourfold:

- To develop a food consumption profile of the population. This will be similar in structure to those available from other studies, except for additional information on income by source.
- To produce a new set of demand parameters based on more theoretically plausible model specifications. Special features of the households, particularly the interaction of consumption and production decisions, will be reflected in estimating these parameters.
- To develop a more systematic linkage between food consumption and nutrition status and estimate parameters of the demand for nutrients.
- To specialize and apply this new descriptive information and the estimated demand parameters to an analysis of a current food policy issue, like the pricing of rice.

This report summarizes the theory used to support the specifications and methods used to obtain the demand parameter estimates. The first part of the report traces the development of modern consumer demand theory and reviews and evaluates commonly applied empirical demand models. The review forms the framework for the studying and evaluating the existing food demand parameters for Indonesia. The final section assesses the gap between existing studies and empirical results, the theory and available data, and develops a plan for the empirical work to be undertaken as a part of the project.

A REVIEW OF CONSUMER DEMAND THEORY

Basic Consumer Demand Theory

This section presents a review of basic consumer demand theory. It is organized in three parts. Part one utilizes the direct approach to the utility maximization problem. The dual version of the consumer allocation problem is presented in part two. The common empirical demand models are surveyed in part three.

Utility Maximization

Assume that a consumer can make a complete and consistent order of preferences within a closed choice set. The choices that can be made are limited by an income opportunity set. The consumer's choice problem is then to find an optimum commodity bundle within the opportunity set.

This allocation problem can be formulated in a utility maximization framework (for example, see Deaton and Muellbauer 1980a; Philips 1983; and Johnson, Hassan, and Green 1984). Suppose there exists a utility function, $U(Q)$, that represents the consumer's preference ordering. The function is defined over an exhaustive vector of commodities Q where $Q' = (Q_1, \ldots, Q_n)$. It is assumed that $U(Q)$ is an increasing function (that is, $U'(Q) > 0$), continuous, twice differentiable and strictly quasi-concave. The consumer choice problem is completed by the addition of a linear budget constraint, $P'Q = Y$ where P is an n-element column vector of prices.

The utility maximization problem is to find an optimal vector $Q^*(P,Y)$ at which, subject to the linear budget constraint, the consumer attains maximum utility $U^*(Q)$. That is,

$$\text{(1)} \qquad \text{Max } U = U(Q) \quad \text{St.} \quad P'Q = Y.$$

The maximization procedure can be viewed as involving four steps. First, formulate the Lagrangian:

$$\text{(2)} \qquad L(Q, \lambda) = U(Q) - \lambda(P'Q - Y).$$

Second, differentiate the equation (2) with respect to the choice variables, Q and λ, that is,

$$\text{(3)} \qquad \begin{aligned} U_Q - P\lambda &= 0 \\ P'Q - Y &= 0, \end{aligned}$$

where $U_Q = \frac{\partial U}{\partial Q} = [U_1, U_2, \ldots, U_n]$ is the vector of the derivatives of the utility function with respect to the vector Q. Third, solve the system of $n + 1$ equations for

$$\text{(4)} \qquad \begin{aligned} Q^* &= \Phi(P, Y) \text{ and} \\ \lambda^* &= \lambda(P, Y), \end{aligned}$$

where Q^* is an n-element vector of optimal quantities expressed as functions of the prices of goods and income. The last equation, $\lambda(P, Y)$, denotes the optimal value for the Lagrangian multiplier. The regularity conditions on the utility function, in particular its strict quasi-concavity, ensure that the solutions are unique. The final step is to test the second order conditions to verify that the first order conditions yield a maximum.

Applications of the consumer theory are centered on the estimation of the parameters of the system $Q^* = \Phi(P, Y)$. For n commodities, there are a total of $n^2 + n$ elasticities to be estimated; n^2 price elasticities and n income elasticities. The actual number of elasticities to be estimated can be reduced by imposing on the elasticities restrictions following from the consumer optimization problem and the properties of the utility function. Moreover, by assuming a specific functional form for the utility and/or demand functions, the number of elasticities to be estimated can be further reduced.

The restrictions on the demand parameters are generated from the properties of the utility function (consistency and symmetry) and the linear budget constraint. Solutions of the fundamental matrix equation of consumer demand theory (Barten 1964) expressed in terms of partial derivatives show:

(5) $$\frac{\partial Q}{\partial P} = \lambda U^{-1} - \lambda(\partial\lambda/\partial y)^{-1} \left(\frac{\partial Q}{\partial y}\right)\left(\frac{\partial Q}{\partial y}\right)' - \left(\frac{\partial Q}{\partial y}\right) Q',$$

(6) $$\frac{\partial Q}{\partial Y} = \left(\frac{\partial\lambda}{\partial Y}\right) U^{-1} P,$$

(7) $$\frac{\partial\lambda}{\partial P} = -\lambda\left(\frac{\partial Q}{\partial Y}\right) - \left(\frac{\partial\lambda}{\partial Y}\right) Q, \text{ and}$$

(8) $$\frac{\partial\lambda}{\partial Y} = (P'U^{-1}P)^{-1},$$

where $\frac{\partial Q}{\partial P}$, $\frac{\partial Q}{\partial Y}$, $\frac{\partial\lambda}{\partial P}$, and $\frac{\partial\lambda}{\partial Y}$ are the derivatives of the demand equation (4) with respect to the prices, P_i, and income, Y, and U^{-1} is the inverse of the Hessian matrix, U. Because of the continuity and differentiability assumptions, the Hessian matrix, U, is symmetric. Also, the strict quasi-concavity assumption implies U is negative definite.

The symmetry and the negative definite properties of the Hessian matrix U imply that the substitution matrix of equation (5),

$$K = \lambda U^{-1} - \lambda(\frac{\partial\lambda}{\partial Y})^{-1} (\frac{\partial Q}{\partial Y})(\frac{\partial Q}{\partial Y})' \tag{9}$$

is symmetric, and that the diagonal elements are negative. The latter result assumes that the income compensated own price elasticities are always negative.

Demand Restrictions

Expressing equations (5) through (8) in elasticities, the consumer demand theory implies that demand functions must satisfy three types of restrictions:

(A) Engel aggregation--

$$\sum_i w_i \eta_{iy} = 1, \tag{10}$$

where $w_i = P_i Q_i / Y$ is the average budget share for the i^{th} commodity. Budget exhaustion for given income, $P'Q = Y$, implies that the sum of the weighted income elasticities adds to unity. Thus, only $n - 1$ of the income elasticities are independent.

(B) Homogeneity--

$$\sum_j \varepsilon_{ij} + \eta_{iY} = 0, \qquad \text{for all } i \tag{11}$$

which means that the demand functions are homogenous of degree zero in prices and income. That is, an equal proportional change in P and

Y will leave commodity demands unaffected. For each demand function, there is therefore one redundant elasticity, and for n functions there are n elasticities.

(C) Slutsky Symmetry--using equation (9), the well-known Slutsky equation (5) is obtained by rewriting as

$$\frac{\partial Q}{\partial P} = K - \left(\frac{\partial Q}{\partial y}\right) Q', \tag{12}$$

where K is again the substitution effect and $\left(\frac{\partial Q}{\partial y}\right) Q'$ is the income effect of a price change. From equation (12) the substitution matrix can be expressed as,

$$K = \left(\frac{\partial Q}{\partial P}\right) + \left(\frac{\partial Q}{\partial y}\right) Q' \tag{13}$$

and, because it is symmetric, $K_{ij} = K_{ji}$. In elasticities, equation (13) corresponds to

$$\varepsilon_{ij} = \frac{w_j}{w_i} \varepsilon_{ji} - w_j(\eta_{iy} - \eta_{jy}). \tag{14}$$

Equation (14) reduces the number of independent elasticities to $1/2(n^2 - n)$.

These three types of restrictions, i.e., Engel aggregation (10), homogeneity (11), and symmetry (14), reduce the number of parameters to be estimated for the demand system to $1/2\ (n^2 + n - 2)$. Additional reductions of the parameters to be estimated can be made through direct imposition of restrictions on the demand parameters or a choice of a specialized utility function.

Specialized Utility Structures

The choice of a specific form for the utility function depends on prior knowledge of the consumer's preference structure. Common behavioral assumptions embedded in specifications of utility functions are separability and additivity. The restrictions that these concepts imply for the demand parameters along with their behavioral consequences are summarized below.

Separability: One specialized utility structure often used in applied demand analysis is a partitioning of commodities into groups. The question is under what conditions do decisions involving these aggregates give a utility level that is equivalent to the one that would be articulated in terms of the individual commodities? An assumption of separability of preferences is required to assure this equivalence relationship.

In the case of a weak separability, the utility function is written as

$$U(Q) = F[U_1(Q_1), \ldots, U_r(Q_r), \ldots, U_m(Q_m)], \tag{15}$$

where $F' > 0$. The n commodities are partitioned into $m < n$ groups and each group has n_r commodities. Then, $U_r(Q_r)$ represents a branch utility function. The necessary and sufficient conditions for $U(Q)$ to be weakly separable with respect to the m groups is that the marginal rate of substitution between two commodities from the same branch is independent of the quantities of all commodities not in the branch (Philips 1983). That is,

$$\partial[U_i(Q_r)/U_j(Q_r)]/\partial Q_k = 0, \tag{16}$$

where $i \in R$, $j \in R$, $k \in K$, and $(R \neq K)$.

Equation (16) has important implications for the demand functions. Specifically, the cross-substitution terms become

(17) $$K_{ij} = \Theta_{IJ} \frac{\partial Q_i}{\partial Y} \frac{\partial Q_j}{\partial Y},$$

where $i \varepsilon I$, $j \varepsilon J$, and $(I \neq J)$. In equation (17), Θ_{IJ} is a parameter summarizing the pattern of substitution between the branches I and J. Note that no restrictions are imposed on the substitution relationships within each branch or commodity group.

Rewriting the Slutsky equation (12), the associated uncompensated cross-price elasticities are shown to be (Johnson, Hassan, and Green 1984)

(18) $$\varepsilon_{ij} = w_j \Theta_{IJ} \eta_i \eta_j - w_j \eta_i.$$

Equation (18) implies that all elements of the matrix of demand elasticities are identified $[1/2(m^2 - m)]$, if the income elasticities (η) and the general (branch) substitution terms Θ_{IJ}'s, are known. Thus, under this separability assumption, the number of independent estimates of elasticities required to determine the system of demand functions is reduced to $n + 1/2\ (m^2 - m)$.

<u>Strong separability</u> is the case, where the branch utilities in (15) are combined:

(19) $$U(Q) = F[U_1(Q_1) + \ldots + U_r(Q_r) + \ldots + U_m(Q_m)],$$

where F is now increasing in only one variable, that is, the sum of the m branch utilities. Equation (19) defines strong separability with respect to m groups if the marginal rate of substitution between two commodities, i and j, from different subsets does not depend upon the quantities of commodities outside I and J. That is,

(20) $$\partial[U_i(Q_i)/U_j(Q_j)]/\partial Q_k = 0$$

for all $i \varepsilon I$, $j \varepsilon J$, $k \varepsilon K$, $K \notin I$ and J, and $I \neq J$.

Because of additivity, the commodity groups are not interconnected, that is, there are no unique utility branches. Any combination of commodity groups is admissible. Additivity implies a Slutsky term of the form

$$K_{ij} = \Theta \frac{\partial Q_i}{\partial Y} \frac{\partial Q_j}{\partial Y}, \tag{21}$$

where Θ is independent of the commodity groups to which i and j belong. With strong separability, the Slutsky equation for cross-price effects is (Johnson, Hassan, and Green 1984)

$$\varepsilon_{ij} = w_j \Theta \, \eta_i \eta_j - w_j \eta_i, \tag{22}$$

where Θ is the same for all groups. Notice the relationship between strong and weak separability by comparing equations (22) and (18). Hence, for the complete demand system, only n + 1 parameters are required--n income elasticities and a value for Θ.

<u>Block Additivity</u>: This is a special case of strong separability where F in Equation (19) is set to unity. Since under the foregoing assumptions on the consumer allocation problem, any monotonic transformation of a utility function represents the same underlying preference ordering, the implied restrictions on demand functions are similar to those expressed in equations (21) and (22).

<u>Direct additivity</u>: (point-wise separability) This is again a special case of Equation (19), where F is defined as an identity function and each component utility function, $U_r(Q_r)$, contains only one element. The condition on the cross-partial derivatives of the utility function becomes

(23) $$\partial U_i/\partial U_j = 0 \quad \text{for all } i \text{ and } j.$$

The Slutsky term, K_{ij}, reduces to a general substitution relation,

(24) $$K_{ij} = \tilde{\Theta} \frac{\partial Q_i}{\partial Y} \frac{\partial Q_j}{\partial Y},$$

where $\tilde{\Theta} = -\lambda \left(\frac{\partial \lambda}{\partial Y}\right)'$. The expression for the uncompensated cross-price elasticities is, in this case,

(25) $$\varepsilon_{ij} = w_j \phi \eta_i \eta_j - w_j \eta_i,$$

where $\omega = -Y/\tilde{\Theta} = 1/\phi$; this is known as the "income flexibility" parameter (Frisch 1959).

This simple preference structure requires only estimates of n income elasticities and the income flexibility parameter ($\tilde{\theta}$) for a complete characterization of the demand system. Also, the substitution matrix K_{ij} is positive (the matrix being negative semidefinite) if $\tilde{\theta} > 0$ and the income elasticities are all positive. Thus, inferior and complement goods are ruled out by the direct additivity assumption. These behavioral implications suggest that direct additivity, if applicable at all, should be used only for broad groups of commodities.

Duality

An alternative approach for obtaining a Marshallian demand system is to start from an indirect utility function,

(26) $$V(P, Y) = \text{Max } [U(Q) : P'Q = Y],$$

where V(P, Y) is the maximum attainable utility level for a given vector of prices and income. Applying Roy's identity to expression (26) produces

$$Q_i^*(P, Y) = V_{P_i}/V_Y \qquad \text{for all } i, \tag{27}$$

where $V_{P_i} = \frac{\partial V}{\partial P_i}$ and $V_Y = \frac{\partial V}{\partial Y}$ are partial derivatives of the indirect utility function with respect to price of commodity i, P_i, and income Y, respectively.

An indirect utility function representing an underlying preference ordering consistent with $U = U(Q)$ has the following properties (Varian 1978):

a. $V(P, Y)$ Continuous at all $P > 0$, $Y > 0$,

b. $V(P, Y)$ nonincreasing in P ($V_P \leq 0$),

c. $V(P, Y)$ nondecreasing in Y ($V_Y \geq 0$),

d. $V(P, Y)$ homogeneous of degree zero in (P, Y), and

e. $V(P, Y)$ quasi-convex in P.

The first property (a) is a direct result of the regularity assumptions on the direct utility function U. According to property (b), a price change has a nonpositive effect on consumer's utility level if a nominal income is held fixed. Property (c) follows from the assumption of nonsatiation. Property (d) is a consequence of the absence of the no-money illusion that is, $Q^*(tP, tY) = Q^*(P, Y)$, and hence $V(Q^*(P, Y)) = V(Q^*(tP, tY))$ where t is a positive constant. The last property (e) implies that the matrix of second order partial derivatives of V, defined as $V_{ij}(P, Y)$, is positive semidefinite.

Alternatively, suppose a target level of utility, U^*, is given. The minimum income level required to reach U^* is

$$E(P, U^*) = \text{Min } [PQ : U(Q) = U^*], \tag{28}$$

where $E(P, U^*)$ is expressed as a function of fixed prices and a given utility level. Expression (28) is known as an <u>expenditure</u> (cost) function.

Shephard's lemma can be applied to the cost function to obtain

$$\frac{\partial E(P, U^*)}{\partial P_i} = Q_i^c(P, U) \tag{29}$$

where $Q_i^c(P, U)$ is a Hicksian demand function, expressed as a function of prices and target utility level, U^*.

The expenditure function satisfies the properties:

a. $E(P, U^*)$ continuous in P $(P > 0)$,

b. $E(P, U^*)$ nondecreasing in P $(E_P \geq 0)$,

c. $E(P, U^*)$ homogeneous of degree 1 in P, and

d. $E(P, U^*)$ concave in P.

Property (b) implies that increases in P require at least as much expenditure as the initial expenditure to remain at U^*. Property (c) states that if prices increase in some proportion, $Q^c(P, U)$ remains unaffected, and hence $E(P, U)$ increases in the same proportion. Property (d) follows from cost minimization, where as the price of a commodity increases, cost will rise to maintain the same U^* but at a decreasing rate as the consumer substitutes other commodities. Provided that property (a) holds, that is, that the derivatives exist, Shephard's lemma can be used in general to obtain the Hicksian (compensated) demand functions.

When U^* is the level that represents the maximum utility in the primal problem, that is, $V(P, Y) = U^*$, both the indirect utility and cost functions yield the same demand functions. That is, the Marshallian and Hicksian demand functions, $Q_i(P, Y) = Q_i^c(P, E)$, are equal. Moreover, the cost function, $E(P, U^*)$, can be obtained by inverting the indirect utility function, $V(P, Y)$. This is possible since $V(P, Y)$ is nondecreasing in Y. Similarly, the indirect utility function can be derived from the cost function by setting $E(P, U^*) = Y$ and solving for $V = U^*(P, Y)$. These results are consistent for a utility-maximizing consumer where cost minimization is dual to the utility maximization problem. An underlying preference ordering can thus be represented by a direct utility function, $U(Q)$, an indirect utility function, $V(P, Y)$, or a cost function, $E(P, U^*)$.

If we redefine the problem in equation (28) as

$$D(Q, U) = \text{Min } [PQ : V(P, Y) = U^*] \tag{30}$$

then $D(Q, U)$ represents the <u>distance</u> function, expressing the minimum cost of achieving a utility level U^* at a given vector Q^*. The distance function yields the vector of prices that will give the amount (proportion) that Q^* must be divided to achieve U^*.

Like the indirect and cost functions, the distance function maps to the same preference structure if it is:

a. continuous in Q,

b. nonincreasing in utility, and

c. nondecreasing, concave, and homogeneous of degree 1 in Q.

<u>Empirical Demand Systems</u>

The linear expenditure system is reviewed first, as it is based on a simple and widely applied utility structure. It has also been used in previous work with Indonesia data (Hedley 1978). This is followed by a discussion on the Indirect Addilog demand model. This model, like the linear expenditure system, is based on a simplified utility function, but overcomes some of the restrictions on the parameters implied by the linear expenditure system. For example, all income elasticities need not be positive. The next two demand models--the Almost Ideal Demand System and the Indirect Translog Model--are derived using duality theorems. An alternative approach to derive a demand system is to start with an algebraic form and impose the general demand restrictions to construct a theoretically plausible demand system. The Rotterdam demand model exemplifies this approach. Finally, a more ad hoc local approximation method more consistent with the past work in agricultural economics is reviewed.

Linear Expenditure System (LES): The demand function for commodity i is given by

$$Q_i = \gamma_i + \beta_i/P_i \ (Y - \Sigma_j P_j \gamma_j), \tag{31}$$

where γ_i is interpreted as the committed quantity of commodity i and $Y - \Sigma P_i \gamma_i$ as supernumerary income, which the consumer allocates in fixed proportions, β_i/P_i. The demand system can be derived from a translated version of the family of the Bergson utility functions (Pollak 1971), known as the Stone-Gary utility function,

$$U(Q) = \Sigma \beta_i \ln(Q_i - \gamma_i), \tag{32}$$

where $\Sigma\beta_i = 1$, $0 < \beta_i < 1$, and $(Q_i - \gamma_i) > 0$. With these restrictions on the parameters of the utility function, the demand system satisfies the adding up ($\Sigma\beta_i = 1$) and symmetry ($0 < \beta_i < 1$ and $Q_i > \gamma_i$) conditions.

The income elasticity for commodity i is

$$\eta_i = \beta_i/w_i, \tag{33}$$

where $w_i = P_i Q_i/Y$ is again the average budget share. Note from (33) that the marginal budget share is $\beta_i = \eta_i w_i$.

The own-price elasticity for commodity i is

$$\varepsilon_{ii} = -1 + (1 - \beta_i)\ \gamma_i/Q_i, \tag{34}$$

where to make the previous statement of conditions more explicit, $K_{ii} < 0$

requires $0 < \beta_i < 1$ and $(Q_i - \gamma_i) > 0$.

The cross-price elasticity for good i is

$$\varepsilon_{ij} = -\beta_i(P_j\gamma_j/P_iQ_i) \qquad \text{for all } i \neq j, \tag{35}$$

so that for the linear expenditure system, all goods are gross complements.

The LES incorporates the restrictions implied by an additive utility structure. The restriction $0 < \beta_i < 1$ implies income elasticities (33) are positive. The fact that the cross-substitution terms are positive ($K_{ij} > 0$) implies that all pairs of goods are net substitutes. Also, for the LES specified for a large number of commodities, the price elasticities are approximately proportional to expenditure elasticities (Deaton and Muellbauer 1980a). Despite these limitations, however, experience with the demand system (Philips 1983) shows that it is a reasonable model if the goods are broadly grouped and price variations within these groups are restricted.

<u>Indirect Addilog Demand Model (Houthakker 1960)</u>: The addilog demand system is derived from the additive, indirect utility function,

$$V(P, Y) = \Sigma\alpha_i(Y/P_i)^{b_i}, \tag{36}$$

with parameter restrictions $\alpha_i < 0$, $\Sigma\alpha_i = -1$, and $-1 < b_i < 0$. The corresponding demand function for the i^{th} commodity, in log form, is

$$\ln Q_i = \ln\alpha_i b_i + (1 + b_i)\ln(Y/P_i) - \ln \Sigma\alpha_j b_j(Y/P_j)^{b_j}. \tag{37}$$

The demand function (37) satisfies the general restrictions from consumer demand theory. Differentiating equation (37), the income and price elasticities of this demand system are (Johnson, Hassan, and Green 1984):

(38) $$\eta_{iY} = (1 + b_i) - \Sigma\, b_j w_j \quad \text{for all } i; \text{ (income elasticity)}$$

where $\eta_{iY} \lessgtr \Sigma\, b_j w_j$;

(39) $$\varepsilon_{ii} = -(1 + b_i) + b_i w_i \quad \text{for all } i; \text{ (own-price elasticity)}$$

where $-1 < \varepsilon_{ii} < 0$ with $-1 < b_i < 0$ and $w_i > 0$; and

(40) $$\varepsilon_{ij} = b_j w_j \quad \text{for all } i \neq j; \text{ (cross-price elasticity)}.$$

Almost Ideal Demand System (AIDS): Using the dual formulation of the consumer allocation problem, Deaton and Muellbauer (1980b) specified the cost function

(41) $$\ln C = \alpha_o + \Sigma_j \alpha_j \ln P_j + 1/2\ \Sigma\Sigma \hat{\gamma}_{jk} \ln P_j \ln P_k + U\beta_o \Pi P_j^{\beta_j}$$

where for the function to be linearly homogeneous in prices, the parameters must satisfy $\Sigma_i \alpha_i = 1$, $\Sigma_j \hat{\gamma}_{jk} = \Sigma_k \hat{\gamma}_{kj} = \Sigma_j \beta_j = 0$. Applying Shephard's lemma to equation (41), the Hicksian demand function for commodity i in share form, becomes

(42) $$w_i = \alpha_i + \Sigma \gamma_{ij} \ln P_j + \beta_i U \beta_o \Pi P_k^{\beta_k}$$

where $\gamma_{ij} = 1/2(\hat{\gamma}_{ij} + \hat{\gamma}_{ji})$ is required to satisfy the symmetry conditions. From the duality relation that $Y = C(P, U)$, the indirect utility function, $U(P, Y)$, corresponding to equation (41) can be expressed as

(43) $$U = \ln Y - (\alpha_o + \Sigma_j \alpha_j \ln P_j + 1/2\ \Sigma\Sigma \hat{\gamma}_{jk} \ln P_j \ln P_k)/\beta_o \Pi P_j^{\beta_j}.$$

Substituting equation (43) into equation (42), the Marshallian demand function for commodity i in share form is

(44) $$w_i = \alpha_i + \Sigma_j \gamma_{ij} \ln P_j + \beta_i \ln \bar{Y},$$

where $\bar{Y} = Y/P^\circ$ is nominal income deflated by the price index, P°. The price index P° is defined by

(45) $$\ln P^\circ = \alpha_o + \Sigma\, \alpha_j \ln P_j + 1/2\; \Sigma\Sigma\gamma_{jk} \ln P_j \ln P_k.$$

Equation (44) represents a consistent system of demand functions if,

(46) $$\Sigma_i \alpha_i = 1, \qquad \Sigma_i \gamma_{ij} = 0, \qquad \Sigma_i \beta_i = 0$$

(47) $$\Sigma_j \gamma_{ij} = 0, \text{ and}$$

(48) $$\gamma_{ij} = \gamma_{ji},$$

where equations (46), (47), and (48) are restrictions assuring the Engel aggregation, homogeneity, and Slutsky symmetry conditions, respectively. Note that the adding-up and homogeneity restrictions simply repeat the restrictions imposed on the parameters of the cost function. These restrictions can be applied to equations (44) and (45) to test the consistency of the demand system with demand theory (Brown, Green, and Johnson 1986).

The share elasticity with respect to income for equation (44) is

(49) $$\frac{\partial \ln w_i}{\partial \ln Y} = \beta_i / w,$$

implying the goods are necessities if $\beta_i < 0$ and luxuries if $\beta_i > 0$. For the prices P_j, the share elasticity is

(50) $$\frac{\partial \ln w_i}{\partial \ln P_j} = \frac{\gamma_{ij}}{w_j} - \frac{\beta_i}{w_i} (\alpha_j - \Sigma\gamma_{jk} \ln P_k).$$

Expressing these elasticities in terms of the quantity demand for commodity i, the income elasticity is

(51) $$\eta_{iY} = \beta_i/w_i + 1.$$

The own- and cross-price elasticities are, respectively,

(52)
$$\varepsilon_{ii} = \frac{\gamma_{ii} - \beta_i\alpha_i - \Sigma\gamma_{ik}\ln P_k}{w_i} - 1$$

$$= \frac{\gamma_{ii} - \beta_i w_i + \beta_i^2 \ln(\bar{Y})}{w_i} - 1, \text{ and}$$

(53)
$$\varepsilon_{ij} = \frac{\gamma_{ij} - \beta_i\alpha_j - \Sigma\gamma_{jk}\ln P_k}{w_i}$$

$$= \frac{\gamma_{ij} - \beta_i w_j + \beta_i\beta_j \ln\bar{Y}}{w_i}.$$

For estimation purposes, the price index P° can be approximated using Stone's index, that is, $\ln P^\circ = \Sigma\, w_k \ln P_k$. The one application available for evaluating this approximation suggests that it is reasonably accurate (Brown, Green, and Johnson 1986). The advantage of the approximation is that if used, the demand system is linear in the structural parameters.

Indirect Translog Model (ITL): Instead of starting with a specific indirect utility function, Christensen, Jorgenson, and Lau (1975) approximate the true indirect function with a second order Taylor series expansion. The approximation, $\psi(\hat{P})$, is in the logarithms of income normalized prices, $\hat{P}_i = P_i/Y$;

(54) $$\psi(\hat{P}) = \alpha_o + \Sigma\alpha_i \ln\hat{P}_i - 1/2\ \Sigma\Sigma b_{ij}\ln\hat{P}_i \ln\hat{P}_j,$$

where $\Sigma\alpha_i = -1$, $b_{ij} = b_{ji}$ $\forall_{i \text{ and } j}$, and $\Sigma_j b_{ij} = 0$ $\forall_i$. Using Roy's identity, the demand function for commodity i in share form is

(55) $$w_i = \alpha_i + \Sigma_j b_{ij} \ln\hat{P}_j / \Sigma\alpha_k + \Sigma\Sigma\, b_{kj} \ln\hat{P}_j.$$

Writing equation (55) in terms of the quantity demanded for commodity i yields,

(56) $$Q_i = \hat{P}_i^{-1}(\alpha_i + \sum_j b_{ij} \ln\hat{P}_j)/\Sigma\alpha_k + \Sigma\Sigma b_{kj} \ln\hat{P}_j.$$

The demand system can be estimated subject to the symmetry restrictions ($b_{ij} = b_{ji}$) and an equality restriction $\Sigma_j b_{kj} = 0$ for all k in all the demand equations. The full demand system requires estimation of $1/2(n^2 + 3n - 2)$ parameters. Compared to the other demand systems reviewed, the ITL requires a great deal of variability or information in the sample data, since the number of parameters to be estimated is comparatively large.

The income and price elasticities (own and cross) for equation (56) are, respectively,

(57) $$\eta_{iY} = 1 + \Sigma_j b_{ij} - w_i \Sigma\Sigma b_{ij} / 1 + \sum_{ij}\Sigma b_{ij} \ln\hat{P}_j,$$

(58) $$\varepsilon_{ii} = (b_{ii} - w_i \Sigma_j b_{ij} / 1 + \Sigma\Sigma b_{ij} \ln\hat{P}_j) - 1, \text{ and}$$

(59) $$\varepsilon_{ij} = b_{ij} - w_i \Sigma_j b_{ij} / 1 + \Sigma\Sigma b_{ij} \ln\hat{P}_j.$$

If $b_{ij} = 0$ for all i and j, the indirect utility function (54) reduces to a simple Cobb-Douglas form. These utility functions (both the direct and indirect) are self-duals, that is, they represent the same preferences. This is the case with the linear logarithmic system popularized by Lau and Mitchell

(1975). The imposition of this restrictive homothetic structure reduces the number of parameters to be estimated, but the demand system becomes much less flexible and less behaviorally plausible when applied to food consumption analysis.

The Rotterdam Demand Model (RDM): Unlike the demand systems reviewed, this approach (Theil 1965, Barten 1969) started with a specific algebriac demand system, then the general demand restrictions were imposed to make it consistent with the theory of consumer demand. The relative price version of this system begins with Stone's (1954) logarithmic demand function:

$$\ln Q_i = \alpha_i + \eta_i \ln(Y) + \Sigma_j \varepsilon_{ij} \ln P_j. \tag{60}$$

Writing equation (60) in differentials yields

$$d\ln Q_i = \eta_i d\ln(Y) + \Sigma_j \varepsilon_{ij} \ln P_j, \tag{61}$$

where η_i is the income elasticity of commodity i and ε_{ij} is the cross-price elasticity of the i^{th} commodity with respect to the j^{th} price.

The cross-price elasticity can be decomposed into cross-substitution and income effects as in (12), or in elasticity form

$$\varepsilon_{ij} = K_{ij} - \phi w_j \eta_i \eta_j - w_j \eta_i, \tag{62}$$

where $K_{ij} = \lambda U_{ij} P_j / Q_i$ is the specific substitution term and $\phi w_i \eta_i \eta_j$ is the general substitution term. Substituting these two terms into equation (61) provides

$$d\ln Q_i = \eta_i d\ln Y + \sum_j [K_{ij} - \phi w_j \eta_i \eta_j - w_j \eta_i]\, d\ln P_j. \tag{63}$$

From the solutions of the "fundamental matrix" of the theory of consumer demand, equations (5) through (8), it can be shown (Thiel 1965) that

$$\Sigma_j K_{ij} = \phi\eta_i. \tag{64}$$

Substituting equation (64) into equation (63) and collecting the like terms, the demand equation for the i^{th} commodity can be written as

$$d\ln Q_i = \eta_i(d\ln Y - w_k d\ln P_k) + \Sigma_j K_{ij}(d\ln P_j - \Sigma w_k \eta_k d\ln P_k). \tag{65}$$

To impose the symmetry restriction, that is, $w_i k_{ij} = w_j k_{ji}$ for all i and j, equation (65) is multiplied on both sides by the budget share w_i, that is,

$$w_i d\ln Q_i = \mu_i d\ln \bar{Y} + \Sigma_j b_{ij} d\ln \bar{P}_j, \tag{66}$$

where $\mu_i = P_i \dfrac{\partial Q_i}{\partial Y}$ is the marginal budget share, $\bar{Y} = d\ln Y - w_k d\ln P_k$ is a measure of real income, $b_{ij} = \lambda U_{ij} P_j P_i / Y$ is the coefficient of the relative price j, and $\bar{P}_j$ is the deflated price of the j^{th} commodity. The demand equation (66) satisfies the restrictions for the consumer allocation problem, that is, adding up ($\Sigma\mu_i = 1$), symmetry ($b_{ij} = b_{ji}$ for all$_{i,j}$) and homogeneity ($\Sigma_i b_j = \phi_i \mu_i$).

The income and price elasticities (Johnson, Hassan, and Green 1984) for commodity i are derived from equation (66). The income elasticity is

$$\eta_i = \mu_i / w_i \qquad \text{for all } i, \tag{67}$$

where $\eta_i \lesseqgtr 1$ according to $\mu_i \lesseqgtr w_i$. The price elasticities for P_i and P_j are, respectively,

$$\varepsilon_{ij} = (b_{ii} - b_{ii}\mu_i - \mu_i w_i)/w_i, \text{ and} \tag{68}$$

$$\varepsilon_{ij} = (b_{ii}\mu_j - \mu_i w_i)/w_i. \tag{69}$$

The parameters of the demand system can be significantly reduced if additivity restrictions are further imposed (Johnson, Hassan, and Green 1984). Then, only n + 1 parameters (η, μ_s, and ϕ) are required to form a complete set of demand elasticities.

The assumption of the constancy of the coefficients (μ_i, b_{ij}) in equation (66) implies a specific structure of the underlying utility function. It has been show (Goldberger 1969; Yoshihara 1969) that the Rotterdam demand system can be derived from the Cobb-Douglas utility function,

$$U = \Sigma_i \ \beta_i \ln Q_i. \tag{70}$$

The demand system derived from equation (70) implies that income elasticities are all equal to unity, all own-price elasticities are equal to -1, and all cross-price elasticities are equal to 0. These results show that the Rotterdam demand system is rather restrictive for empirical work.

<u>A Local Box-Cox Approximation</u>: The Box-Cox procedure (1964) and, in fact, other functional forms provide a basis for developing "local" approximations of demand systems. The Box-Cox form utilizes a transformation of variables defined by

$$C_i(\lambda) = Z_i(\lambda)\beta, \tag{71}$$

where $C_i(\lambda) = C_i^{\lambda} - 1/\lambda$ and $Z_i(\lambda) = Z_i^{\lambda} - 1/\lambda$, and λ is a transformation variable. The function can be specified to include a value, λ, for each variable, generalizing equation (71) as well. If one postulates that $C_i(\lambda)$ represents a demand function for a particular commodity i, equation (71) can be viewed as defining a general Box-Cox demand system (Johnson et al. 1985). The original demand system (4) is replaced by

$$Q_i(\lambda) = \underset{\sim}{\phi}_i(P_i(\lambda),\ Y(\lambda)); \qquad i = 1,\ 2,\ \ldots,\ n. \tag{72}$$

The corresponding restrictions from the demand theory are derived by Johnson et.al. (1985), who note that the restrictions hold only locally at specified prices, income, and budget proportions. Those expressions can be used to combine, in a mixed estimation context, prior and sample information to estimate local approximations to demand systems.

The most commonly used flexible functional forms also fall out if equation (71) represents a generalized Box-Cox cost function (Berndt and Kahlad 1979). The function expressed as a quadratic in Box-Cox transformations is a translog as $\lambda \rightarrow 0$, generalized Leontief if $\lambda = 1$, generalized square-root if $\lambda = 0.5$, and quadratic if $\lambda = 2$. Hence, tests for specific values of λ can be used to select among an extended a family of local flexible approximations.

Extensions of the Demand Theory

Three extensions of the basic demand theory to be utilized in the study for Indonesia are introduced in this section. First, a multinomial logit model is presented as an improved approach basis for food budget analysis with disaggregated commodity groups. This model, which is consistent with consumer demand theory, has two distinct features. One, it allows one to estimate relative food budget shares at disaggregated commodity levels. Two, the elasticities reflect budget substitution across all the food commodity groups. The latter provides a unique advantage over past studies which do not account for commodity interactions in budget share analyses. After the model is presented, availabe systematic techniques for incorporating demographic variables in demand systems are discussed. The intent is to present the rationale, the development of these techniques, and their implications for utility and demand structures. The final section introduces basic models that incorporate the idea that consumers do not purchase all they consume. Part of their consumption goods may be produced at home, using production inputs and technology. Production activities should therefore be an integral component of demand systems. The farm household model is presented as a special case of these household production models.

Integrated Food Budget Share Analysis

The multinomial logit model (for example, Theil 1969) forms the basic theoretical framework for analyzing the food budget shares. Suppose expenditure on commodity group i takes an exponential form,

$$C_i = e^{f_i(X)}, \tag{73}$$

where C_i is an expenditure on group i, and X is a vector of conditioning socioeconomic variables. The budget shares for the commodity groups can be defined as

$$w_i = \frac{e^{f_i(X)}}{\Sigma\, e^{f_j(X)}}; \qquad i = 1, \ldots, S, \tag{74}$$

where $Y = \Sigma\, e^{f_j(X)}$ is the total expenditure. Equation (74) represents a general logistic form in the budget shares. If the function $f_i(X)$ takes a linear form in the parameters, the model represents a linear logit model.

The model satisfies the adding-up conditions, that is, Engel and Cournot aggregation. It can also be constrained to satisfy the homogeneity and Slutsky symmetry restrictions (Tyrell and Mount 1982). Equation (74) can therefore be constrained to satisfy the basic restrictions of the consumer demand theory.

Only S-1 relative share equations can be estimated, with S the total number of commodities. But, using the Engel aggregation condition, all the budget shares are uniquely identified. If food group one is used as a reference, the predicted budget shares are

(75) $$w_1 = 1/(1 + \sum_{j=2}^{S} e^{f_j(X)}) \text{ and,}$$

(76) $$w_i = e^{f_i(X)}/(1 + \sum_{j=2}^{S} e^{f_j(X)}); \qquad i = 2, \ldots, S.$$

The predicted budget shares always lie between 0 and 1, and their sum adds to unity.

The budget share elasticities with respect to the conditioning variables, X_i, can be written

(77) $$\varepsilon_{w_i X_i} = X_i(\frac{\partial f_i}{\partial X_i} - \sum_j^S W_j \frac{\partial f_j}{\partial X_i}).$$

Recall that the X_i are socioeconomic variables (for example, income, prices, and household-specific characteristics).

The budget shares in equation (74) can be expressed alternatively in quantity form as

(78) $$Q_i = \frac{w_i e^{f_i(X) + \ln Y - \ln P_i}}{\sum e^{f_j(X)}} \qquad i = 1, \ldots, S,$$

where Q_i is the quantity of the i^{th} food group, Y is household income, and P_i is the price of the i^{th} food group. Using equation (78), income elasticities (η_{iY}), own-price elasticities (ε_{ii}), cross-price elasticities (ε_{ij}), and elasticities for specific socioeconomic characteristics (ε_{iX_r}) can be derived for the i^{th} good:

(79) $$\eta_{iY} = Y(\frac{\partial f_i}{\partial Y} - \sum_{j=1}^{S} w_j \frac{\partial f_j}{\partial Y}) + 1,$$

(80) $$\varepsilon_{ii} = P_i(\frac{\partial f_i}{\partial P_i} - \sum_{j=1}^{S} w_j \frac{\partial f_j}{\partial P_i}) - 1,$$

(81) $$\varepsilon_{ij} = P_i(\frac{\partial f_i}{\partial P_j} - \sum_{j=1}^{S} w_j \frac{\partial f_j}{\partial P_j}) - 1 \qquad \text{for } i \neq j, \text{ and,}$$

(82) $$\varepsilon_{iX_r} = X_r(\frac{\partial f_i}{\partial X_r} - \sum_{j=1}^{S} w_j \frac{\partial f_j}{\partial X_r}) \qquad \text{for } r = 1, \ldots, R.$$

Note a unique feature of these elasticities. The elasticities incorporate the substitutions that take place across all commodities due to change in exogenous variables. Thus, the multinomial logit model provides an improved capacity to estimate elasticities that account for commodity interrelations, an attractive feature for applications with food commodities specified as disaggregated.

Incorporating Demographic Variables

The utility function $U = U(Q)$ assumes that households with different socioeconomic characteristics have similar preference structures. This assumption likely has, however, little validity in situations where socioeconomic characteristics (family size, age-sex composition, location, etc.) influence consumption behavior of the household unit. A more plausible approach is to respecify the utility function conditioned by these variables, that is , $U = U(Q/\eta)$ where $\eta = (\eta_1, \eta_2, \ldots, \eta_r)$ is a vector of demographic characteristics. This section reviews selected procedures that have been developed to modify utility and demand functions to systematically incorporate household specific demographic variables.

A simple approach is to express quantities demanded and income (Equation 4) in per capita terms. This specification, however, fails to incorporate variations due to the age-sex composition of individuals in households. The classical approach is Engel's (1895) work which reflects differences in household composition in income-consumption relationships (holding prices constant). The quantities and income in the demand functions are normalized in adult equivalents

$$(83) \qquad Q_i/m_o = \bar{Q}_i(Y/m_o)$$

where m_o is the adult equivalent index and a function of household characteristics.

Prais and Houthakker (1955) provide a commodity specific generalization of Engel's specification with adult equivalent scales, m_i's, defined separately for each commodity,

$$(84) \qquad Q_i/m_i = \bar{Q}_i(Y/m_o),$$

where m_i is a commodity specific scale and m_o is a general or income scale. That is, m_o is a weighted average of the individual commodity scales, $m_o = m_o(m_1, m_2, \ldots, m_n, Y)$. Note that these commodity specific scales incorporate no relative price effects. The Prais-Houthakker specification is, hence, consistent with demand theory where only prices are held constant by experimental control, as in cross section data.

Barten (1964) presented a generalization of the Prais-Houthakker work in a modified utility framework. The resulting modified demand function is

$$(85) \qquad Q_i = m_i\bar{Q}_i(P_1m_1, P_2m_2, \ldots, P_nm_n, Y) \qquad \text{for all } i,$$

or, in scaled quantities and prices,

(86) $$\hat{Q}_i = \hat{Q}_i(\hat{P}_1, \hat{P}_2, \ldots, \hat{P}_n, Y); \qquad \text{for all } i,$$

where $\hat{Q}_i = Q_i/m_i$ is a "normalized" quantity of commodity i, m_i is a commodity-specific-adult-equivalent scale, and $\hat{P}_i$ is a normalized price. Changes in family composition therefore modify relative prices and, consequently, substitution among goods.

The Barten approach has been defined by Pollak and Wales (1969, 1978, 1981) as a scaling technique for incorporating household-specific demographic variables in demand systems. The procedure involves first postulating the scaling parameters, $m_1, \ldots, m_n$, which depend only on demographic variables. That is,

(87) $$m_i = \bar{m}_i(\eta); \qquad \text{for all } i,$$

where the modified demand function is as specified in equation (86).

The demand function in equation (86) has an attractive interpretation. The demand for, say, number of kilograms of rice per (rice) equivalent person is expressed as a function of price per kilogram of rice per (rice) equivalent person, and income. Similarly, as shown in Table 1, the direct and indirect utility functions are expressed in normalized quantities and prices. A problem with the specification is that changes in relative prices are not distinguishable from changes in household composition.

Pollak and Wales (1981) reviewed and/or developed the other four procedures for reflecting nonhomogeneous household effects: demographic translation procedure, the Gorman procedure, the reverse Gorman procedure, and the modified Prais-Houthakker procedure. The translation procedure facilitates the introduction of parameters, $d_1, \ldots, d_n$, linked to the demographic variables through the functional form

$$d_i = d_i(\eta); \qquad \text{for all } i. \tag{88}$$

The modified demand system replacing equation (4) is

$$Q_i = d_i + \bar{Q}_i(P,\ Y - \Sigma P_k d_k), \tag{89}$$

where only the d's depend on the demographic variables. These translating variables represent characteristics of all household members as opposed to scales, for example, race, region, location, etc. The d's can be interpreted as parameters reflecting "subsistence" or "necessary" consumption levels. Alternatively, the demand function in equation (89) can be viewed as being generated in a two-stage budgeting process. First, the household allocates part of its total expenditure to a vector of necessary quantities, $d_1, d_2, \ldots, d_n$. Then, in the second stage, it allocates the balance, $Y - \Sigma P_k d_k$, among the various commodities. This interpretation is similar to that advanced for the Linear Expenditure System (LES).

The <u>Gorman procedure</u> can be viewed as equivalent to first scaling and then translating the original demand function, $Q_i = Q(P, Y)$. The modified demand system becomes

$$Q_i = d_i + m_i \bar{Q}_i(P_1 m_1,\ P_2 m_2, \ldots, P_n m_n,\ Y - \Sigma P_k d_k), \tag{90}$$

where the d's and m's are parameters postulated to depend on sociodemographic variables. If the order is reversed, that is, the demand function is first translated and then scaled, the resulting procedure (<u>reverse Gorman</u>) yields a system

$$Q_i = m_i[d_i + \bar{Q}_i(P_1 m_1,\ P_2 m_2, \ldots, P_n m_n,\ Y - \Sigma P_k d_k)]. \tag{91}$$

The <u>modified Prais-Houthakker procedure</u> adjusts the original demand system (4) as

$$(92) \qquad Q_i = m_i\bar{Q}_i(P,\ Y/m_o),$$

where the commodity-specific scales, m's, depend on the demographic variables, $m_i = \bar{m}(\eta)$. The income or composite scale, m_o, is defined through the budget constraint,

$$(93) \qquad \Sigma P_i m_i \bar{Q}_i(P,\ Y/m_o) = Y$$

and a function of all prices, income, and demographic variables, $m_o = \bar{m}_o(P,\ Y,\ \eta)$.

The main difference among these procedures is in the way the utility functions are modified (Table 1). All the modified demand functions are, in general, consistent with the theory of consumer demand. The only exception is the demand system in equation (92) which, according to Pollak and Wales (1981), is a theoretically plausible demand system only if the original demand system (4) is derived from an additive direct utility function.

Finally, by incorporating household characteristics, the demand functions can add more realism to empirical studies. These gains are, however, achieved at a cost of estimating additional parameters. Pollak and Wales (1981) have suggested simple and convenient specifications of the functions for relating the d's and m's to observed household characteristics:

$$(94) \qquad d_i = \bar{d}_i(\eta) = \gamma \sum_{j=1}^{r} a_{ij}\eta_j, \text{ and}$$

Table 1. Specifications of Direct and Indirect Utility Functions Under Four Alternative Techniques

Procedure	Direct utiltity function $U = U(Q)$	Indirect Utility Function $V = V(P, Y)$
Scaling	$U = U[Q_1/m_1,\ Q_2/m_2,\ \ldots,\ Q_n/m_n]$	$V = V[P_1m_1,\ P_2m_2,\ \ldots,\ P_nm_n,\ Y]$
Translating	$U = U[(Q_1-d_1),\ (Q_2-d_2),\ \ldots,(Q_n-d_n)]$	$V = V[P,\ Y-\Sigma P_jd_j]$
Gorman	$U = U[(Q_1-d_1/m_1),\ (Q_2-d_2/m_2),\ \ldots,\ (Q_n-d_n/m_n)]$	$V = V[P_1m_1,\ P_2m_2,\ \ldots,\ P_nm_n,\ Y-\Sigma P_jd_j]$
Reverse Gorman	$U = U[Q_1/m_1)-d_1,\ (Q_2/m_2)-d_2),\ (Q_n-d_n)/m_n]$	$V = V[P_1m_1,\ P_2m_2,\ \ldots,\ P_nm_n,\ Y - \Sigma P_jm_jd_j$

$$m_i = \bar{m}_i(\eta) = 1 + (1 - \gamma) \sum^{r} b_{ij}\eta_j, \tag{95}$$

where linear translating corresponds to $\gamma = 1$ and linear scaling to $\gamma = 0$.

Household Production Theory

The household production theory, primarily an outgrowth of the traditional consumer theory, has two major themes. First, the classical consumer demand theory assumes that a consumer derives satisfaction from a consumption of a vector of quantities of market goods. The "new" approach hypothesizes that the consumer derives satisfaction from consumption of characteristics, derived in part from market goods. These characteristics are produced in the household from the combination of purchased market goods, labor, and human and physical capital. Second, the explanatory variables in the classical demand functions are vectors of market prices, income, and taste. The classical theory is incapable of either explaining tastes or predicting *a priori* effects of selected proxies for tastes on consumption behavior. The approaches to alter demand models demographically can be interpreted as, for example, attempts to reflect these characteristics, thereby enhancing the explanatory power of demand theory. The household production approach adds this dimension by rationalizing the incorporation of production-related parameters in demand systems.

The household production theory is essentially a combination of theory of the consumer and of the firm. The households, as producers, decide the mix and level of production of the home-produced consumption characteristics (known in the literature as the Z-commodities). Simultaneously, the household decides the amounts of the market purchased goods, labor, and other factors to allocate to the production of these characteristics or commodities.

Efficiency of allocation of resources is guaranteed if the household firm maximizes profit or minimizes the cost of producing a given level of the outputs. As a consumer, the household allocates the income derived from the production activity to the consumption of the "commodities" from which utility is derived. Utility maximization conditions guarantee that the consumer maximizes satisfaction.

The basic structure of the household production theory can be summarized by the relationships:

$$\begin{aligned} &\text{Max} \quad U = U\ (Z) \\ &\text{St.} \quad PQ + W\ T_H = C \qquad (96) \\ &\qquad F(Q,\ T,\ Z;\ K) = 0 \end{aligned}$$

where Z is a row vector of home-produced commodities, Q is a row vector of market goods, P is a column vector of prices, T_H is a row vector of home-used labor or other factors, W is a column vector of wages or prices of these home-used factors, C is cost, F is household production function in implicit form, and K is a vector of inputs fixed in the short run.

The optimal choice of the Z-commodities can be determined by two alternative but equivalent approaches: (1) the direct approach, and (2) the two-stage approach. The direct approach is to maximize the utility function in the consumed commodities, subject to a full income constraint. This maximization problem can be represented by the Langrangian equation,

$$L = U(Z) + \lambda_1(C - PQ - WT_H) + \lambda_2 F(Q,T,\ Z;\ K). \qquad (97)$$

The optimal solution is characterized by the condition that the ratio of marginal rate of substitution between any pair of consumed commodities is equal to the ratio of their respective relative shadow prices. These shadow prices, Π,

$$\Pi = \Pi(P, W, Z; K) \tag{98}$$

are endogenously determined as functions of the input prices, the demand for Z-commodities, fixed inputs, and the technology parameters.

In most cases the Z-commodities and their respective shadow prices are not observable. Thus, it is more tractable to optimize through the inputs that go into the production of the basic commodities. The process is accomplished in two stages. Stage one is to determine the minimum cost of producing the Z-commodities at particular output levels (Z^*). That is, to solve the Lagrangian problem,

$$L = PQ + W\,T + \Theta\,F(Q, T, Z; K), \tag{99}$$

such that the cost of production is minimized for a given technology. The solution to this problem gives the short-run cost function,

$$C = C(P, W, Z^*; K), \tag{100}$$

where C is expressed as a function of the vector of the prices of market goods, wage rates or factor prices conditioned upon the output, Z^*, and capital, K^*, vectors. Thus, the cost function characterizes the minimum cost for producing Z^*, given the other parameters. Of course, it has properties similar to the cost function for the firm. Applying Shephard's lemma to the cost function, the derived input demand functions for market goods and labor in household production are

$$\frac{\partial C}{\partial P_i} = Q_i(P, W, Z; K), \tag{101}$$

$$\frac{\partial C}{\partial W} = T_H(P, W, Z; K), \text{ and} \tag{102}$$

$$\frac{\partial C}{\partial Z_i} = \Pi_i(P,\ W,\ Z;\ K) \tag{103}$$

where equation (101) is the demand for market goods, equation (102) is demand for labor in household production, and equation (103) represents the shadow price; which Π_i measures the marginal cost of output Z_i.

Stage two is to maximize the utility function, defined in the Z space, subject to income determined as a solution in equation (6). That is, in the second stage, the Lagrangian equation

$$L = U(Z) + \lambda[C - \bar{C}(P,\ W,\ Z;\ K)] \tag{104}$$

is solved. The solution to this second stage optimization problem yields the demand functions for the commodities, Z:

$$Z_j = Z_j(C,\ \Pi) \qquad j = 1,\ 2,\ \ldots,\ m. \tag{105}$$

The complete set of the structural equations constitute the derived demand for inputs [equations (101) and (102)], the shadow price function [for example, equation (103)] and the demand functions for Z-commodities [for example, equation (105)]. Note that the shadow prices are determined within the system.

The principal complication with the household production approach is the nonlinearity of the budget constraint in the Z-commodity space. An ad hoc approach that can be used to obtain a linear budget constraint is to impose the assumption of linear homogeneity in Z (constant returns to scale) and to define the shadow prices, Π, conditional on the optimal level of Z^*. Thus, the demand function for the basic commodity, Z_j, is specified as

$$\hat{Z}_j = \hat{Z}_j(C,\ \Pi^*). \tag{106}$$

The demand functions, $\hat{Z}_j$, satisfy the adding-up condition:

$$\Sigma_j \Pi_j^* Z_j (C, \Pi^*) = C$$

by Eulers theorem, and the Slutsky sign and symmetry conditions (LeFrance 1983). An alternative is to view the technology as nonjoint and linearly homogeneous in Z (Muellbauer 1974). The cost function then becomes

$$C = \Sigma_j C_j (P,\ W,\ K)\ Z_j, \tag{107}$$

which is independent of the level of Z. Since C_i is a unit price of commodity j, it is equivalent to $\Pi_i = \Pi_i(P,\ W,\ K)$. The shadow price is also independent of the levels of the demand consumption goods for Z. The imposition of the assumption of additive production functions renders the model simple to estimate but restrictive in behavioral implications (Pollak and Watcher 1975).

There are two variants of the household production theory: the commodity characteristics (Lancaster 1966) and the production function approaches (Becker 1965, Muth 1966, and Michael and Becker, 1973). The latter can be specialized to the farm household production-consumption decision problem.

The Characteristics Approach

According to the characteristics approach, the consumed Z-commodities represent objective features of market goods. Consumers buy commodities, not for the commodities per se, but for their characteristics, the primary objects of choice. The decision to allocate income, for example, to food purchases reflects a conscious and rational effort of consumers to purchase a desired mix of nutrients.

The Lancaster model is similar in specification to equation (96). The consumed Z-commodities are characteristics transformed from purchased market goods. A linear transformation function is assumed where

$$Z_j = \Sigma b_{ji} Q_i \tag{108}$$

and b_{ji} represents the quantity of the j^{th} characteristics provided by one unit of market good i. These characteristics are measureable, objective, and the same for all consumers.

The demand for the characteristics can be derived by the linear optimization procedure discussed above (Deaton and Muellbauer 1980a). From the assumption of constant returns to scale,

$$P_i = \Sigma \Pi_j b_{ji}, \tag{109}$$

where the price of market good i, P_i, is a weighted linear combination of the characteristics of good i. That is, the prices of market goods reflect the values of the characteristics. Since b_{ji}'s are assumed constant and observable and the P's are known parameters, equation (9) can be solved (for interior solutions) to determine the implicit prices of the characteristics.

The main limitations of the Lancaster model are (1) the assumption of linear consumption technology (Lucas 1975); (2) the assumption that the utility function depends upon the level of characteristics and not on their distribution among commodities; and (3) the nonnegativity of the marginal utility of characteristics (Hendler 1975).

The Production Approach

Like the Lancaster model, the production approach assumes that consumers derive satisfaction from the consumption of Z-commodities or characteristics. The consumed Z-commodities are "nonmarket basic commodities". Leisure time, for example, is an element of the vector of the Z-commodities in Becker's (1965) pure producer model. Nonleisure time used in the production of the basic commodities is assumed, implicitly, to have no contribution to the utility of the household.

The production technology is usually assumed nonjoint, and the production of the basic commodities depends on the market goods, labor, and a given stock of capital,

$$\bar{Z}_j = \bar{Z}_j(Q,\ T_H;\ K). \tag{110}$$

Equation (110) implies that market goods, Q, and time, T_H, can be allocated to a separate production process for the outputs Z_j. Demands for the consumed Z-commodities are then derived in either a two-stage process or directly through maximization in the Z-commodity space. An additional assumption of linear homogeneity of production in the Z-commodities facilitates simpler derived demand functions.

The Farm Production Model: This model is a specialization of the household production approach. First, it recognizes that a farm household integrates, more fully, both consumption and production activities. The nature of the integration depends on the commodity markets and production processes (Tesfaye 1984). Second, the household, as a firm, combines inputs including labor to produce farm output conditioned by a given technology and a stock of human and physical capital stock. The income from these production activities, wage income, sales income, and asset income flow to the households. As a consumer, the household, in turn, allocates income to alternative consumption of goods.

Unlike the simple household model (Becker 1965), the farm household is not treated as a producer of all the goods that it consumes. The household can derive satisfaction from consumption of home-produced as well as purchased market goods. The household maximizes utility, subject to three constraints, that is,

$$\text{maximize} \quad U = U(Q,\ T_L;\ \gamma)$$

(111) $$\text{subject to: } Q = F(T_F,\ X_F;\ k_F),$$

(112) $$T = T_L + T_F + T_M, \text{ and}$$

(113) $$Y = \Pi + W_M T_M + V.$$

Equation (111) represents farm technology, where Q and T_F are vectors of farm outputs and inputs, respectively, and X_F is a vector of variable inputs with k_F a matrix of fixed farm inputs. The value T in Equation (112), total available time to the household, is allocated to leisure (T_L), farm inputs (T_F), and off-farm wage-work (T_M). Equation (113) is the income equation, where $\Pi(P,\ R;\ k_F)$, $W_M T_M$, and V represent farm net income, wage income, and nonfarm-nonwage income, respectively. Net income, Π, is $P_F'Q - R'X_F - W_M T_F$ where P_F, R, and W_M are vectors of producer prices, variable input prices, and wage rates, repectively.

The resulting demand system is

(114) $$Q = D(P_c,\ Y(P_F,\ R,\ V,\ k_F);\ \gamma)$$

where P_c is a vector of consumer prices and γ is a vector of household characteristics. A price-transmission equation can be used in the demand system to connect consumer and producer prices.

The distinctive feature of this farm household demand structure, compared to equation (4), is the presence of production parameters. The income equation serves as a link betwen production and consumption in the model. Full characterization of these farm household demand functions requires all price elasticities and the elasticities associated with levels on factor endowments, technology, and household specific characteristics.

Food Demand Studies on Indonesia

The food consumption patterns in Indonesia exhibit distinct features and variations by region, season, and socioeconomic characteristics (report #1-Indonesia, 1985).

1. Food is the main share of total household expenditure. An average Indonesian household has a food budget share of 68 percent (Chernichovsky and Meesook, 1984).
2. The shares for the staple crops, that is, rice, corn, cassava, potatoes, and wheat, account for no less than one-third of the food budget.
3. Among the staples, rice is dominant. Households in every region spend, on average, at least two-thirds of their staple food budgets on rice. The share of rice above this minimum varies depending on the availability of the other staples. Next to rice, for example, maize and cassava are important crops in Central Java, Yogyakarta, Maluku, and Irian Jaya.
4. Compared with the other staples, the diet is centered more on rice in urban than in rural areas.
5. The share of the staple crops in the food budget declines as the average income rises. At the same time, the high income groups tend to consume larger quantities of rice compared to low income groups.
6. Except in urban areas where nonrice crops are less important, the secondary crops play more of a stabilizing role in maintaining the food consumption level in rural areas.

Several studies have estimated the demand elasticities for the staple crops of Indonesia. Timmer (1971), using the 1967 Susenas Survey, estimated the expenditure elasticities for rice in rural and urban Java. Boediono (1978) estimated price and income elasticities for forty-one commodity groups using the 1969/70 and 1976 Susenas Surveys. Hedley (1978), Timmer and Alderman (1979), the World Bank [in Dixon (1982)], and Dixon, in collaboration with Anwar and Mears [in Mears (1981)], also estimated separately demand elasticities based on the 1976 Susenas Survey. Further, Chernichovsky and Meesook (1984), using a more recent Susenas, have estimated demand elasticities for fourteen food groups. The World Bank report (1983) also contains demand elasticity estimates from time series data. All elasticity estimates, except those from the World Bank (1983) are from cross section data.

Selected demand elasticity estimates from these studies are presented in Table 2. Specifically, Table 2 shows the data source, the demand system specification, and the regional and income breakdowns for the estimated elasticities. The studies vary greatly in time, commodities covered, commodity aggregation, classification of income groups, demand systems specifications, and estimation procedures.

Hedley (1978) used data collected in the second round of the 1976 Susenas Survey. He specified ten commodity groups and disaggregated by region (Java/outer Java) and by location (rural/urban). Rice and other staple crops were aggregated in a cereals category. A linear expenditure system was used to estimate expenditure elasticities for all of the commodity groups. The World Bank study of 1978 [in Dixon (1982)] used all of the 1976 Susenas expenditure survey. Following Hedley (1978), the data were partitioned by island group and location. Each partition of the data was further divided by income group, based on per capita monthly expenditures (Table 2, Column 7).

The approach of Timmer and Alderman (1979) used a similar classification system to that adopted by the World Bank (1978) [in Dixon (1982)]. The difference was the cut-off points for partitioning the sample by income group. Two staple crops, (rice and fresh cassava) and one diet component (calories) were included. A double-log-quadratic function was used to estimate price and expenditure elasticities. A covariance analysis was applied, in addition, to isolate the effects of spatial and seasonal variations in consumption responses.

Chernichovsky and Meesook (1984) extended the work of Timmer and Alderman (1979) by estimating demand elasticities for fourteen food groups and eleven diet components. The estimates include expenditure elasticities for the staple crops and calories and protein. Separate elasticities were estimated for populations deficient in calories. A log-linear procedure was applied in the three-round 1978 Susenas Survey to generate these results.

Dixon (1982) estimated price and expenditure elasticities for rice, fresh cassava, dried cassava (gaplek), and sweet potatoes. The 1976 Susenas expenditure survey was the data base. Like most of the previous studies, the data were partitioned by island, rural and urban areas, and income (consumption) groups. But unlike the other studies, the grouping of the population was by caloric intake level. Three calorie consumption population groups were identified using daily totals: less than 1755 k calories, 1755 to 2300 k calories, and over 2300 k calories. The objective was to group the population by equivalent calorie consumption, regardless of income. The estimation procedures then applied were, by and large, similar to Timmer and Alderman (1979).

The results of these studies are not, in general, directly comparable technically. However, they are comparable in the sense of their potential application in food and agriculture policy issues. Still, caution should be exercised in jointly applying and interpreting consequences these coefficients for food and nutrition policy. Notwithstanding these qualifications, however, useful structural and policy inferences can be drawn from these studies. It is emphasized that these studies represent the present empirical basis for food policy analysis; and while not directly comparable theoretically, they do have the same policy focus.

Rice: The cross-section based expenditure elasticities for rice for all Indonesia range between 0.47 and 0.69. These estimates are higher than those estimated from time series data (0.20). Despite the variations in the elasticities, all the coefficients suggest that the consumption of rice increases with income, but not proportionally.

The expenditure elasticities for rice are, in general, lower in urban areas. For example, according to Timmer and Alderman (1979), the coefficients were 0.58 and 0.27 for rural and urban areas, respectively. The coefficients appear to fall much faster as income rises within Java than for the off-Java islands. This pattern is consistent with the increased diversity of foods in urban areas.

The estimated expenditure elasticities for rice give a general view of the income-consumption relation. The income elasticities are positive for all income groups. The income-specific expenditure elasticities for all Indonesia range between 0.98 and 1.16 for the poor, and 0.19 and 0.28 for the higher income groups. The urban expenditure elasticities are low for all income groups. These estimates range between 0.83 and 1.52 for the rural poor and 0.36 and 0.96 for the urban poor. Among the upper income groups, the coefficients vary between 0.13 and 0.29 in rural areas and -0.12 and 0.03 in urban areas.

Rice is a superior food among the poor in rural areas. Because of the increasing diversity of foods and a declining share of rice in the food budget with rising income levels, the expenditure elasticities are lower for higher income groups. For regions, the studies suggest (except Chernichovsky and Meesook 1984) that the income elasticities for Java are lower than for the off-Java islands (World Bank 1978, in Dixon 1982; and Dixon 1982).

Over the years, these elasticities have shown a pattern of decline with time. In the years between 1967 and 1976, for example, the rice expenditure elasticities fell from 0.44 (Timmer 1971) to 0.15 (World Bank 1978) for urban Java, and from 0.74 (Timmer 1971) to 0.56 (World Bank 1978) for rural Java. For Indonesia as a whole, the elasticities declined from 0.69 (Boedino 1978) to 0.47 (World Bank 1978) for the period between 1976 and 1978. Such a trend is likely to continue as the country experiences a rising level of per capita income.

The estimated own-price elasticities present a less conclusive picture of consumption behavior. However, the studies provide noticeable patterns. First, rice consumption responds to changes in relative prices. Second, the own-price elasticities are all negative regardless of location and income partition. Third, the own-price elasticities decline in absolute terms as the average income level rises. This pattern is possibly associated with the rice-centered staple food consumption of high income groups. Finally, the absolute-price elasticities based on cross-section data are higher than those from time series data.

Cassava: The expenditure elasticities for fresh cassava range between 0.26 and 0.29. For dried cassava, consumed largely by the rural population, the elasticity is -0.62 (Dixon 1982). The expenditure elasticities for cassava are positive for the low and medium groups, but, regardless of the location, negative for high income groups. On a regional basis, the elasticities are larger in off-Java than Java (see Chernichovsky and Meesook 1984). Cassava,

Table 2: Selected Own Price and Expenditure Elasticities for Staple Crops - Indonesia

Study	Data Source	Demand System	Country/ Region	Location	Crop	Income Group ('000 Rp/Pop/month)	Elasticity Price	Elasticity Expenditure
Timmer (1971)	Susenas-III(1967)	*	Java		Rice			0.69
				Rural		LN. 0.3		0.92
						0.3-1.0		0.63
						GR. 1.0		0.34
						AV.		0.74
				Urban				
						LN. 0.3		0.75
						0.3-1.0		0.44
						GR. 1.0		0.13
						AV.		0.44
Boedino	Susenas-	LES	Indonesia		Cereals			

Table 2: Selected Own-Price and Expenditure Elasticities for Staple Crops - Indonesia

Study	Data Source	Demand System	Country/ Region	Location	Crop	Income Group ('000 Rp/Pop/month)	Elasticity Price	Elasticity Expenditure
Timmer	Susenas-	*	Java		Rice			0.69
(1971)	III(1967)			Rural		LN. 0.3		0.92
						0.3-1.0		0.63
						GR. 1.0		0.34
						AV.		0.74
				Urban				
						LN. 0.3		0.75
						0.3-1.0		0.44
						GR. 1.0		0.13
						AV.		0.44
Boedino	Susenas-	LES	Indonesia		Cereals			
(1978)	IV(1969-			Rural			-0.68	0.71
	1970)			Urban			-0.51	0.50
Boedino	Susenas-	log	Indonesia		Rice		-.63	0.69
(1978)	IV/V	linear			Corn, tuber			
	(1976)				& root crops		-.26	0.30
Hedley	Susenas-	LES	Java		Cereals			
(1978)	V(1976)			Rural				0.56
				Urban				0.24
			Outer-Java					
				Rural				0.69
				Urban				0.39
World	Susenas-	*	Indonesia		Rice			
Bank	V(1976)					LN. 2.0		0.98
(1978)						2.0-3.999		0.61
						4.0-7.999		0.33
						GE. 8.0		0.19
						AV.		0.47

Table 2 (continued)

Study	Data Source	Demand System	Country/ Region	Location	Crop	Income Group ('000 Rp/Pop/month)	Elasticity Price	Elasticity Expenditure
			Java			LN. 2.0		0.96
						2.0-3.999		0.58
						4.0-7.999		0.32
						GE. 8.0		0.16
						AV.		0.49
				Rural				
						LN. 2.0		0.99
						2.0-3.999		0.62
						4.0-7.999		0.38
						GR. 8.0		0.24
						AV.		0.56
				Urban				
						LN. 2.0		0.46
						2.0-3.999		0.25
						4.0-7.999		0.12
						GR. 8.0		0.07
						AV.		0.15
			Off-Java			LN. 2.0		1.04
						2.0-3.999		0.67
						4.0-7.999		0.34
						GR. 8.0		0.22
						AV.		0.44
				Rural				
						LN. 2.0		1.15
						2.0-3.999		0.68
						4.0-7.999		0.33
						GR. 8.0		0.29
						AV.		0.49
				Urban				
						LN. 2.0		0.90
						2.0-3.999		0.55
						4.0-7.999		0.42
						GR. 8.0		0.03
						AV.		0.32

Table 2 (continued)

Study	Data Source	Demand System	Country/ Region	Location	Crop	Income Group ('000 Rp/Pop/month)	Elasticity Price	Elasticity Expenditure
Timmer & Alderman (1979)	Susenas-V(1976)	log linear	Indonesia		Rice			
						LN. 2.0	-1.92	1.16
						2.0-3.0	-1.48	0.92
						3.0-5.0	-1.16	0.68
						GE. 5.0	-0.74	0.28
						AV.	-1.11	0.53
					Fresh Cassava			
						LN. 2.0	1.28	0.99
						2.0-3.0	-0.82	0.68
						3.0-5.0	-0.94	0.39
						GE. 5.0	-0.78	-0.08
						AV.	-0.80	0.39
				Rural	Rice			
						LN. 2.0	-1.33	1.17
						2.0-3.0	-0.99	0.92
						3.0-5.0	-0.82	0.70
						GE. 5.0	-0.61	0.36
						AV.	-0.84	0.58
					Fresh Cassava			
						LN. 2.0	-1.26	0.99
						2.0-3.0	-0.81	0.68
						3.0-5.0	-0.94	0.39
						GE. 5.0	-0.78	-0.05
						AV.	-0.91	0.41
				Urban	Rice			
						LN. 2.0	-1.32	0.997
						2.0-3.0	-1.06	0.76
						3.0-5.0	-0.92	0.53
						GE. 5.0	-0.72	0.07
						AV.	-0.81	0.27
					Fresh Cassava			
						LN. 2.0	-1.27	0.84
						2.0-3.0	-0.81	0.52
						3.0-5.0	-0.94	0.23
						GE. 5.0	-0.78	-0.37
						AV.	-0.86	-0.05

Table 2 (continued)

Study	Data Source	Demand System	Country/ Region	Location	Crop	Income Group ('000 Rp/Pop/month)	Elasticity Price	Elasticity Expenditure
World Bank (1984)	*	*	Indonesia					
					Rice		-0.15	0.20
					Corn		-2.27	-0.21
					Wheat		-0.53	0.99
					Cassava		-0.19	0.20
					Sweet Potatoes		-0.47	-0.02

Table 2 (continued)

Study	Data Source	Demand System	Country/ Region	Location	Crop	Income Group ('000 Rp/month)	Elasticity Price	Elasticity Expenditure
D. Cherni-		log	Java		Rice			
chovsky	Susenas-	linear				LE. 12.999		3.02
& Meesook	VI(1978)					13.0-23.999		0.91
(1984)						GE. 24.00		0.03
					Corn			
						LE. 12.999		-0.62
						13.0-23.999		-0.43
						GE. 24.00		0.20
					Wheat			
						LE. 12.999		0.06
						13.0-23.999		-0.03
						GE. 24.00		0.94
					Cassava			
						LE. 12.999		0.24
						13.0-23.999		0.79
						GE. 24.00		-0.07
					Potatoes			
						LE. 12.999		0.54
						13.0-23.999		1.24
						GE. 24.00		1.67
			Off-Java		Rice			
						LE. 22.999		1.15
						23.0-35.999		0.40
						GE. 36.000		0.05
					Corn			
						LE. 22.999		-0.29
						23.0-35.999		-0.13
						GE. 36.000		0.57

Table 2 (continued)

Study	Data Source	Demand System	Country/ Region	Location	Crop	Income Group ('000 Rp/month)	Elasticity Price	Elasticity Expenditure
					Wheat			
						LE. 22.999		0.42
						23.0-35.999		1.22
						GE. 36.000		1.67
					Cassava			
						LE. 22.999		0.37
						23.0-35.999		0.72
						GE. 36.000		0.11
					Potatoes			
						LE. 22.999		0.67
						23.0-35.999		1.67
						GE. 36.000		1.63

Table 2 (continued)

Study	Data Source	Demand System	Country/ Region	Location	Crop	Calorie Level ('000 kcalories/day)	Elasticity Price	Expenditure
Dixon, Anwar, & Mears in Mears (1981)	Susenas-V(1976)	*	Java		Rice			
				Rural		LN. 1.755		0.97
						1.755-2.300		0.36
						GR. 2.300		
				Urban				
						LN. 1.755		0.37
						1.755-2.300		
						GR. 2.300		
			Off-Java					
				Rural		LN. 1.755	-1.9	1.52
						1.755-2.300	-1.58	0.58
						GR. 2.300	-0.88	0.28
				Urban				
						LN. 1.755	-2.05	0.96
						1.755-2.300	-0.81	0.35
						GR. 2.300	-0.80	
Dixon (1982)	Susenas-V(1976)	log linear	Java	Rural	Fresh Cassava			
						LN. 1.755		0.85
						1.755-2.300		0.12
						GR. 2.300		-0.63
						AV.	-0.81	0.28
					Gaplek			
						LN. 1.755		0.83
						1.755-2.300		-1.02
						GR. 2.300		-2.90
						AV.	-1.86	-0.62
					Sweet Potatoes	LN. 1.755		1.56
						1.755-2.300		0.39
						GR. 2.300		-0.80
						AV.		0.64
				Urban	Fresh Cassava			
						LN. 1.755		0.09
						1.755-2.300		-0.28
						GR. 2.300		-0.65
						AV.		-0.13

Table 2 (continued)

Study	Data Source	Demand System	Country/ Region	Location	Crop	Calorie Level ('000 kcalories/day)	Elasticity Price	Elasticity Expenditure
					Sweet Potatoes	LN. 1.755		0.46
						1.755-2.300		-0.15
						GR. 2.300		-0.78
						AV.	-2.69	0.09

Key:
- *: unidentified
- LN: <
- LE: ≤
- GR: >
- GE: ≥

in short, appears to be consumed mainly by the low-income, rural population. The general pattern of elasticities suggests that cassava is an inferior good.

Other staples: According to the World Bank (1983), the expenditure elasticity for sweet potatoes is on average, -0.02. This estimate, from time series data, implies that consumers reduce their consumption of sweet potatoes as their incomes rise. Dixon (1982), using 1976 Susenas data for Java, found expenditure elasticities of 0.64 and 0.09 for rural and urban Java, respectively. Across income groups, however, the elasticities are negative for upper income groups. Dixon (1982), therefore, suggests that sweet potatoes are the inferior crop only among the wealthier groups.

Chernichovsky and Meesook (1984) combine sweet potatoes with potatoes, targo, and sago and enter all as "potatoes" in their model. They find the elasticities to be positive both in Java and on off-Java islands regardless of income levels. And, contrary to the case of sweet potatoes, the expenditure elasticities increase with income.

What is to be learned from these demand elasticity estimates?

(1) The majority of the studies have centered on the principal food crop--rice.

(2) Expenditure elasticities, for rice in particular, appear to decline with time.

(3) Price elasticity estimates are largely limited to own-price effects. Cross-price elasticity estimates are absent or highly erratic in value.

(4) The double-log demand system has been widely used in estimating demand parameters. This specification, despite its convenience, imposes restrictive assumptions on preference structure and is not

consistent except under highly specialized assumptions, with demand theory and unnecessary in analyses of survey data.

(5) The studies have abstracted from the interdependency of consumption and production decisions. This may be particularly restrictive for farm households that retain part of their output for own consumption.

(6) No systematic linkages have been developed between food consumption and nutritional status

Closing the Gap

The current project has the objective of estimating probable effects of policy changes in food consumption patterns and nutritional status. This entails

(1) understanding consumption patterns of households with different socioeconomic characteristics,

(2) identifying their nutritional status, and

(3) estimating food and/or nutrition demand parameters.

Using these results, a linkage between policy driven price changes to food consumption patterns and nutrition status will be established.

Three main considerations will be used in choosing specific empirical demand systems to be applied. First, the demand systems will be consistent with the consumer demand theory. Second, the applied demand systems will be flexible, yet simple enough to be estimated and adapted to the data for Indonesia. Third, their theoretical structures will permit generation of market demand systems consistent with the individual demand systems. The empirical models reviewed in this report will be evaluated and applied on the basis of these criteria.

The food demand models will be estimated for different levels of commodity aggregation. In the case of rice and other secondary staple crops (corn, cassava, and potatoes), there will be separate demand parameters for each crop. Given the importance of these commodities in the Indonesian diet and their priority in food policy programs, these parameter estimates are of prime importance for the planned policy analysis. Other commodities will be grouped into composite products and their respective demand parameters will be estimated.

The household production approach will be used as a theoretical base in developing empirical nutrient demand specifications. First, indices of nutrient availability will be estimated. Second, a two-equation including the Engel curve for food cost and indices of nutrient availability will be estimated. Finally, the availability of the selected micronutrient will be linked to the indices of nutrient availability. The estimation will be joint reflecting the likely simultaneous nature of food and nutrition choices.

The research approach will be to broadly categorize the sample into farm and nonfarm households. This distinction permits dealing separately with farm and nonfarm households. The nonfarm households will be further split into urban and rural households. These latter groups are treated as if consumption choices are made as conditioned by an exogenous income.

For the farm households, the household production function approach will be adopted in developing the demand parameters. This model recognizes the interdependency of consumption and production choices, but assumes the decisions are separable. That is, decisions flow in one direction--production linked to consumption via the endogenously determined income.

The empirical significance of the farm household production model has been documented elsewhere (Tesfaye 1984; Singh, Squire, and Strauss 1985). Unlike the conventional demand system, this model admits farm output, input price, and production parameters in the consumption choice decision. Table 3 shows selected results obtained with this demand framework. Observe in Table 3 that production parameters have sizable influence on food consumption patterns. Note that with this framework, it is theoretically plausible for the demand curve to be positively sloped as indicated by the signs of the coefficients in Table 3. The property of demand functions for food in the integrate production-consumption model has far reaching implications on food policy in low income agricultural countries like Indonesia.

Table 3. Selected Food Demand Elasticities Under Variable Income Hypothesis

Commodity	Country	Demand System	Own Price	Wage Rate	Family Labor Force	Size of Dependents	Land Quality
			----------Elasticities with respect to----------				
Rice	Korea	LES	.01	.01	--	--	--
	Malaysia	LES	.38	-.08	.44	.23	--
	Sierra Leone	QES	-.66	.37	--	--	.01
All Food Crops	Japan W_F	LLES	-.35	.15	.07	.14	.19
	W_{NF}			.32			
	Taiwan		.22	-.03	.84	.43	

Keys: LES (Linear Expenditure System)
LLES (Linear Logarithmic Expenditure System)
QES (Quadratic Expenditure System.
W_F = Farm Wage
W_{NF} = Non-farm Wage

SOURCE: Singh, Squire, and Strauss (1985)

REFERENCES

Barten, A. P. Consumer Demand Functions Under Conditions of Almost Additive Preferences. Econometrica 32 (1964):1-38.

________. Maximum Likelihood Estimation of a Complete System of Demand Equations. European Economic Review (1969):7-73.

________. The Systems of Consumer Demand Functions Approach: A Review. Econometrica 45(1977):23-51.

Becker, Gary S. A Theory of the Allocation of Time. Economic Journal 75(1965):493-517.

Bernde, E. R. and Mohammed S. Khaled. Parametric Productivity Measurement and Choice Among Flexible Functional Forms. Journal of Political Economy 87(1979):1220-45.

Boedino. Elasticitas Permintaan Untuk Ber bagai Barang di Indonesia: Penerapan Metode Frisch. Ekonomi dan Keldangan Indonesia. September 1978.

Box, G. E. P. and D. R. Cox. An Analysis of Transformations. Journal of the Royal Statistical Society 26(1964):211-243.

Brown, J. A. C. and A. Deaton. Surveys in Applied Economics: Models of Consumer Behavior. The Economic Journal 82(December 1972):1145-1236.

Brown, M., Richard Green, and S. R. Johnson. Preferences and Optimization Tests Within the Almost Ideal Demand System. 1986.

Chernichovsky, D. and D. A. Meesook. Patterns of Food Consumption and Nutrition in Indonesia. World Bank Staff Working Paper #670, September 1984.

Christensen, L. R., D. W. Jorgenson, and L. J. Lau. Transcendental Logarithmic Utility Function. American Economic Review 65(1975):367-383.

Deaton, A. and J. Muellbauer. Economic and Consumer Behavior. Cambridge: Cambridge University Press, 1980a.

________. An Almost Ideal Demand System. American Economic Review 70(1980b): 312-326.

Dixon, J. A. Food Consumption Patterns and Related Demand Parameters in Indonesia: A Review of Available Evidence. June 1982 (Mimeo).

Engel, E. Die Lebenskosten Beligisher Arbeiter-Families früker and jetzt. International Statistical Institute Bulletin 9(1895):1-1.74.

Frisch, R. A Complete Scheme for Computing All Direct and Cross Demand Elasticities in a Model with Many Sectors. Econometrica 27(1959):177-196.

Goldberger, A. S. Directly Additive Utility and Constant Marginal Budget Share. The Review of Economic Studies 36(1969):251-254.

Hedley, Douglas D. Supply and Demand for Food in Indonesia. Paper presented at the Workshop on Research Methodology, Department of Agricultural Economics and Rural Sociology, Bogor Agricultural University, March 1978.

Hendler, R. Lancaster's New Approach to Consumer Demand and Its Limitation. American Economic Review 65(75):194-199.

Houthakker, H. S. Additive Preferences. Econometrica 28(1960):244- 257.

Johnson, S. R., Z. A. Hassan, and R. D. Green. Demand Systems Estimation--Methods and Applications. Ames: Iowa State University Press, 1984.

Johnson, S. R., R. D. Green, Z. A. Hassan, and A. N. Safyurtlu. Market Demand Functions. February 1985 (Mimeo).

Ladd, George W., and Veraphol Suvannut. A Model of Consumer Goods Characteristics. American Journal Agricultural Economics 58(1976):504-510.

LaFrance, Jeffrey T. The Economics of Nutrient Content and Consumer Demand for Food. Ph.D. Thesis, University of California-Berkeley. 1983.

Lancaster, Kelvin J. A New Approach to Consumer Theory. Journal of Political Economy 74(1966):132-157.

Lau, L. J. and B. M. Mitchell. A Linear Logarithmic Expenditure System: An Application to U.S. Data. Econometrica 65(1975):367-383.

Lucas, Robert E. Hedonic Price Function. Economics Inquiry 13(1975):157-178.

Magira, Stephen L. The Role of Wheat in Indonesia's Food System. Foreign Agricultural Economic Report No. 170, USDA. December 1981.

Mears, L. A. The New Rice Economy of Indonesia. Jakarta: Gadjah Mada University Press, 1981.

Michael, R. T. and G. S. Becker. On the New Theory of Consumer Behavior. Swedish Journal of Economics 75(1973):378-396.

Muth, Richard F. Household Production and Consumer Demand Functions. Econometrica 34(1966):698-708.

Muellbauer, J. Household Production Theory, Quality, and the "Hedonic Technique." American Economic Review 64(1974):977-994.

Parks, R. W. System of Demand Equations: An Empirical Comparison of Alternative Functional Forms. Econometrica 37(1969):629-650.

Phlips, L. Applied Consumption Analysis. Amsterdam: North-Holland Publishing Company, 1983.

Policy Issues, Project Design and Implementation Plan: Final Research Strategies Based on Host Country Review. Report #1-Indonesia. Center for Agricultural and Rural Development, Iowa State University. July 1985.

Pollak, R. A. Additive Utility Functions and Linear Engel Curves. Review of Economic Studies 38(1971):401-413.

Pollack, R. A. and M. C. Watcher. The Relevance of the Household Production Function and Its Implications for the Allocation of Time. Journal of Political Economy 83(1975):255-277.

Pollak, R. A. and T. J. Wales. Estimation of the Linear Expenditure System. Econometrica 37(1969):611-628.

________. Estimation of Complete Demand System from Household Budget Data: The Linear and Quadratic Expenditure Systems. American Economic Review 68(1978):348-359.

________. Welfare Comparisons and Equivalence Scales. American Economic Review 69(1979):216-221.

________. Demographic Variables in Demand Analysis. Econometrica 49(1981): 1533-1555.

Prais, S. J. and H. S. Houthakker. The Analysis of Family Budgets. Cambridge: Cambridge University Press. 1955.

Singh, I, L. Squire, and J. Strauss. Agricultural Household Models: A Survey of Recent Findings and Their Policy Implications. Economic Growth Center: Yale University. May 1985.

Stone, J. R. N. Linear Expenditure Systems and Demand Analysis: An Application to the Pattern of British Demand. Economic Journal 64(1954): 511-527.

Teklu, Tesfaye. An Economic Analysis of Resource and Income Uses Among Farm Households of Ethiopia: Applications of the Household Production Approach. Ph.D. Thesis, Iowa State University. 1984.

Theil, H. The Information Approach to Demand Analysis. Econometrica 33(1965): 64-87.

________. A Multinomial Extension of the Linear Logit Model. International Economic Review 10(1969):251-259.

________. Principles of Econometrics. New York: John Wiley & Sons. 1971.

Timmer, P. C. Estimating Rice Consumption. Bulletin of Indonesian Economic Studies. July 1971.

Timmer, P. C. and H. Alderman. Estimating Consumption Parameters for Food Policy Analysis. American Journal of Agricultural Economics 61(1979).

Tyrrell, T. and T. Mount. A Nonlinear Expenditure System Using a Linear Logit Specification. American Journal of Agricultural Economics 64(1982): 539-546.

Varian, H. R. Micro Economic Analysis. New York: W. W. Norton and Company, 1978.

World Bank. Indonesia: Policy Options and Strategies for Major Food Crops. Report No. 36865-IND. April 4, 1983.

Yoshihara, K. Demand Functions: An Application to the Japanese Expenditure Pattern. Econometrica 37(1969):257-274.