A DEMAND SYSTEM ANALYSIS OF FOOD CONSUMPTION IN NEPAL

By

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ABSTRACT

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In this study an analysis is made of food consumption in Nepal using the Almost Ideal Demand System (AIDS). This demand system is consistent with the economic theory of consumer behavior and allows perfect aggregation over consumers so that the theory of individual consumer behavior can be applied to grouped data. Empirical estimates are generated using data from the nation-wide second household budget survey conducted by Nepal Rastra Bank in 1984/85.

Ordinary least squares (OLS) estimates of the demand system parameters for six food groups are reported by four income strata: low, middle, high and average. The parameters satisfy the adding-up restriction. The homogeneity restriction is rejected in a majority of the cases. To test the empirical validity of the symmetry restriction the parameters are estimated using full information maximum likelihood. This restriction is also rejected in most cases.

Demand elasticities calculated from the OLS parameters indicate that grains and pulses are necessary and inferior

goods, respectively. The remaining food groups, vegetables, meat, milk, and oils and fats are preferred goods. The results show considerable variations in consumption patterns across income groups. The budget shares and expenditure and price elasticities generally decline with increasing affluence indicating the low income consumers to be more sensitive to income and price changes than high income consumers.

The effect of income and price changes on food consumption by the low income group is carried out with eight scenarios. The simulation results show that the poor are very sensitive to price increases and a smaller increase in the price of grain can negate the positive response of a larger increase in income. These results are used to discuss the policies for strenghening food security. It is argued that while faster growth in income is essential for long-term food security, in the short-run, improvements in the nutritional status of the low income group will be well served by a policy of low prices for the specific food grains which are the major sources of calories for the poor.

Dedicated to my uncle

SITARAM PRASAD MUDBHARY

without whose constant support and encouragement

higher education would have been a distant dream for me.

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Statement of Problem

Nepal is a small landlocked and mountainous country located between India and China. It has an area of 147,181 sq km, about 83 per cent of which consists of high mountains and rolling hills. The remaining 17 per cent is flat and is called the Tarai. The country has a rectangular shape with an average length of 885 km east to west and a north-south width averaging 193 km. The topography varies from merely 152 m above the sea level in the south to 8,839 m in the north. Similarly, the climate ranges from sub-tropical in the south to alpine in the north. The nearest sea coast is about 1,127 km from Nepal's border. In 1986, Nepal's population was estimated at 17.1 million and growing at a rate of 2.62 per cent per annum.

The Tarai region bordering with India on the south has a better transport and communications network than the hills and mountains. It produces surplus foodgrains which meet the deficits in the north. A portion of this surplus flows to the bordering regions of India which are traditionally food deficit. Rice, wheat and maize are the major foodgrains.

With a GNP per capita of $160, Nepal is one of the poorest countries of the world. After emerging from centuries of isolation from the outside world in 1951, Nepal started planned development efforts in 1956 with the launching of the First Development Plan. Development of physical infrastructure received high priorities in the first four development plans. Nepal is currently midway through the Seventh Plan. Despite appreciable improvements in the transport and communications system, literacy levels and some other social indicators of welfare, per capita real income has stagnated at the levels of 1960s (World Bank 1987). The National Planning Commission (NPC 1987) has estimated that 42.55 per cent of population comprising 46.92 per cent of households are below the poverty line. In 1984/85, this segment of population shared only 12.6 per cent of personal disposable income. In realization of this situation, Nepal has recently adopted a program for fulfillment of basic needs of food, clothing, shelter, health and security by the year 2000. This program is to become the cornerstone of development programs and projects in the country for the remainder of the century.

Nepal is a predominantly agricultural country employing roughly nine out of ten economically active persons in agriculture which contributes 59 per cent of the GDP. Poor performance of the agricultural sector is the main cause of economic stagnation in Nepal (NPC 1985, p. 5). As Svejnar and Thorbecke (1986, p. 113) observe: "Nepal's agricultural performance over the last twenty years has been

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disappointing with respect to most indicators and mildly positive with respect to some. Overall, it has fallen short of everyone's expectations and in most respects it has been inferior to that of other countries in the region." During 1961-81, production of cereal grains which provide about 78 per cent of the calorie consumption in Nepal (DFAMS 1986/87) increased at an annual rate of only 1.1 per cent (Yadav 1987). Food production lagging behind population growth, and skewed pattern of income distribution implies that the poor's access to food has declined during the last two decades. This situation is likely to worsen unless the economy grows faster and the employment opportunities for the poor expand.

The NPC (1987, p. 3) believes that the "basic needs satisfaction is feasible within a relatively short span of time if national income can be increased at an accelerated pace and the incremental income is redistributed through effective policy and other measures." The program for fulfillment of basic needs aims at raising the consumption from 1958 calories per person/day during 1980/81 - 1985/86 (DFAMS 1986/87) to 2250 calories by the year 2000 - an increase of 28 per cent. Meeting this consumption target will require, according to NPC estimate, an increase in per capita income of the poor by 5, 8 and 9 per cent per annum during the Seventh, Eighth and Ninth Plan periods, respectively. Similarly, the share of national income that goes to the people below the poverty line will have to nearly double from 12.6 per cent in 1984/85 to 23 per cent in 2000.

In the literature on poverty and malnutrition, there is general consensus that redistribution of income in favor of the poor can lead to reduction in malnutrition - for example Pinstrup-Andersen and Caicedo (1978), World Bank (1986) and Sahn (1988). A number of empirical analyses have, however, indicated that such redistribution needs to be enormously larger than one that can be expected to be achieved without major changes of the existing distribution of assets and production relations. Gray's analysis of food consumption patterns in Brazil (1982), Trairatvorakul's study of alternative rice price policies in Thailand (1984) and Behrman and Deolalikar's case study of rural south India (1987) all show that income increases for the low income people do not automatically translate into substantial improvements in nutrition. This is because of preference for taste and variety in diet with increasing income. Murti and Radhakrishna (1982, p. 170) analyzing agricultural prices, income distribution and demand patterns in India have shown that "eradication of poverty by a mere transfer of purchasing power will not help, unless it is backed by effective intervention in the grain markets." Another study on India by Panda (1986, p. 288) argues the need for "setting suitable price targets along with income targets so as to induce a person to purchase normatively stipulated quantities when the targets are met." Unless relative prices are properly aligned, consumer's optimal allocation of his income results in a consumption pattern different from the normative one. Gray's analysis has shown targeted food subsidies to be superior to income transfer policies in meeting nutritional objectives.

Based on this empirical evidence, it seems that the question of fulfillment of basic needs in Nepal should be analyzed in greater depth taking into account the possibility of restructuring market prices of major food commodities. Such analysis requires reliable estimate of demand parameters for food in Nepal. According to Timmer (1981) demand parameters should be analyzed both in aggregate and disaggregated forms. Aggregate market demand parameters help understand the macro linkages in the food sector and thus facilitate design of appropriate policies for influencing domestic production, consumption and international trade. The disaggregated parameters are needed to trace the effects of income and price changes on the consumption of the poor. In the present context, knowledge of demand parameters by income stratum will be helpful in determining whether income support or price subsidy is a better means of enhancing the poor's access to food.

Despite such importance of demand parameters, there has

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been no attempt to estimate a complete elasticity matrix for Nepal. Past estimates of demand relationships, such as one by Tulachan (1979), were partial demand analyses estimating demand elasticities of a single commodity. These estimates were generated using national aggregate data for prices and per capita income as the main explanatory variables, and per capita consumption quantity, indirectly derived from national aggregate data, as the dependent variable. Generally estimated as a single equation, these estimates failed to consider the complete interdependent nature of demand. Moreover, the demand equations were directly specified without any reference to the utility theory.

Clearly, a more reliable set of demand elasticities are needed for policy analysis in Nepal. Such elasticities can be derived from a complete system of demand equations which describes the households allocation of expenditure among some exhaustive set of consumption categories and are theoretically plausible and consistent with observed behavior, such as a nonlinear Engel curve.

Objectives of Research

The main objective of this research is to fill the gap in the knowledge of food demand parameters in Nepal. For this purpose, a complete demand elasticity matrix using a demand system will be estimated. The demand system parameters will then be used for analyzing some policy issues faced by decision makers in Nepal.

To be specific, the research objectives are as follows.

1. To generate a complete and reliable set of demand elasticities for major food groups in the Nepalese diet.

2. To test empirical validity of theoretical restrictions on demand equations.

3. To compare price subsidy v. income transfer as alternative policies for fulfillment of basic food needs in Nepal.

4. To develop policy recommendations and future research possibilities based on the analysis of data.

Organization of the Dissertation

Chapter II deals with the derivation and specification of demand models. It discusses the theoretical basis of expenditure allocation models. In doing so, it describes the economic theory of consumer behavior and separability conditions that allow for aggregation across commodities and specific classes of preferences that allow consistent aggregation across consumers. After wading through the question of functional form in demand analysis, this chapter presents the derivation of the so-called Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980a). This demand system will be used for estimation.

In Chapter III, the second household budget survey conducted by Nepal Rastra Bank, Nepal's central bank, is discussed. Data from this survey is used for analysis of food demand in Nepal. Besides describing the sample size, sampling procedure, and grouping and aggregation procedures, this chapter includes a descriptive analysis of data.

Chapter IV details specifications of the demand model, estimation procedures, interpretation of results and some tests of restrictions.

Demand system parameters are applied to policy analysis in Chapter V. Effects of price and income changes on food consumption is studied with particular attention to the low income group. Summary and conclusions of the research together with future research topics are presented in Chapter VI.

II. DERIVATION AND SPECIFICATION OF DEMAND MODEL

Introduction

The purpose of this chapter is to provide a brief discussion of some aspects of the theory and application of demand analysis. The orientation of the chapter is towards laying the theoretical foundation for the type of research reported in subsequent chapters, specifically the use of demand models in analyzing household budget data.

There are basically two approaches to demand analysis: directly specified demand models and utility based demand models. Directly specified demand models are older in tradition and do not rely on the economic theory of consumer behavior beyond recognizing the importance of prices and incomes. The utility based demand models, on the other hand, are derived by postulating that the consumer behaves as if he chooses the consumption basket to maximize a utility function subject a budget constraint. Following the theory, these models assume that the demand for each commodity depends on all prices and on income and the result is complete systems of demand equations. A complete system of demand equations describes the household's allocation of expenditure among some exhaustive set of consumption categories. Estimation of such a complete system may sound ambitious and generally impractical in view of data requirements if every single commodity which is consumed is to be included separately in the model. As we will see later, separability assumptions allow the use of the demand system approach to a subset of consumption categories, such as the demand for food.

This research uses utility based demand models which, according to Theil and Clements (1987, p. 2), "give rise to elegant and intuitive interpretations of the coefficients of the demand equations in terms of utility function". Moreover, these models can be used to test empirical validity of theoretical restrictions on demand equations.

Economic Theory of Consumer Behavior

The theory of choice of a single consumer under static conditions is one of the well developed parts of the economic theory. A consumer is assumed to have preferences which are summarized by means of a utility function.[1] A utility function is an interpretive measure of the satisfaction derived from the consumption of alternative

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[1] For a thorough treatment of consumer preferences, including axioms required for preferences to be representable by a utility function and those required for the maximization problem to be well-behaved, see Varian (1984, pp. 111-15), Phlips (1983, pp. 3-16) and Deaton and Muellbauer (1980b, pp. 25-30). Briefly, axioms of completeness (or comparability), reflexivity, transitivity (or consistency) and continuity are needed to establish the "existence" of a continuous utility function. In addition, axioms of strong monotonicity, local nonsatiation, strict convexity and differentiability are required for the maximization problem to yield a unique solution.

commodity bundles. It is further assumed that in choosing a bundle of commodities at a point in time, the consumer seeks to maximize utility.

The standard utility maximization problem faced by a consumer is stated as

$$\max u = f(q_1, \ldots, q_n) \quad (2.1)$$

$$\text{subject to } \Sigma_i p_i q_i = x \quad (2.2)$$

where u is a strictly increasing, strictly quasi-concave and twice differentiable utility function, p_i represents the price of the ith commodity and x designates the consumer's total expenditure, called "income". Equation (2.2) is the linear budget constraint which implies that the consumer takes the prices of all goods as given and expenditure on n goods $(p_1q_1 + \ldots + p_nq_n)$ must equal a fixed total x.

Equation (2.1) is solved as a simple calculus problem of finding a constrained maximum of u. The result is a set of n equations with

$$q_i = m_i (x, p_1, \ldots, p_n) \quad (2.3)$$

This set of equations is known as the Marshallian demand functions implying that the demand for the ith commodity is a function of its own price, prices of other commodities and income.

The utility function u = f (q) expresses utility in terms of quantities consumed and is called direct utility function. If we insert the demand functions (2.3) in (2.1), we get

$$u = f\,[m_1\,(x,\ p_1,..,p_n),...,\ m_n\,(x,\ p_1,..,\ p_n)]$$
$$= v\,(x,\ p) \tag{2.4}$$

which are called <u>indirect utility functions</u>. Indirect utility functions express utility in terms of prices and income. In the above equation, u represents the maximum attainable utility at given set of prices and a particular income.

The direct and indirect utility functions, (2.1) and (2.4), represent the same preference ordering and a duality relation exists between these two functions. Maximization of f with respect to q's, with given prices and income, or minimization of v with respect to prices and income result in the same demand functions.[2]

The advantage of the indirect utility function approach lies in the ease with which the demand functions can be derived. Demand functions can be derived by application of <u>Roy's identity</u> to the indirect utility function

$$\frac{\delta\ v\ /\ \delta\ p_i}{\delta\ v\ /\ \delta\ x} = q_i. \tag{2.5}$$

Alternatively, preferences can be defined in terms of a <u>cost function</u>. The cost (or expenditure) function is derived by assuming that the consumer is interested in

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2 For properties of indirect utility functions, see Varian (1984, pp. 121-22). Briefly, indirect utility functions are continuous, non-increasing and quasi-convex in p, non-decreasing in x and homogeneous of degree zero in p and x.

minimizing the cost of attaining utility u at price p. This problem is stated as follows

$$c\ (u,\ p) = \min_{q}\ p.q \tag{2.6}$$

$$\text{subject to } u\ (q_1, .., q_n) = u \tag{2.7}$$

where c (u,p) is the minimum cost associated with the consumption of the optimal quantities q_i at prices p_i (i = 1,.., n) and utility level u. p.q denotes $\Sigma\ p_i q_i = x$.[3] If x is the total budget to be allocated, then x is the cheapest way of reaching whatever u can be reached at p and x, so that c (u, p) = x.

Application of Shephard's lemma, taking the partial derivative of the cost function with respect to prices, leads to Hicksian or compensated demand function. Mathematically, Hicksian demand functions are expressed as follows.

$$\frac{\delta\ c\ (u,\ p)}{\delta\ p_i} = h_i\ (u,\ p) = q_i, \text{ for } i= 1,....,n \tag{2.8}$$

Hicksian demand functions are not directly observable as they depend on utility which is not directly observable. However, another important feature of cost functions which Deaton (1986, p. 1773) calls Shephard-Uzawa duality theorem which, given convex preferences, allows a constructive

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3 Properties of cost functions described in Varian (1984, p. 123) are: (1)non-decreasing in p; (2) homogeneous in degree 1 in p; (3) concave in p; (4) continuous in p, for p >> 0; and (5) $h_i\ (u,p) = \delta\ c\ (u,\ p)\ /\ \delta\ p_i$ for i =1,..,n. See Theil (1980, p. 22) for an interpretation of these properties.

recovery of utility function from the cost function. In other words, any cost function with the correct properties can serve as an alternative to the direct utility function. The following procedure is, therefore, followed in empirical analysis. Inverting the cost function c (u, p) = x leads to indirect utility function u = v (x, p). Substituting the indirect utility function (2.4) in (2.8) gives q_i in terms of p and x, i.e.,

$$q_i = h_i\ (u,\ p) = h_i\ [\ v\ (x,\ p),\ p\ ] = m_i\ (x,\ p) \qquad (2.9)$$

where m_i (x, p) is Marshallian demand function. Conversely, we can derive the Hicksian demand function by substituting the cost function c (u, p) = x from (2.6) in (2.3).

$$q_i = m_i\ (x,p) = m_i\ (\ c\ (u,\ p),\ p) = h_i\ (u,\ p) \qquad (2.10)$$

The identity of the last two terms in (2.10) shows that the Marshallian and Hicksian demand functions are equal at an appropriate level of income, i.e., the minimum income necessary to achieve the desired level of utilities at given prices. Therefore, any demanded bundle can be expressed either as the solution to the utility maximization problem or cost minimization problem. Another notable feature of the identity is that it leads to the derivation of the famous Slutsky equation. Differentiating the identity with respect to p_i and evaluating at p^* gives rise to

$$\frac{\delta\ m_i(x,p)}{\delta\ p_i} = \frac{\delta\ h_i(v(p,x),p)}{\delta\ p_i} - \frac{\delta\ m_i(x,p)}{\delta\ x}\ .\ q_i \qquad (2.11)$$

which is the Slutsky equation.[4] Equation (2.11) can be

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[4] See Varian (1984, pp. 130-31) for proof.

rearranged as follows to show the components of the Slutsky's matrix (s_{ij}).

$$s_{ij} = \frac{\delta\, h_i(u,p)}{\delta\, p_j} = \frac{\delta\, m_i(x,p)}{\delta\, p_j} + \frac{\delta\, m_i(x,p)}{\delta\, x_j} \cdot q_j \quad (2.12)$$

In simple terms, the Slutsky equation shows that there are two effects of a price change in the commodity's demand: substitution effect and income effect.[5] In equation (2.11) the term on the left represents the total effect of price change. On the right, the first term represents substitution effect and the second term is income effect. The own (or direct) substitution effect, k_{ii}, is always negative. Income effect is positive for normal goods and negative for inferior goods. The sign of the cross-substitution effect, k_{ij}, is not determined. In fact, the sign of k_{ij} indicates if a good is a complement or substitute of another good. If the sign is positive, goods i and j are substitutes and if it is negative, the goods are complements. The sign of the term on the left is also not determined. This means that the Marshallian (ordinary) demand curves are not necessarily downward sloping. While k_{ii} is always negative, the element ($- \delta\, m_i\, (x, p)/\delta\, x$) may

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[5] Houthakker (1960, pp. 248) has divided the substitution effect into specific and general substitution effects. The specific substitution effect is the effect on q_i of a change in p_j when this change is accompanied by an income change so that the marginal utility of income remains unchanged. The general substitution effect describes the general competition of all commodities for an incremental dollar of the consumer's budget.

be positive and larger in absolute value than k_{ii}, in which case $\delta m_i(x, p)/\delta p_i$ will be positive. Hicksian (compensated) demand curves, on the other hand, always slope downward because the direct substitution effect, k_{ii}, always has a negative sign.[6] The third important feature of the cost function is budget shares, w_i, are the logarithmic derivatives of the cost function.[7]

$$\frac{\delta \ln c(u, p)}{\delta \ln p_i} = \frac{p_i q_i}{x} = w_i \qquad (2.13)$$

<u>General Restrictions on Demand Functions</u>

The demand system, i.e., the system of demand equations obtained by utility maximization, has a few properties which take the form of mathematical restrictions on the derivatives of the demand functions. These restrictions are (1) adding up, (2) homogeneity, (3) symmetry and (4) negativity. For completeness, a brief discussion of each will be given here. A more detailed discussion can be found in Theil (1975), Deaton and Muellbauer (1980b), Phlips (1983) and
Johnson et al. (1984).

The adding up restriction arises from the budget constraint. Defining the budget share of the ith commodity, $w_i = p_i q_i/x$, it is easy to see that $\Sigma w_i = 1$, i.e., the sum

[6] This point is further discussed in the following section under the negativity property of a demand system.

[7] See Deaton (1986, pp. 1774-75) for details.

of the budget shares equal one. The adding up restriction has two parts: <u>Engel aggregation condition</u> and <u>Cournot aggregation condition</u>.

Engel aggregation condition requires that the sum of income elasticities weighted by their respective budget shares equals one. This can be shown as follows. Differentiating the budget constraint (2.2) with respect to x we get

$$\Sigma\, p_i \frac{\delta\, q_i}{\delta\, x} = \Sigma \frac{\delta\, (p_i q_i)}{\delta\, x} = 1 \tag{2.14}$$

where $p_i q_i$ is the expenditure on good i. $\delta\, (p_i q_i)/\, \delta\, x$ is called the marginal propensity to consume good i (or its marginal budget share). The marginal budget share, θ, like the average budget share, w_i, sums to one, but, unlike w_i, it can be negative if i is an inferior good. Defining income elasticity of demand,

$$\eta_i = \frac{\delta\, q_i}{\delta\, x} \cdot \frac{x}{q_i}$$ we can see that

$$w_i \eta_i = \frac{p_i q_i}{x} \cdot \frac{\delta\, q_i}{\delta\, x} \cdot \frac{x}{q_i} = p_i \frac{\delta\, q_i}{\delta\, x} = \frac{\delta\, (p_i q_i)}{\delta\, x} \tag{2.15}$$

that is

$$w_i \eta_i = \theta_i \tag{2.16}$$

or $$\eta_i = \frac{\theta_i}{w_i} \tag{2.17}$$

Since $\Sigma\, \theta_i = 1$, it follows from (2.16) that the sum of budget share weighted income elasticities is equal to unity, $\Sigma_i\, w_i \eta_i = 1$.

The Cournot aggregation condition, like the Engel aggregation condition, comes directly from the budget constraint. This condition is concerned with the effect of a change in the price of the jth commodity assuming other prices to be constant. Differentiating the budget constraint with respect to p_j, we obtain

$$p_1 \frac{\delta q_i}{\delta p_j} + \ldots\ldots + p_n \frac{\delta q_n}{\delta p_j} + q_j = 0$$

or, $$\sum_{i=1}^{n} p_i \frac{\delta q_i}{\delta p_j} = -q_j, \qquad j = 1, \ldots\ldots, n \qquad (2.18)$$

Multiplying the left side of (2.18) by q_i/q_i and the both sides by p_j/x, we get the Cournot aggregation condition as follows.

$$\sum_{i=1}^{n} w_i\ e_{ij} = -w_j, \qquad j = 1,\ldots.,n \qquad (2.19)$$

where e_{ij} is the cross elasticity of commodity i with respect to commodity j. Under uncompensated price changes, the sum of own price and cross price elasticities of the jth commodity (j = 1,....,n) all weighted by their respective average budget shares, equal to the negative of the budget share of the jth commodity.

The <u>homogeneity</u> restriction is that demand functions are homogeneous of degree zero in prices and income. This restriction means that quantity demanded remains unchanged if all prices and income change by the same proportion. This assumes that there is no money illusion and all that a consumer cares about is relative prices and real income which do not change when all prices and income change by the same proportion. In terms of uncompensated price changes, this restriction states that the sum of own and cross price elasticities and income elasticity of a commodity is zero. That is,

$$\sum_{i=1}^{n} e_{ij} + \eta_i = 0, \quad i = 1,\ldots., n. \tag{2.20}$$

The Slutsky symmetry restriction is that the matrix, S, of Slutsky substitution terms (or compensated price derivatives), defined as $s_{ij} = \delta h_i (u, p) / \delta p_i$ in (2.12) is symmetric. Mathematically, it can be stated as

$$\frac{\delta h_i}{\delta p_j} = \frac{\delta^2 c}{\delta p_j \delta p_i} = \frac{\delta^2 c}{\delta p_i \delta p_j} = \frac{\delta h_j}{\delta p_i}. \tag{2.21}$$

The negativity restriction states that the matrix of Slutsky substitution terms must be negative semi-definite. Since the cost function is a concave function of p, S must be negative semi-definite. Negative semi-definite Slutsky matrix implies that the matrix's diagonal terms are non-positive. That is for all i,

$$\frac{\delta h (u, p)}{\delta p_i} = \frac{\delta^2 c (u, p)}{\delta p_i^2} \leq 0 \tag{2.22}$$

Although S is not directly observed, the symmetry and negative semi-definiteness can be checked through the right hand terms in (2.12) which can be estimated econometrically.

One legitimate question at this stage is does observed demand behavior in fact always satisfy the theoretical restrictions discussed above. Phlips (1983, pp. 53-54) argues that they need not because theory is a simplification of reality and statistical data always contain some measurement errors. We should, therefore, only hope that unrestricted demand system parameters will not be inconsistent with these general restrictions. Use of a flexible functional form allows testing of theoretical restrictions on empirical results. We will discuss this point further in a later section.

Separability Assumptions

Econometric analysis of a complete demand system for all the items entering into a consumer's budget is not generally possible because the number of parameters to be estimated becomes extremely large. For a system of n commodities, there are n direct price elasticities, $n^2 - n$ cross price elasticities and n income elasticities to be estimated. Even after imposing Engel and Cournot aggregation restrictions and the symmetry restriction, $\frac{1}{2}(n^2 + n) - 1$ parameters remain to be estimated. Estimating such a large system poses problems of degrees of freedom and multicolinearity among price series. Hence, some sort of aggregation of commodities into groups is required. Separability concepts solve the problem of aggregation among commodities. The consumption set is partitioned into subsets each including commodities that are closer substitutes or complements to each other than to commodities in other subsets.

Preferences are weakly separable if the marginal rate of substitution between any two commodities, i and j, is independent of the quantity consumed of a third commodity, k, in any other group. That is,

$$\frac{\delta\,(u_i\ /\ u_j)}{\delta\, q_k} = 0 \qquad \text{for i, j in I; k not in I} \qquad (2.23)$$

where u_i and u_j are marginal utilities of commodities i and j belonging to group I, q_k is the quantity of good k which does not belong to group I.

A preference structure is strongly separable if the marginal rate of substitution between two commodities i and j belonging to two different groups I and J, respectively, is independent of the consumption of good k which does not belong to group I or J. Formally, it can expressed as follows.

$$\frac{\delta\,(u_i\ /\ u_j)}{\delta\, q_k} = 0$$

for all i in I, j in J and k not in I and J (2.24)

The preference structure implied by strong separability is also referred to as `preference independence' or `groupwise independence'. Strong separability implies additivity between groups. From an economic point of view, additivity is justified only if the goods are broad aggregates (see Phlips 1983, p. 70).

The concept of weak separability is very appealing in applied work. It provides the basis for the assumption of a two-stage budgeting procedure for the allocation of the consumer's expenses over groups of commodities. In the first stage, the consumer is assumed to allocate his total expenditure to broad commodity groups such as food, rent, clothing etc. In the second stage, the consumer is assumed to optimally allocate his spending in specific items in a particular commodity group, say food. In the second stage of the two-stage budgeting, the consumer decides how much of each food item to purchase on the basis of the prices of food items and the total food budget. Total income and prices of non-food items affect the quantity demanded of food only through their effect on the budget allotment to food. Demand functions based on a separability assumption are in effect conditional demand functions.[8]

Mathematically, the two-stage demand equations are expressed as

$$q_r = q_r [p_{R_1}, \ldots, p_{R_n}, x_R(p_I, \ldots, p_S, x)] \qquad (2.25)$$

where q_r is the quantity demanded of commodity r in group R, $p_{R_1}, \ldots, p_{R_n}$ are prices of specific commodities in group R, x_R is the group expenditure determined in the first stage as a function of group price indexes P_I to P_S and total expenditure x (Bieri and de Janvry 1972, p.20).

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[8] See Phlips (1983, Ch. 3) and Johnson et al. (1984, Ch. 3) for detailed discussions of separability assumptions and their implications on demand analysis.

Aggregation Across Consumers

Neoclassical demand theory is developed around the individual consumer, while the real world data which could be used to test the theory are often for a group of consumers such as households. There is no obvious reason why such a theory should be applicable in a study of household behavior. The market demand function has all the properties of the individual consumer demand function if preferences are homothetic and distribution of income is independent of prices (Eisenberg).[9]

Muellbauer (1975, 1976) shows that if preferences belong to a `price independent generalized linear' (PIGL) class, consistent aggregation across consumers and the existence of a "representative consumer" is possible.[10] According to Muellbauer, a representative consumer exists if each average budget share, w_i, can be written as a function of prices, p, and a representative budget level, designated by x_o. For x_o to exist, the individual budget share equations must have the `generalized linear' (GL) form

$$w_{ih}\ (x_h,p) = v_h\ (x_h,p)\ A_i(p) + B_i(p) + C_{ih}(p) \qquad (2.26)$$

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[9] A function is called homothetic if it is a monotonic transform of a homogeneous function. Another implication is that the composition of the budget is independent of total expenditure or of utility. Hence, all expenditure elasticities are unity (Deaton and Muellbauer 1980b, pp. 142-43). Household budget studies have shown expenditure elasticities do not behave as such in the real world.

[10] For a complete description of what follows, see Deaton and Muellbauer (1980a, pp.323-25).

where h represents hth family, p denotes a price vector, and v_h, A_i, B_i and C_i are functions satisfying $\Sigma_i A_i = \Sigma_i C_{ih} = \Sigma_h C_{ih} = 0$, and $\Sigma_i B_i = 1$. The form of the budget share is then transformed from GL to PIGL form by restricting the function v_h in (2.26) to

$$v_h (x_h, p) = \{ 1 - (x_h/k_h)^{-\alpha} \}^{\alpha^{-1}} \qquad (2.27)$$

where α is a constant and k_h, although not a function of x_h, and p are free to change from household to household. In order to be consistent with PIGL class of preferences, the cost function takes the form

$$\{c (u_h, p) / k_h\}^{\alpha} = (1- u_h) \{a (p)^{\alpha} + u_h \{b (p)\}^{\alpha} \qquad (2.28)$$

where c represents the cost function, u denotes the utility level of the hth family, k_h can represent family composition effects, and a(p) and b(p) are functions of the price vector p. When α approaches zero, we obtain the `price independent generalized logarithmic' (PIGLOG) form

$$\log \{ c (u_h, p) / k_h \}$$
$$= (1-u_h) \log \{ a (p) \} + u_h \log \{ b (p) \} \qquad (2.29)$$

where a(p) and b(p) are linear homogeneous concave functions. In the PIGLOG case, representative expenditure level is independent of prices and depends only on the distribution of income. Practical application of PIGL class requires selection of specific functional forms for the functions a(p) and b(p). We will see this while discussing the AIDS model of Deaton and Muellbauer in the next section.

Specification of a Model of Consumer Demand

There are four approaches to the derivation of a theoretically plausible demand system.

The first approach starts with a well-defined functional form for the utility function and then derives demand functions by maximizing the utility function subject to the budget constraint. The linear expenditure system (LES) is an example of demand systems derived from this approach. LES was developed by Klein and Rubin (1947-48) in an attempt to conduct a true cost-of-living index. Klein and Rubin expressed the expenditure on a good as a linear function of total expenditure and all prices. Then they derived LES by imposing the adding-up, homogeneity and symmetry restrictions. Subsequently, Samuelson and Geary showed that these demand functions represented a specific utility function (Howe 1974, p.12). With Stone's (1954) application of LES to British data, LES has the distinction of being the first empirically estimated demand system satisfying all general restrictions. This system was very popular until the 1970s and is still used.[11]

LES implies strong separability and, therefore, additive preferences. It has the advantage that the knowledge of the average budget share, w_i, (n-1) independent expenditure elasticities and one single price elasticity is

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11 See Phlips (1983, pp.128-29) for some applications of LES.

sufficient to determine the whole (n x n) array of price elasticities. It is, therefore, immensely useful for estimating price elasticities on data with little or no price variation. The problem, however, is that additivity is generally not true even for broad categories of goods (Deaton 1986, pp. 1817-18). Some of the other limitations of LES are it (1) implies linear Engel's curve, (2) excludes inferior goods, and (3) arbitrarily rules out possible specific substitution effects in the Slutsky term and thus imposes a very restrictive pattern on the cross price elasticities across different commodity groups (Theil 1975; Deaton and Muellbauer 1980b; Phlips 1983; and Blanciforti et al. 1986). Theil and Clements (1987, p.11) mention an implausible behavior of income elasticities implied by LES : "increasing affluence causes the income elasticities of necessities to rise, while those of luxuries fall; the elasticities of both types of goods become closer to unity."

The second approach is based on an algebraic specification of the indirect utility function. An explicit solution for the demand functions corresponding to this indirect utility function is obtained by applying Roy's theorem.[12] Indirect addilog demand systems

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[12] Roy's theorem expresses the ith quantity as minus the ratio of the price and income derivatives of the indirect utility function, i.e.,

$$q_i = - \frac{\delta v / \delta p}{\delta v / \delta x} \qquad i = 1, \ldots, n.$$

(Houthakker 1960) and indirect translog functions (Christensen et al. 1975) are examples of this approach. The indirect addilog demand system yields income elasticities which are independent of the level of income and differences between income elasticities are constant. Moreover, the cross price elasticities depend only on the commodity whose price is changing and not on goods whose quantity is responding (Johnson et al. 1984, p. 66). The indirect translog model is more flexible, but the derived demand equations are complicated and nonlinear in parameters. The number of unrestricted and unknown structural parameters is very high and, therefore, their estimation, even when adequate data points are available, is costly and time consuming (Johnson et al. 1984; Huang 1985).

The third approach is based on a direct approximation of the Marshallian demand functions. The Rotterdam model of Theil and Barten is an example. The demand systems under this model is similar to Stone's (1954) logarithmic demand function, but instead of working in the levels of logarithms it works in differentials. The resulting system is a first order approximation of any demand system.[13]

The fourth approach can be termed as consumer's cost function approach. This approach uses the principle of "duality" to transform the consumer's problem from one of

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[13] For more detailed discussions on the Rotterdam system, see Phlips 1983, pp. 89-90; Deaton and Muellbauer 1980b, p. 73; and Theil 1980, pp. 159-61.

maximizing utility with given prices and income to that of minimizing the cost of attaining a given level of utility with the same prices and income. Deaton and Muellbauer (1980a) used the cost function approach to derive the Almost Ideal Demand System (AIDS) in budget share form.

Deaton and Muellbauer start from the PIGLOG form of preferences which, as already discussed in the previous section, allows perfect aggregation over consumers. The PIGLOG class of preferences in its general form of equation (2.29) is defined by

$$\log c\,(u,p) = (1 - u)\log\{a\,(p)\} + u\log\{b\,(p)\} \qquad (2.30)$$

Then specific functional forms for log a(p) and log b(p) are defined so that the resulting cost function has a flexible functional form and the system of demand functions derived from it has desirable properties. Functional forms of log a(p) and log b(p) and the resulting cost functions are as follows.

$$\log a(p) = a_o + \sum_k \alpha_k \log p_k + \tfrac{1}{2}\sum_{kj}\sum \gamma^*_{kj} \log p_k \log p_j \qquad (2.31)$$

$$\log b(p) = \log a(p) + \beta_o \prod_k p_k^{\beta_k} \qquad (2.32)$$

$$\log c(u,p) = \alpha_o + \sum_k \alpha_k \log p_k + \tfrac{1}{2}\sum_{kj}\sum \gamma^*_{kj} \log p_k \log p_j + u\,\beta_o \prod_k p_k^{\beta_k} \qquad (2.33)$$

where α_o, α_1, β_i and γ^*_{ij} are parameters.

From equation (2.13) we know that the logarithmic differentiation of (2.33) gives the budget share as a function of price and utility:

$$w_i = \alpha_i + \sum_j \tau_{ij} \log p_j + \beta_i u \beta_o \pi p_k^{\beta_k} \qquad (2.34)$$

$$\text{where } \tau_{ij} = ½ (\tau^*_{ij} + \tau^*_{ji}) = \tau_{ji} \qquad (2.35)$$

For a utility maximizing consumer, x = c (u, p), and this equality can be inverted to derive the indirect utility function which gives u as a function of p and x. The indirect utility function for any PIGLOG cost function is

$$u = \frac{\ln x - \ln a(p)}{\ln b(p) - \ln a(p)} \qquad (2.36)$$

(El-Eraky 1987, p. 38). Substituting (2.36) in (2.34) we get the AIDS demand functions in budget share form as follows:

$$w_i = \alpha_i + \sum_j \tau_{ij} \ln p_j + \beta_i \ln (x/P) \qquad (2.37)$$

where w_i is the budget share of good i; α_i, β_i, and τ_{ij} are parameters; x is total expenditure and P is a price index defined by

$$\log P = \alpha_o + \sum_j \alpha_k \log p_k + ½ \sum_k \sum_j \tau_{kj} \log p_k \log p_j \qquad (2.38)$$

Restrictions on the parameters of AIDS are:

- adding-up restrictions

$$\sum_i \alpha_i = 1, \qquad \sum_i \tau_{ij} = 0, \qquad \Sigma \beta_i = 0; \qquad (2.39)$$

where i = 1,..., n;

- homogeneity

$$\sum_j \tau_{ij} = 0; \qquad (2.40)$$

Slutsky symmetry

$$\tau_{ij} = \tau_{ji}. \qquad (2.41)$$

The AIDS estimating equation can be derived by substituting (2.38) into (2.37). The estimation would, however, require the use of a nonlinear technique because of nonlinearity arising from the price index (2.38). Deaton and Muellbauer have suggested that when prices are highly correlated, a linear approximation of the estimating equation can be found by using Stone's (1953) index $\log P^* = \Sigma\, w_k \log p_k$ where $P = \Phi\, P^*$; that is P is assumed to be approximately proportional to P^*. If $P = \Phi\, P^*$ then (2.37) can be estimated as follows.

$$w_i = \alpha_i^* + \sum_j \tau_{ij} \log p_j + \beta_i \log (x/P^*) \qquad (2.42)$$

where $\alpha_i^* = \alpha_i - \beta_i \log \Phi$.

Likelihood tests obtained from models using P rather than P^* on British annual data from 1954 to 1974 confirmed the empirical unimportance of the difference (Deaton and Muellbauer 1980a, Table 4).

A Review of Functional Form

Reliability of estimated demand parameters is considerably affected by the functional form of the estimating equation. Economic theory does not provide much guidance as to the shape of the demand structure. Theory may suggest what types of variables are involved or even what forms should be excluded, but it cannot specify the exact nature of relationship. Therefore, most demand analysts either arbitrarily choose one functional form or try alternative functions and select the best one on the basis of a few predetermined criteria, such as expected magnitudes and statistical significance of parameter estimates, and goodness of fit. Several authors have compared empirical performance of different functional form specifications. Examples are Parks (1969) and Goldman (1971) who used Theil's (1967) average information accuracy measure, and Deaton (1974) who used maximized values of likelihood functions (Barten 1977, pp. 44-45). Deaton (1986, p. 1799), however, observes that satisfactory methods for comparing different (non-nested) functional forms are very much in their infancy.

Prais and Houthakker (1955) rejected the linear Engel function because it is inappropriate when variation in the variables is large and tried several forms of nonlinear functions, namely, double-logarithmic, semi-logarithmic, hyperbolic and log-reciprocal.[14] The economic considerations guiding these authors in algebraic formulations of Engel curves were: (1) there is an initial income below which these commodities are not purchased, (2) there is a satiety level which is not exceeded however high income may rise, and (3) the adding-up criteria implies that

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[14] Phlips (1983, pp. 109-10) shows that income elasticities implied by linear Engel curves are intuitively unacceptable.

all commodities cannot have a satiety level; otherwise, for some income level total income would not be entirely spent (pp. 82-84). They also argue that a better representation of consumer behavior may be obtained by postulating different forms of Engel curve for different types of commodities rather than imposing the same algebraic form for all commodities.

Leser (1963, p. 694), however, postulates that the Engel functions for all commodities studied should have the same functional form and satisfy the adding-up condition. While none of the functional forms suggested by Prais and Houthakker are fully consistent with adding-up, Leser successfully used the semi-log function which relates budget shares linearly to the logarithm of outlay. This function was first proposed by Holbrook Working (1943) when he applied it to the analysis of U.S. household budget data and found it to fit data very well, particularly for food commodities group. Working's model is expressed as follows.

$$w_i = \alpha_i + \beta_i \log x \qquad (2.43)$$

Since the sum of budget shares equal one,

$$\sum_{i=1}^{n} w_i = 1$$

α's and β's in (2.43) are subject to the following constraints

$$\sum_{i=1}^{n} \alpha_i = 1; \qquad \sum_{i=1}^{n} \beta_i = 0.$$

Working's model satisfies Engel aggregation condition which requires that the sum of income elasticities weighted by their respective budget shares equal one.[15] This can be shown as follows.

Multiplying (2.43) by x we get $p_i q_i = \alpha_i x + \beta_i x \log x$. Differentiation of this expression with respect to x gives us the marginal budget share of i

$$\frac{\delta (p_i q_i)}{\delta x} = \alpha_i + \beta_i (1 + \log x) = \theta_i$$

or $\theta_i = w_i + \beta_i$. (2.44)

Equation (2.44) means that under Working's model, marginal budget share exceeds the corresponding average budget share by β_i which is a constant with respect to total expenditure.

As shown in (2.17) income elasticity is simply a ratio of θ_i to w_i, i.e.,

$$\eta_i = \frac{\theta_i}{w_i} = \frac{w_i + \beta_i}{w_i} = 1 + \frac{\beta_i}{w_i} \qquad (2.45)$$

Since $\eta_i w_i = \theta_i$ (see 2.16), the Engel aggregation condition boils down to $\Sigma \theta_i = \Sigma (w_i + \beta_i) = 1$. This condition is satisfied because, as noted earlier, $\Sigma w_i = 1$ and $\Sigma\beta_i = 0$, $i = 1,\ldots,n$.

Under Working's model, the sign and magnitude of β_i have the following implications. A positive β_i results in $\eta_i > 1$ implying good i to be a luxury (or a preferred good). For such goods, as income rises, budget share

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[15] Since there is no price variable in Working's model, Cournot aggregation condition and other restrictions in terms of price derivatives, namely homogeneity, Slutsky symmetry and negativity, are not relevant to the model.

increases and this causes the elasticity to decline toward unity. With a negative β_i, $\eta_i < 1$ and the good is a necessity. With rising income, income elasticity of necessities also declines. The decline in elasticities with rise in income is more marked, the more the elasticity differs from unity. For goods with unit elasticity, elasticity does not decline with income. Another important implication is that if the negative β_i is larger in absolute value than w_i, both the marginal share and income elasticity are negative, implying an inferior good.

The Almost Ideal Demand System

The AIDS demand function in (2.37) is reproduced below.

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log (x/P)$$

The above expression simplifies to the Working's model (2.42) if one assumes the price of each good to be unity and constant. AIDS may, therefore, be regarded as an extension of the Working's model in explicitly accounting for the price variable. Formally, AIDS functions state that the budget share of good i changes due to changes in relative prices and real expenditure. The parameters γ_{ij} represent the effect of change in relative prices; each γ_{ij} represents 100 times the effect on the ith budget share of a 1 per cent change in the price of j holding the real expenditure constant. The effect of change in (x/P) is measured by β_i which was discussed in the previous paragraph.

Deaton and Muellbauer (1980a) describe the properties of AIDS as follows. "AIDS gives an arbitrary first order approximation to any demand system; it satisfies the axioms of choice exactly; it aggregates perfectly over consumers without invoking parallel Engel's curves; it has a functional form which is consistent with known household budget data; it is simple to estimate, largely avoiding the need for nonlinear estimation; and it can be used to test the restrictions of homogeneity and symmetry through linear restrictions on fixed parameters."

Elasticity expressions for AIDS are derived as follows.

Expenditure elasticity as derived in (2.45) is

$$\eta_i = 1 + \frac{\beta_i}{w_i}$$

Uncompensated own price elasticity (e_{ii})

$$\frac{\delta\, w_i}{\delta \log p_i} = \frac{\delta\, (p_i q_i / x)}{\delta \log p_i}$$

$$= \frac{1}{x} \frac{\delta\, (p_i q_i)}{\delta \log p_i}$$

$$= \frac{p_i}{x} \frac{\delta\, q_i}{\delta \log p_i} + \frac{q_i}{x} \frac{\delta\, p_i}{\delta \log p_i}$$

$$= \frac{p_i}{x} \frac{q_i}{q_i} \frac{\delta\, q_i}{\delta \log p_i} + \frac{q_i}{x} \frac{p_i}{p_i} \frac{\delta\, p_i}{\delta \log p_i}$$

$$= w_i \frac{\delta \log q_i}{\delta \log p_i} + w_i \frac{\delta \log p_i}{\delta \log p_i}$$

$$= w_i\, e_{ii} + w_i$$

$$\frac{\delta\ w_i}{\delta\ \log\ p_i} = w_i\ (e_{ii} + 1)$$

$$\text{Therefore, } e_{ii} = \frac{1}{w_i}\ (\frac{\delta\ w_i}{\delta\ \log\ p_i}) - 1$$

Due to the use of Stone's price index, for (2.37),

$$\frac{\delta\ w_i}{\delta\ \log\ p_i} = \tau_{ii} - \beta_i\ w_i$$

and $e_{ii} = \frac{1}{w_i}\ (\tau_{ii} - \beta_i w_i) - 1$

$$= \frac{\tau_{ii}}{w_i} - (1+\beta_i) \tag{2.46}$$

Uncompensated cross-price elasticity (e_{ij})

$$\frac{\delta\ w_i}{\delta\ \log\ p_j} = \frac{\delta\ (p_i q_i/x)}{\delta\ \log\ p_j}$$

$$= \frac{p_i}{x}\ \frac{\delta\ q_i}{\delta\ \log\ p_j}$$

$$= \frac{p_i}{x}\ \frac{q_i}{q_i}\ \frac{\delta\ q_i}{\delta\ \log\ p_j}$$

$$= w_i\ \frac{\delta\ \log\ q_i}{\delta\ \log\ p_j}$$

$$\frac{\delta\ w_i}{\delta\ \log\ p_j} = w_i\ e_{ij}$$

$$\text{Therefore, } e_{ij} = \frac{1}{w_i}\ \frac{\delta\ w_i}{\delta\ \log\ p_j}\ .$$

Since with Stone's index $\frac{\delta\ w_i}{\delta\ \log\ p_j} = \tau_{ij} - \beta_i w_j$

$$e_{ij} = \frac{1}{w_i} (\tau_{ij} - \beta_i w_j) \quad (2.47)$$

Compensated cross-price elasticity $(e_{ij})^*$

$$e^*_{ij} = \eta_i \, w_j + e_{ij}$$

$$= \frac{\tau_{ij}}{w_i} + w_j \quad (2.48)$$

Compensated own price elasticity $(e_{ii})^*$

$$e^*_{ii} = \eta_i \, w_i + e_{ii}$$

$$= \frac{\tau_{ii}}{w_i} + w_i - 1 \quad (2.49)$$

AIDS equations can be estimated with the ordinary least squares (OLS) technique if we have information on x_i, expenditure on commodity (or commodity group) i ($i = 1,\ldots,n$) and p_i. w_i is simply x_i/x. OLS estimation of AIDS would satisfy the adding-up restriction because $\Sigma x_i = x$ and $\Sigma w_i = 1$. However, because of the restriction, which implies that if more is spent on good i=1 less will have to be spent on the remaining goods i = 2 to n, the disturbance in the demand equation for good i = 1 is likely to be correlated with the disturbance terms in demand equations for goods i = 2 to n. If such correlation exists, the system of demand equations is called <u>seemingly unrelated regression equations</u>. OLS estimators of the regression coefficients of such equations are unbiased and consistent but inefficient. The generalized least squares estimators, proposed by Zellner (1962) will be asymptotically more efficient than those obtained by the application of OLS to each equation. The greater the correlation between the disturbance terms, the higher the gain in efficiency (Johnston 1972, p. 238). However, the Zellner estimators and the OLS estimators will be equivalent when each of the seemingly unrelated regression involves exactly the same values of the same explanatory variable (Kmenta 1986, p. 639) which is the case with the AIDS equations.

The AIDS model has been successfully used by several researchers in estimating consumption parameters and testing of restrictions of demand theory. The first application of the model was by its propounders Deaton and Muellbauer (1980a) in analyzing the British consumption pattern during 1954 to 1974. Ray (1980, 1982) applied AIDS to time series and pooled cross-section household budget survey data from India. In his studies, Ray extended the AIDS model by including family size explicitly. Barewal and Goddard (1985) applied AIDS to estimate demand elasticities for Canada. Capps, Tedford and Havlicek (1985) studied the demand for convenience and nonconvenience foods in the United States including demographic variables in the model. Blanciforti, Green and King (1986) developed and applied a dynamic version of AIDS to take account of the effect of "habit" on U.S. consumer's expenditure patterns over the postwar period. Savadogo (1986) applied AIDS to study food consumption parameters for urban households in Burkinafaso. El-Eraky (1987) compared the performance of AIDS with Theil and Sumh's (1981) differential approach in estimating the budget shares of food commodity groups in Egypt by applying Theil's (1980) information measure of goodness of fit and found that the latter model fits the data better. However, as Deaton (1986, p. 1818) maintains Theil and Sumh's model assumes additivity which is a very restrictive assumption as already discussed.

New developments in the application and extension of AIDS include works of Chalfant (1987) and Parikh (1986). Chalfant combined AIDS with Fourier series approach of Gallant to derive a flexible form which is consistent with the PIGLOG class of preferences and has the global flexibility of the Fourier cost function and called it a globally flexible almost ideal demand system. Chalfant used this system to estimate an aggregate demand system for meat and fish using annual U.S. data from 1947 to 1978, and found that it fits better than AIDS which is only locally flexible. However, the superiority of the new demand system will not be certain until the small-sample distribution of the asymptotically normal P statistics, which Chalfant uses for comparing the fit, is established.

Parikh adapted the AIDS model in an analysis of trade between developing countries of Asia and the Pacific and the rest of the world over the period from 1965 to 1980. Parikh found that AIDS performed better than differential AIDS or the constant elasticity of substitution (CES) approach in predicting bilateral trade share matrix.

On the basis of the above discussion, AIDS is considered to be an appropriate model for analyzing food demand subsystem in Nepal.

III. THE DATA

Introduction

This research is based on the Multi-Purpose Household Budget Survey conducted by Nepal Rastra Bank, the country's central bank in 1984/85. This survey is second of the two household budget surveys conducted by the Bank. The first survey was conducted during 1973-75 in 18 urban areas (town *panchayats*) with a total sample of 6,624 households.[1] A complete set of reports for the first survey was published in 1976. For the second survey, data compilation was in final stages when the author undertook the field trip in Nepal in June/July 1987. At the time of writing, no information on the status of publication of the survey report was available.

Data analyzed in this research are, therefore, computer print-out of block level data released to the author by the Multi-Purpose Household Budget Survey Project during the field trip. Data on average expenditure were available for all 12 food groups by income decile for each round of survey in all 15 blocks. Block-wise price data were available for the same 12 food groups for each round of the survey. The

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[1] *Panchayats* are the lowest level of governance unit in Nepal.

budget share equations in Chapter IV are, therefore, estimated on the basis of 30 observations.

Description of the Survey

The Multi-Purpose Household Budget Survey was conducted in two rounds. The first round was conducted from mid-January 1984 to mid-July 1984 and the second round was conducted in the following six months. The survey covered a sample of 16 towns and 135 village *panchayats* throughout the country. The first round of survey covered 5,294 households and the second round enumerated 5,224 of the same households. Household level information were collected with variable reference periods. For example, expenditure on food items were recorded for a week, expenditure on consumer goods were recorded for a month, expenditure on and income from farming were enumerated for the last year, and income from other sources were recorded for the last month in the first round and for the last month and year in the second round. Income in cash and in kind were recorded, and cash expenditure and consumption of home produced goods valued at appropriate market prices were included.

Information collected by the survey included demographic makeup, employment, land holding and tenure, cropping pattern, ownership of durable assets and savings and borrowing. Food expenditure were classified into the following 13 groups.[2]

1. Cereal grains and products
2. Pulses (and beans)
3. Vegetables (potato, roots and tubers, green leafy vegetables, green vegetables and dried vegetables)
4. Spices
5. Fruits
6. Condiments
7. Fish, meat and eggs
8. Milk and dairy products
9. Sugar and sweets
10. Oil and fats
11. Non-alcoholic beverages
12. Alcoholic beverages
13. Meals away from home

Sample Design and Procedure

The basic principle followed in sample design and procedure was to capture the heterogeneity in income and expenditure patterns of the Nepalese households due to place of residence. In the urban areas households have diversified sources of income, while in the rural areas operational land holding is a major source of income and local employment. Rural and urban households also differ in their expenditure patterns. For example, urban households

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[2] At the data processing stage, the number of food groups was reduced to 12 by combining groups 4 and 6.

will spend more on rent and transportation than the rural ones. Employment opportunities, technology, and eventually income level and expenditure patterns are also affected by topography and access to market. Thus, whether a household is located in the rural or urban area and whether it is located in the mountains, hills or Tarai makes a substantial difference in the level of living.

There are three ecological belts running west to east in the kingdom of Nepal: the mountains, hills and Tarai. The National Planning Commission has divided the country into five development regions: eastern, central, western, mid-western and far-western. The Multi-Purpose Household Budget Survey reclassified regions as follows. While the eastern development region was kept intact, the central and western development regions were combined as the central region and the mid-western and far-western development regions were combined as the western region.

The superimposition of the two sets of divisions discussed above generated nine geographical blocks which were adopted as main strata. The districts within a block were considered more or less homogeneous in terms of altitude, climate, topography and vegetation.[3] Sharp and distinct interblock differences in farm size, farming system, sources of income generation and expenditure

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[3] District is a collection of contiguous panchayats and the most important unit of civil administration. It may be considered equivalent to a county in the United States.

patterns were expected in sample design.

The district formed the primary sampling unit. The number of districts in a main stratum is fixed and, after excluding five districts due to inaccessibility, ranged from two in the central mountains to 20 in the western hills. For statistical reasons, 25 percent of the districts, or at least two districts, were randomly selected from each stratum, and as a result, the sampling fraction among the strata ranged from 25 to 66 per cent. Village and town panchayats form the secondary sampling units. At the district level, separate sampling frames were constructed for the rural areas comprising all village panchayats and urban areas consisting of all wards of town panchayats. Approximately ten percent of village panchayats and, with a few exceptions, 30 per cent or a minimum of four wards were randomly selected with equal probability without replacement.

Each village panchayat consists of nine wards. In each village panchayat three artificial clusters were created by grouping three contiguous wards in a cluster. Each cluster forming the third stage in the sampling procedure comprised roughly 300 households and this was expected to facilitate selection of a sufficiently large number of households from each stratum in the final stage. From each selected panchayat, two out of three clusters were randomly selected with equal probability without replacement.

Rural households formed the fourth, and final, stage sampling unit. A comprehensive list of rural households serving as the sampling frame was prepared for each selected cluster. The list included information on operated land holding corresponding to individual rural households. Using operated land holding as a proxy variable for income, the rural households were substratified into five categories: four land operating classes - large, medium, small and marginal farm households - and the fifth comprising the non-cultivator households. The size of land holding as a criterion of substratification was different for the mountains and hills than from the Tarai. After substratification, a random sample of five per cent of households with a minimum of two were selected for enumeration from each substratum.

In the urban areas, a complete enumeration of all households residing in the selected wards was done and they were identified by four major characteristics, viz. family size, occupation of the household head, place of employment and type of work. Serial numbers were assigned to them in occupation within size order. From this sampling frame 2.5 per cent of the households were selected for interviews by a systematic sampling method.

The mountain belt is sparsely populated and remote in terms of economical and efficient means of transport and, therefore, the survey project determined that practically this belt does not have urban areas. After incorporating the rural/urban dichotomy, the number of blocks increases from nine to 15. Table 3.1 shows the composition of blocks and the number of samples from each block in the first round of survey.

Grouping and Aggregation Procedure

The Multi-Purpose Budget Survey Project grouped the commodities consumed by the sample households by their characteristics. The groupings were defined before the survey and are logically consistent.

The household level data were aggregated into block level as follows. Expenditure of all households in a block were added by commodity group and divided by the block's population to arrive at per capita expenditure on a particular commodity group, say grains and cereal products. For each block, the price of a food group was calculated by using the budget share of each commodity within the group as the weight.

More general aggregations, such as rural/urban or by ecological belts or for the country as a whole, which will be seen in the following sections have been done by using block population as the weight. This weighing procedure is justified because the block level data are in per capita terms and the block-wise distribution of samples was determined in a representative manner.

Table 3.1: Distribution of Sample Households by Block

Belt		Development Region			Total
		Eastern	Central	Western	
Mountains	Rural	156	323	155	634
Hills	Rural	333	772	352	1457
	Urban	112	536	226	874
Tarai	Rural	575	761	235	1571
	Urban	289	236	233	758
Total		1465	2628	1201	5294

Descriptive Analysis of Data

Classification of Households into Income Groups

The household budget survey data analyzed in this study has categorized households into ten classes based on the ascending order of monthly per capita income range. Each class consists of 10 per cent of total households. The income range for the same class are higher in the urban areas than in the rural areas.

Since household consumption behavior is hypothesized to differ by income status, it needs to be analyzed for different income classes. Income differences between the ten classes are very narrow and therefore income classes have been regrouped into three - low, middle and high - income groups for interpreting and presenting results and analyzing income distribution. The reclassification is carried out as follows. The first four classes of households have been combined to form the low income group, classes fifth through the ninth comprise the middle income group and the tenth class is designated as the high income group. The average group represents the average of all classes and is presented to note how each group differs from it.

The first four income classes making up the low income group constitute 40 per cent of the sample households and, thus, this group may be regarded as the one below the poverty line defined by the National Planning Commission.

The cut off point for the grouping of the middle income and high income groups is the point of major change in per capita income between the upper income classes.

Income Distribution

The weighted average annual per capita incomes for the low, middle and high income strata, calculated from the household survey data, are Rs. 1,414, Rs. 2,867 and Rs. 6,838, respectively. The weighted average for all income strata works out to Rs. 2530. The differences in these figures indicate income inequality in Nepal. For instance, while the per capita income of the poorest 40 per cent is only 56 per cent of the average per capita income, the richest 10 per cent have an income which is 2.7 times the national average. The usual measures of income distribution are discussed below.

Income distribution in a country is usually portrayed in three ways. The first is an arithmetic measure showing the percentage of national income received by the lowest 20 per cent or 40 per cent and by the top 10 per cent or 20 per cent of families. Table 3.2 presents income distribution in Nepal using this approach. The data from the household budget survey shows that the lowest 40 per cent of the households share 21 per cent of all households' income which according to the classification used by Ahluwalia (1974, pp. 8-9) depicts low inequality. While this result is significantly different from the National Planning

Table 3.2: Cumulative Percentage of Households and their Share in Income

Income Group	Cumulative Percentage of Households	Cumulative Percentage of Income
1	10	3.64
2	20	8.64
3	30	14.43
4	40	21.02
5	50	28.64
6	60	37.32
7	70	47.57
8	80	59.78
9	90	74.91
10	100	100.00

Commission's estimate that the lowest 47 per cent families receive only 12.6 per cent of income and the World Bank estimate[4], it is not implausible considering similar patterns of distribution in Bangladesh and several other low income countries with similar per capita income (Ahluwalia et al. 1979, Tables 1 and 2).

The second measure of income distribution is based on a logarithmic concept and is called the Lorenz curve. A Lorenz curve for Nepal based on the budget survey is presented in Figure 3.1. Cumulative percentage of the population and cumulative percentages of their income is plotted, beginning from the lower left corner, and beginning with the lowest-income group. The 45° line from the lower left corner to the upper right corner is the line of perfect equality. The farther the distance of the Lorenz curve from this line the greater the inequality. The Lorenz curve gives an illustration of inequality but not a precise measure of it.

The third one is an algebraist's measure known as the Gini coefficient, after an Italian mathematician. The Gini coefficient is the ratio of the area between the 45° line and the Lorenz curve to the entire area below the 45° line. Calculated from the budget survey data, this coefficient is

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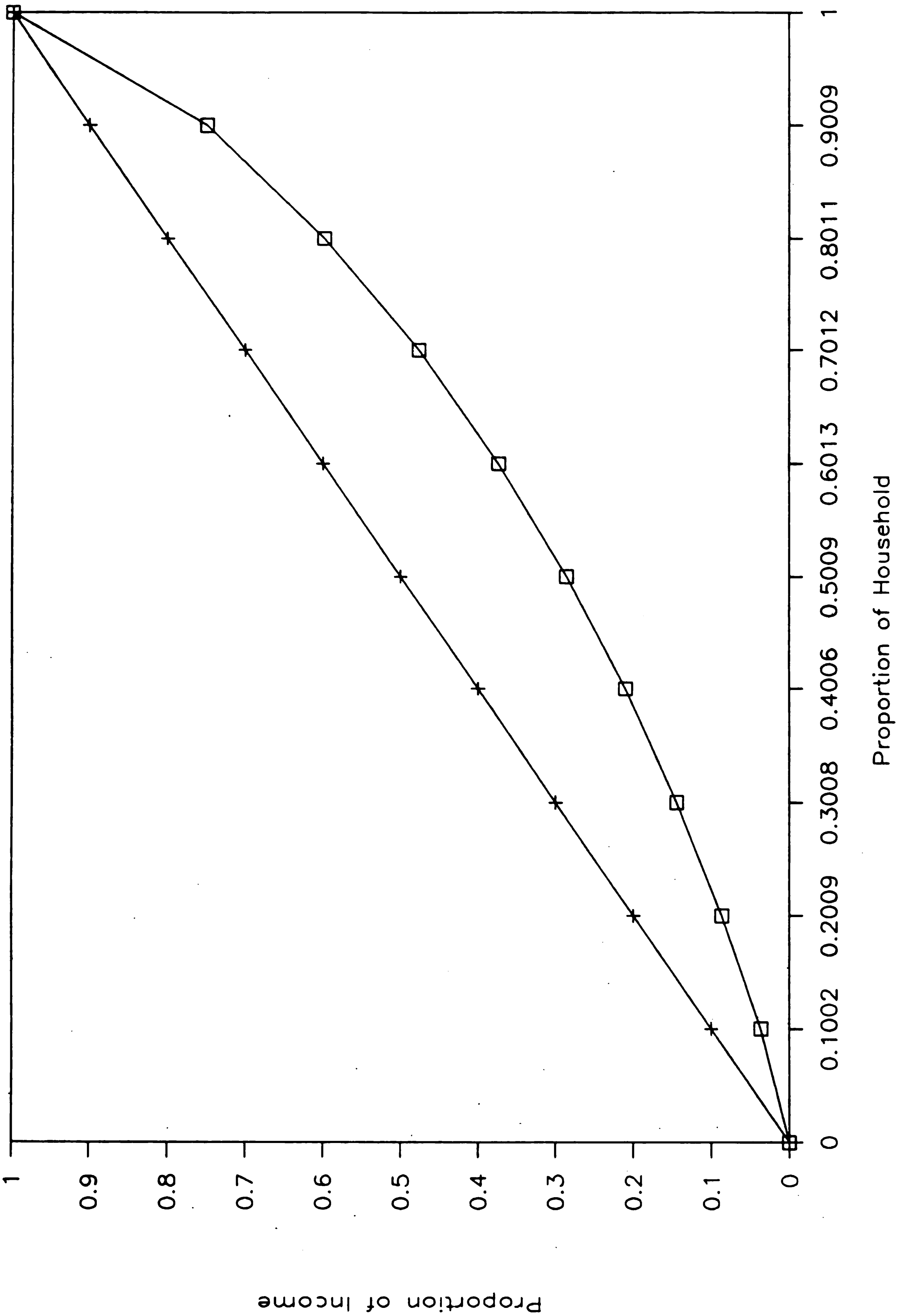
[4] The World Bank (1984, Table 28) has reported that the lowest 20 per cent households in Nepal share 4.6 per cent of income against 36.2 per cent for the 2d, 3d and 4th quintiles and 59.2 per cent and 46.5 per cent going to the top 20 per cent and 10 per cent, respectively.

Figure 3.1: Lorenz Curve

of Income Distribution in Nepal



0.31 for the Nepalese population.[5] This is approximately half the coefficient of 0.6 suggested by a National Planning Commission study (1978 quoted in Pant and Jain 1980, p.23). Although the method of computation used by the National Planning Commission is not discussed and the linear approximation method slightly underestimates the Gini-ratio (Riemenschneider 1976, p. 21), the Gini-ratio of 0.31, if true, indicates a low level of inequality in the country. Comparable figures for the other South Asian countries are: 0.43 in Sri Lanka (Edirisinghe 1987, p. 33), 0.37 in Pakistan and 0.46 in India (Todaro 1985, p. 150).

Allocation of Consumer Budget

Allocation of consumer expenditure into food groups is presented in Tables 3.3 and 3.4. In Nepal, the average consumer spends approximately 64 per cent of its income on food. The budget share on food declines from 72 per cent among the low income households to 50 per cent among the high income group. This is as expected by Engel's law. Among the food groups, expenditure on grains and cereal products account for more than half of total expenditure on food. Other important food groups in descending order of the average budget proportions are vegetables, milk and dairy products, meals away from home, meat, fish and eggs, oils and fats, and pulses. Among these food groups, the

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[5] The calculation is based on a straight-line approximation discussed in Yotopoulous and Nugent (1976, pp. 239-42).

Table 3.3: Percentage Distribution of Food Expenditure by Income Group

Food Group	Income Group Low	Medium	High	Average
Grains and Cereal Products	62.34	52.86	43.75	54.70
Fine rice	7.63	13.75	15.38	12.00
Coarse rice	32.63	21.10	14.84	23.97
Other rice products	0.76	1.19	1.81	1.13
Wheat and products	16.47	11.52	7.70	12.60
Maize and products	4.29	4.24	2.87	4.08
Coarse grains	0.51	1.05	1.12	0.89
Other grain products	0.07	0.01	0.04	0.03
Pulses and beans	4.18	4.38	4.42	4.32
Vegetables	9.31	9.66	9.14	9.48
Spices and condiments	3.15	3.17	2.73	3.10
Fruits and nuts	0.38	0.81	1.82	0.80
Meat, fish and eggs	3.82	5.32	7.20	5.08
Milk and dairy products	3.77	6.48	8.45	5.87
Oils and fats	4.04	4.84	5.32	4.65
Sugar and sweets	0.84	1.65	2.35	1.48
Nonalcoholic beverages	2.41	3.75	4.72	3.45
Alcoholic beverages	1.19	1.31	1.64	1.32
Meals away from home	4.56	5.79	8.45	5.75

Table 3.4: Percentage Share of Food Groups in Nepal

	Low	Middle	High	Average
Average expenditure on food as proportion of total expenditure	71.78	63.93	49.52	63.72
Average expenditure on six food groups as proportion of total expenditure on food	87.46	83.54	78.28	84.10
Average expenditure on six food groups as proportion of total expenditure	62.78	53.40	38.76	53.58
Budget share of six food groups as proportion of total expenditure				
Grain & cereal products	44.75	33.79	21.66	34.85
Pulses	3.00	2.80	2.19	2.75
Vegetables	6.68	6.18	4.53	6.04
Meat	2.74	3.40	3.57	3.24
Milk	2.71	4.14	4.18	3.74
Oil & fats	2.90	3.09	2.63	2.96

data shows that with increase in income the budget the proportions on grains and cereals decline, while on meat and dairy products increase. This is consistent with findings in other countries (Chaudhri and Timmer 1986).

The data also show that within a food group, consumers substitute more preferred quality for less preferred quality of the same commodity as their income rises. In the grains and cereal products group, the influence of changing affluence is evidenced by opposite movements in the budget proportions of coarse and fine rice.

This research concentrates on six of the seven important food groups discussed earlier: (1) grains and cereal products, (2) pulses, (3) vegetables, (4) meat, fish and eggs, (5) milk and dairy products, and (6) oils and fats.[6]

The main reason for concentrating on these six food groups is their importance in the Nepalese diet and their budget shares. Rice, pulses and vegetables constitute the main items of the Nepalese diet. Meat and milk are considered important sources of nutrient and are preferred by all consumers. Oils and fats are essential ingredients in making curries. As shown in Table 3.4, together these food groups comprise approximately 54 per cent of total

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[6] Although meals away from home claims a higher share of food expenditure (5.75 per cent) than meat, fish and eggs (5.08 per cent) and oils and fats (4.65), it could not be included in the analysis because for this group price information is not available.

expenditure and 84 per cent of consumer food budget. The other reason for limiting our analysis to the six food groups is the limited number of observations (see Chapter IV). If more food groups are included, the degrees of freedom and the reliability of the estimated parameters will be lowered.

The data show that the average expenditure on six food groups comprises from 78 to 87 per cent of total food expenditure and thus, varies narrowly across income groups. In terms of percentage share of total expenditure, major variation in seen only in the case of grains and cereal products. For other food groups variation in the budget share across income groups is relatively small.

Levels of Consumption

The foregoing analysis of budget shares allocated to different foods is not complete. Although inter-group differences in the budget shares allocated to different foods is narrow, given the wide magnitude of income differences across the income groups, discussed earlier, the level of food consumption may differ substantially. Hence, it is necessary to look into the data on quantities of foods consumed by different income strata.

Table 3.5 presents the income group-wise average consumption of the commodities included in this research. The consumption quantities were derived by dividing the average consumption expenditure on a commodity or food group

Table 3.5: Per Capita Food Consumption Per Annum

Food Group	Income Group			
	Low	Middle	High	Average
Grains and cereal products	158	194	245	182
Fine rice	16	43	74	33
Coarse rice	83	76	78	79
Rice products	1	3	6	2
Wheat and products	56	56	58	56
Maize and products	12	17	18	15
Coarse grains	2	6	11	4
Other grain products	2	*	*	1
Pulses and beans	6	10	15	8
Vegetables	37	54	76	48
Meat, fish and eggs	2	5	9	4
Milk and dairy products	9	24	48	19
Oils and fats	2	3	5	3

Notes:

1. Grains and pulses are in kilograms, and oils and fats are in liter. Commodities within vegetables, meat and milk groups are in variable units of measurement.

2. * indicates less than 0.5.

by its corresponding average price. The average price, as explained before, was calculated by using the budget share of each commodity in a food group as the weight, and is same for all income group.

The figures in Table 3.5 have two major limitations which must be taken into account before using them seriously. First, because a weighted average price rather than a set of income group-specific prices are used, the average consumption is likely to be underestimated for the low income group and overestimated for the high income group. Second, for some commodities, such as cereal products and vegetables, the unit of measurement is not clear. Vegetables are measured in different units: potatoes in kilograms, cauliflower in heads and green leafy vegetables in bunch. Similarly, bread and pastries, and cheese and butter are measured in different units than wheat and milk, but they are lumped together in the food groups. Thus, in those cases the figures in Table 3.5 provide only an indicative measure of the difference in absolute level of consumption across income groups.

The figures show large differences in the consumption of all foods across income groups. The poor consume only 158 kilograms of grains and cereal products which provide from 78 to 83 per cent of the average calorie intake in Nepal (DFAMS 1984, p. 67). For this income group, the consumption of pulses which is an important source of protein in the Nepalese diet is also low. Consumption of meat and milk vary a great deal across the income groups.

IV. ESTIMATION OF DEMAND MODEL

Introduction

In this section, the Almost Ideal Demand System (AIDS) model propounded by Deaton and Muellbauer (1980a) will be used to estimate the food demand system for Nepal. The scope of research has been limited to food commodities, expenditure on which averages 65 per cent of household budget in Nepal. Food items have been grouped into 12 groups and, of these, six groups, namely, (1) grains and cereal products, (2) pulses, (3) vegetables, (4) meat, fish and eggs, (5) milk and dairy products and (6) oil and fats, accounting for 84 per cent of food expenditure are selected for the demand system. Expenditure and price data for the two rounds of survey in the 15 blocks are used for the estimation of the food demand system. The number of degrees of freedom was also an important consideration in determining the number of food groups to be included in the demand system.

Specification of the Estimating Equation

The following AIDS equation is used to estimate the demand system for each food group.

$$w_{ibr} = \alpha_i + \sum_j \tau_{ij} \ln p_{jbr} + \beta_i \ln (x_{br} / P_{br}) + u_{ir} \qquad (4.1)$$

where food groups i and j = 1,...,6; block b = 1,...,15 and round r = 1,2. Equation (4.1) is subject to the following definitions.

1. w_{ibr} is the ratio of per capita expenditure on food group i in block b in round r of the survey to the total per capita expenditure on all six food groups in the same block and round of survey. Mathematically, $w_{ibr} = v_j / x$, where $v_j = \sum_{k \epsilon j} v_k$, is the total per capita expenditure in all commodities in group j by all sample households in block b in round r, and $x = \sum_j v_j$. This is simply referred to as the budget share of food group i.

2. α_i is the intercept and τ_{ij} and β_i are price and income parameters.

3. ln p_{jbr} is the natural log of the weighted arithmetic average of price of food group j in block b in round r. The price p_{jbr} is calculated as

$$p_{jbr} = \sum_{k \epsilon j} \frac{v_k^*}{q_k} * \frac{v_k^*}{v_j^*}$$

where v_k^* is the total expenditure on food k in group j by all sample households in block b in round r, q_k is the total quantity of commodity k in group j consumed by all sample households in block b in round r, and $v_j^* = \sum_{k \epsilon j} v_k^*$, represents total expenditure on all commodities in group j by sample households in block b in round r.

4. $\ln (x_{br} / P_{br}) = \ln x_{br} - \ln P_{br}$, where $\ln x_{br}$ is the logarithm of total per capita expenditure on the six food groups in block b in round r. $\ln P^*$ is Stone's price index $\ln P^* = \sum_i w_i \ln p_i$ for block b in round r.

5. u_{ir} is the stochastic error term.

Underlying Assumptions and Limitations of the Demand System

1. The demand system estimated here assumes weakly separable preference ordering. The demand for each of the six food groups included in the system depends only on the prices of the six food groups and total expenditure alloted to them. Prices of commodities not included in the system are assumed to have influence on the demand system parameters only through their influence on the determination of the total expenditure proportion allocated to the six food groups. In other words, we follow the two-stage budgeting procedure discussed in Chapter II. Thus, total expenditure on the six food groups is exogenously determined, and so are the composite prices for these food groups.

2. Sample households have the same utility function. This assumption is essential because we are dealing with aggregate data.

3. Following Muellbauer (1975), it is assumed that income distribution across the regions are constant, and therefore, y_o, the representative level of income that takes

account of income distribution is also constant. Constant y_o is crucial for aggregation across consumers.

4. Due to data constraint, the influence of non-economic factors such as demographic characteristics are not taken into account and it is assumed that only prices and income influence consumer demand. While the influence of household size is partly taken care of by representing expenditures in per capita terms, the questions of economies of scale in consumption and the proportion of children in a household are not addressed. The random errors or structural disturbance terms are assumed to enter additively into demand equations.

5. In this research food group prices differ both spatially and intertemporally. An internal real income deflator, known as Stone's index, has been estimated by including all prices and commodity groups. It is assumed that this index is a close approximation of the real price index.

6. The usual mean-variance assumptions are made about the stochastic error term. The disturbances are assumed to be stochastically independent of prices and total expenditures. The error term, u_{ir}, is also assumed to be uncorrelated with the disturbances of demand equations of commodities not included in the system.

7. Our estimation is based on grouped data. Ordinary least squares estimators of α and β based on grouped means

are unbiased and the error term is nonautoregressive. However, since the number of observations is not the same for every group (see Table 3.1), the error term is heteroskedastic and therefore, estimators of α and β are not efficient. Kmenta (1986, p.370) notes that "there will always be some loss of efficiency by going from individual observations to group unless X's within each group are all equal. This conclusion holds whether the groups contain the same number of observations or not" (author's emphasis).

Kmenta also proposes formulas for estimators of α, β and σ^2 which are unbiased, consistent, and asymptotically efficient among the classes of all estimators that are based on the same information. Modification in the estimating equation to correct for the loss of efficiency was considered but not carried out. The main reason for this decision was that there are other more serious matters, such as possible errors in measurement of consumption expenditure, affecting the estimators that no substantial gain in efficiency is likely by correcting for heteroskedasticity.

Estimation Procedure

The demand equation 4.1 was estimated by ordinary least squares method for each of the six food groups separately. Parameters estimated by the regression are presented in Table 4.1 through Table 4.4. Out of 24 income parameters and 144 price parameters, 13 income parameters and 30 price

Table 4.1: Unrestricted Parameter Estimate of AIDS for Low Income Group

(t-values in parentheses)

Food Group	α_i	β_i	τ_{i1}	τ_{i2}	τ_{i3}	τ_{i4}	τ_{i5}	τ_{i6}	R^2
Grains and cereal products	2.092	-.332	-.109	-.072	.008	-.050	.076	-.038	.465
	(4.78)	(-3.2)	(-1.91)	(-1.99)	(.32)	(-1.6)	(1.02)	(-.80)	
Pulses and beans	.354	-.02	.040	-.042	-.018	.032	-.052	-.068	.210
	(.94)	(-.22)	(.82)	(-1.35)	(-.90)	(1.18)	(-.82)	(-1.68)	
Vegetables	-.47	.16	.049	.055	.005	.035	-.096	-.005	.531
	(-1.82)	(2.60)	(1.46)	(2.58)	(.39)	(1.88)	(-2.18)	(-.18)	
Meat, fish and eggs	-.414	.132	.018	.032	.002	-.01	-.044	.029	.47
	(-2.5)	(3.34)	(.81)	(2.30)	(.29)	(-.82)	(-1.54)	(1.63)	
Milk and dairy products	-.102	.007	.064	-.021	-.006	-.008	.024	.021	.51
	(-.54)	(.16)	(2.61)	(-1.37)	(-.62)	(-.63)	(.74)	(1.06)	
Oils and fats	-.217	.053	.024	.002	.002	.012	-.006	.014	.445
	(-2.82)	(2.92)	(2.46)	(.46)	(.48)	(2.2)	(-.50)	(1.66)	

Table 3.6: An Estimated Parameter Estimates of AIDS for Middle Income Group

Table 4.2: <u>Unrestricted Parameter Estimate of AIDS for Middle Income Group</u>

(t-values in parentheses)

Food Group	α_i	β_i	τ_{i1}	τ_{i2}	τ_{i3}	τ_{i4}	τ_{i5}	τ_{i6}	R^2
Grains and cereal products	2.36	-.378	.042	-.136	-.011	-.090	-.008	-.024	.603
	(4.23)	(-2.57)	(.72)	(-3.17)	(-.38)	(-2.38)	(-.097)	(-.49)	
Pulses and beans	.482	-.126	-.092	.045	-.012	.014	.038	-.024	.706
	(2.78)	(-2.746)	(-4.97)	(3.36)	(-1.35)	(1.18)	(1.42)	(-1.58)	
Vegetables	-.554	.202	.015	.048	.018	.035	-.077	-.024	.544
	(-1.92)	(2.66)	(.49)	(2.2)	(1.28)	(1.78)	(-1.70)	(-.94)	
Meat, fish and eggs	-.676	.184	.012	.042	.012	.007	-.018	.020	.438
	(-2.80)	(2.90)	(.46)	(2.28)	(1.04)	(.43)	(-.48)	(.96)	
Milk and dairy products	-.291	.054	.028	-.016	-.008	.015	.056	.022	.372
	(-1.50)	(1.07)	(1.36)	(-1.08)	(-.80)	(1.14)	(1.86)	(1.26)	
Oils and fats	-.32	.062	-.006	.016	-.001	.019	.008	.03	.436
	(-2.42)	(1.78)	(-.41)	(1.58)	(-.14)	(2.16)	(.42)	(2.61)	

Table 4.3: Unrestricted Parameter Estimate of AIDS for High Income Group

Table 4.3: Unrestricted Parameter Estimate of AIDS for High Income Group

(t-values in parentheses)

Food Group	α_i	β_i	τ_{i1}	τ_{i2}	τ_{i3}	τ_{i4}	τ_{i5}	τ_{i6}	R^2
Grains and cereal products	.68	.02	.232	-.168	.011	-.138	-.038	.07	.532
	(1.16)	(.16)	(2.36)	(-2.19)	(.22)	(-2.10)	(-.26)	(.84)	
Pulses and beans	.415	-.076	-.083	.003	-.010	.030	-.011	-.011	.732
	(3.95)	(-3.46)	(-4.73)	(.25)	(-1.08)	(2.56)	(-.43)	(-.77)	
Vegetables	.110	.034	.002	.054	.012	.039	-.068	-.076	.41
	(.46)	(.70)	(.06)	(1.76)	(.55)	(1.48)	(-1.16)	(2.31)	
Meat, fish and eggs	.155	-.053	-.042	.064	.001	.036	-.032	-.003	.248
	(.50)	(-.82)	(-.82)	(1.60)	(.04)	(1.04)	(-.42)	(-.06)	
Milk and dairy products	-.494	.084	-.084	.02	-.018	.020	.198	.026	.516
	(-1.91)	(1.54)	(-1.96)	(.58)	(-.80)	(.72)	(3.04)	(.70)	
Oils and fats	.132	-.010	-.024	.026	.004	.012	-.046	-.004	.136
	(.66)	(-.24)	(-.71)	(1.02)	(.24)	(.54)	(-.93)	(-.15)	

Table 4.4: Unrestricted Parameter Estimate of AIDS for Average Income

Table 4.4: Unrestricted Parameter Estimate of AIDS for Average Income

(t-values in parentheses)

Food Group	α_i	β_i	τ_{i1}	τ_{i2}	τ_{i3}	τ_{i4}	τ_{i5}	τ_{i6}	R^2
Grains and cereal products	2.25	-.35	.011	-.114	-.005	-.085	.019	-.036	.592
	(4.96)	(-3.22)	(.22)	(-3.00)	(-.21)	(-2.52)	(.26)	(-.78)	
Pulses and beans	.398	-.095	-.064	.032	-.008	.014	.024	-.030	.672
	(2.67)	(-2.66)	(-3.94)	(2.54)	(-.96)	(1.32)	(.98)	(-2.0)	
Vegetables	-.538	.183	.002	.050	.01	.038	-.059	-.01	.589
	(-2.23)	(3.16)	(.10)	(2.47)	(.72)	(2.13)	(-1.48)	(-.40)	
Meat, fish and eggs	-.608	.164	.002	.042	.008	.006	-.020	.03	.513
	(-3.14)	(3.53)	(.08)	(2.63)	(.73)	(.45)	(-.63)	(1.48)	
Milk and dairy products	-.3	.057	.048	-.022	-.006	.010	.036	.028	.486
	(1.92)	(1.54)	(2.8)	(-1.71)	(-.66)	(.9)	(1.39)	(1.74)	
Oils and fats	-.202	.041	.001	.012	.001	.015	.0	.02	.356
	(-1.94)	(1.64)	(.12)	(1.40)	(.24)	(1.96)	(.01)	(1.80)	

parameters have t-values exceeding 2 and thus statistically significant at 5 per cent. Five income parameters and 45 price parameters have t-values between 1 and 2. R^2s range from .136 for oils and fats in high income group to .732 for pulses in high income group. Given the cross-section nature of the data, R^2s are generally satisfactory. The negative sign of β's for grains and cereal products, and pulses in all income groups imply income elasticities less than one, and thus these food groups are necessities.[1] For all other food groups, the signs of β's are positive. This implies that these food groups contain preferred commodities.

<u>Testing of Theoretical Restrictions</u>

With respect to obeying the theoretical restrictions, the adding-up restriction (2.39), $\Sigma\alpha_i = 1$, is satisfied. The homogeneity restriction $\sum_j \tau_{ij} = 0$ (2.40) is imposed on equation (4.1) and the resulting equation (4.2) is estimated for each food group by OLS.

$$w_{ibr} = \alpha_i + \sum_{j=1}^{n-1} \tau_{ij} \ln(p_{jbr} / p_{nbr}) + \beta_i \ln(x_{br} / P_{br}) \qquad (4.2)$$

Parameters estimated with the above equation are presented in Tables 4.5 through 4.8. The τ_{i6}'s are calculated from the homogeneity restriction and their respective

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[1] The positive sign of β for grains and cereal products and the negative sign of β for oils and fats in high income group have extremely low t-values, and therefore are not reliable.

Table 4.3: Homogeneous Parameter Estimate of AIDS for Low Income Group

Table 4.5: Homogeneous Parameter Estimate of AIDS for Low Income Group

(t-values in parentheses)

Food Group	α_i	β_i	τ_{11}	τ_{12}	τ_{13}	τ_{14}	τ_{15}	τ_{16}	R^2
Grains and cereal products	1.522	-.286	-.18	-.075	-.008	-.122	.284	.101	.186
	(1.60)	(-.96)	(-1.02)	(-.68)	(-.11)	(-1.22)	(1.40)	(.86)	
Pulses and beans	-.012	.03	.056	-.03	-.017	.034	-.007	-.036	.147
	(-.04)	(.36)	(1.14)	(-.98)	(-.83)	(1.24)	(-.14)	(-1.1)	
Vegetables	-.323	.140	.043	.050	.004	.034	-.114	-.017	.518
	(-1.84)	(2.52)	(1.32)	(2.48)	(.35)	(1.86)	(-3.06)	(-.78)	
Meat, fish and eggs	-.322	.119	.014	.028	.002	-.010	-.055	.021	.456
	(-2.86)	(3.36)	(.66)	(2.2)	(.26)	(-.88)	(-2.28)	(1.49)	
Milk and dairy products	.146	-.026	.054	-.03	-.007	-.01	-.006	-.001	.437
	(1.08)	(-.62)	(2.15)	(-1.9)	(-.68)	(-.70)	(-.22)	(-.06)	
Oils and fats	-.051	.030	.018	-.002	.001	.011	-.027	-.001	.223
	(-.84)	(1.60)	(1.58)	(-.36)	(.29)	(1.76)	(-2.08)	(-.13)	

Table 4.6: Homogeneous Parameter Estimate of AIDS for Middle Income Group

Table 4.6: Homogeneous Parameter Estimate of AIDS for Middle Income Group

(t-values in parentheses)

Food Group	α_i	β_i	τ_{i1}	τ_{i2}	τ_{i3}	τ_{i4}	τ_{i5}	τ_{i6}	R^2
Grains and cereal products	1.703	-.313	.052	-.108	-.007	-.086	.117	.032	.515
	(3.34)	(-2.01)	(.80)	(-2.44)	(-.23)	(-2.1)	(1.62)	(.70)	
Pulses and beans	.392	-.116	-.092	.048	-.011	.014	.056	-.015	.694
	(2.67)	(-2.60)	(-4.92)	(3.82)	(-1.3)	(1.24)	(2.7)	(-1.14)	
Vegetables	-.506	.197	.014	.046	.018	.034	-.086	-.026	.542
	(-2.12)	(2.71)	(.48)	(2.24)	(1.3)	(1.80)	(-2.56)	(-1.22)	
Meat, fish and eggs	-.454	.162	.009	.033	.011	.006	-.06	.001	.362
	(-2.14)	(2.50)	(.34)	(1.79)	(.90)	(.33)	(-2.02)	(.05)	
Milk and dairy products	-.009	.027	.024	-.028	-.009	.013	.002	-.002	.160
	(-.04)	(.48)	(1.04)	(-1.73)	(-.85)	(.88)	(.11)	(-.12)	
Oils and fats	.124	.042	-.008	.008	-.002	.018	-.028	.012	.236
	(-.98)	(1.10)	(-.53)	(.72)	(-.27)	(1.78)	(-1.61)	(1.06)	

Table 4.7: [illegible] Parameter Estimate of [illegible]

Table 4.7: Homogeneous Parameter Estimate of AIDS for High Income Group

(t-values in parentheses)

Food Group	α_i	β_i	τ_{11}	τ_{12}	τ_{13}	τ_{14}	τ_{15}	τ_{16}	R^2
Grains and cereal products	.604	.025	.232	-.164	.012	-.138	-.019	.077	.531
	(1.54)	(.21)	(2.41)	(-2.32)	(.24)	(-2.14)	(-.194)	(1.08)	
Pulses and beans	.218	-.066	-.082	.016	-.008	.03	.038	.006	.531
	(2.74)	(-2.72)	(-4.21)	(1.1)	(-.74)	(2.29)	(1.90)	(.41)	
Vegetables	.019	.04	.002	.06	.012	.039	-.046	-.067	.402
	(.12)	(.83)	(.07)	(2.11)	(.62)	(1.50)	(-1.16)	(-2.32)	
Meat, fish and eggs	.213	-.056	-.042	.061	.001	.036	-.047	-.009	.246
	(1.04)	(-.90)	(-.84)	(1.65)	(.02)	(1.07)	(-.91)	(-.24)	
Milk and dairy products	-.112	.062	-.086	-.004	-.023	.021	.102	-.01	.427
	(-.60)	(1.10)	(-1.88)	(-.12)	(-.94)	(.69)	(2.16)	(-.29)	
Oils and fats	.056	-.006	-.023	.031	.005	.012	-.028	.003	.125
	(.42)	(-.14)	(-.71)	(1.3)	(.3)	(.54)	(-.82)	(.12)	

Table 4.[illegible]: [illegible] Parameter Estimate of [illegible]

Table 4.8: <u>Homogeneous Parameter Estimate of AIDS for Average Income</u>

(t-values in parantheses)

Food Group	α_i	β_i	τ_{i1}	τ_{i2}	τ_{i3}	τ_{i4}	τ_{i5}	τ_{i6}	R^2
Grains and cereal products	1.599	-.278	.014	-.09	-.004	-.080	.136	.024	.498
	(4.24)	(-2.48)	(.26)	(-2.26)	(-.13)	(-2.19)	(2.34)	(.56)	
Pulses and beans	.297	-.084	-.064	.036	-.008	.016	.042	-.022	.655
	(2.59)	(-2.46)	(-3.91)	(2.96)	(-.92)	(1.4)	(2.38)	(-1.70)	
Vegetables	-.442	.172	.002	.046	.009	.038	-.076	-.019	.582
	(-2.42)	(3.16)	(.08)	(2.42)	(.71)	(2.12)	(-2.71)	(-.92)	
Meat, fish and eggs	-.397	.14	.001	.034	.007	.004	-.058	.012	.449
	(-2.57)	(3.05)	(.03)	(2.14)	(.65)	(.32)	(-2.44)	(.69)	
Milk and dairy products	-.009	.026	.046	-.034	-.006	.008	-.016	.002	.289
	(-.06)	(.62)	(2.36)	(-2.32)	(-.65)	(.61)	(-.78)	(.12)	
Oils and fats	-.048	.024	.001	.006	.001	.014	-.028	.006	.204
	(-.54)	(.92)	(.06)	(.7)	(.15)	(1.66)	(-2.05)	(.61)	

t-statistics are based on the following formulas.

$$\frac{\tau_{ij}}{\sqrt{\text{var}(\tau_{ij})}} = t; \text{ and}$$

$$\text{var } \tau_{ij} = \sum_{j=1}^{5} \text{var } (\tau_{ij}) + 2 \text{ cov } (\tau_{ij}, \tau_{ik}) \qquad j \neq k.$$

After imposition of the homogeneity restriction, the number of demand parameters with t-statistics greater than 2 has increased from 42 to 47 while those with t-statistics between 1 and 2 has decreased from 51 to 40. Both the sign and magnitude of parameters differ widely between the unrestricted and the homogeneous estimates.

The validity of the homogeneity restrictions is tested with F-statistics which are calculated as follows.

$$F = \frac{(ESS_R - ESS_{UR})/q}{ESS_{UR}/\ (T-n-2)}$$

where, ESS_R and ESS_{UR} are error sum of square of restricted and unrestricted equations, respectively; q is the number of restriction(s); T is the number of observations; n is the number of τ_{ij} parameters in the unrestricted equation. In our model, q, T and n are 1, 30, and 6, respectively. Thus the degrees of freedom is 1 in the numerator and 22 in the denominator. The critical value of F-statistics at 5 per cent level of significance is $F_{.05}\ (1,22) = 4.30$.

F-statistics presented in Table 4.9 show that the assumption of homogeneity is rejected for only nine out of 24 equations. The F-test shows that the vegetable and meat

Table 4.9: Test of Homogeneity (F-Ratios)

Food Group	Income Group			
	Low	Middle	High	Average
Grains and Cereal Products	207.98*	4.86*	.03	5.02*
Pulses and beans	1.78	.96	6.52*	1.12
Vegetables	.60	.098	.28	.39
Meat, fish and eggs	.59	2.94	.06	2.88
Milk and dairy products	3.28	7.45*	4.06	8.48*
Oils and fats	8.80*	7.76*	.27	5.34*

* Statistically significant at 5 per cent.

groups are homogeneous of degree zero in prices and total expenditure in six commodities. The assumption of homogeneity is rejected for pulses only in the high income group and for milk in middle and average income groups. Grains and cereal products, and oils and fats reject the homogeneity assumption except in the high income group.

A review of results obtained in a few applications of static AIDS models indicates that there is no general pattern with respect to the hypothesis of homogeneity. In Deaton and Muellbauer (1980a) and Blanciforti et al. (1986) homogeneity was rejected for four out of eight, and five out 11 commodity groups, respectively. In studies by Ray (1980) and El-Eraky (1987), however, homogeneity was not rejected in most cases.

The third and final theoretical restriction tested in this research is that of symmetry, i.e. $\gamma_{ij} = \gamma_{ji}$. Since this is a cross-equation restriction, testing it requires the use of a simultaneous equation system. The Full Information Maximum Likelihood (FIML) technique is used to reestimate demand system parameters.

FIML is a consistent, asymptotically efficient and asymptotically normally distributed estimator for simultaneous models. The main advantage of the FIML technique in the present context is that it is linked up with the likelihood ratio test to verify the symmetry restriction. The main disadvantage of this procedure is the possible small sample bias of the estimator for the variances and covariances. However, with the assumption of a multivariate normal distribution of the disturbance terms, FIML can be used in this study as in other applications of AIDS. One major problem in the use of FIML to a demand system is that the variance covariance matrix of the disturbance term is singular because the n components of the disturbance term identically add up to zero (Barten 1969, p.24). However, Barten has shown that this problem can be solved by dropping one of the components of the disturbance term, and that it is irrelevant which equation is deleted from the system. The parameters of the deleted equations can be calculated by the adding up condition and the t-statistics can be calculated in the same manner as in the case of homogeneity restriction.

Time Series Processor (TSP), version 4.0, available at the MSU mainframe computer was used for the implementation of the FIML technique. Gauss method of iteration is used to compute the approximation to the Hessian which is used to weight the gradient. In this method the model is linearized in variables and then estimated by multivariate regression applied to the reduced form. This method is appropriate for our model which is linear in parameters (Hall 1983, p. 79).

Three sets of FIML system were estimated for each income group. The first set of estimation consisted of equation (4.1) which is referred as the unconstrained system. With the deletion of the last (oils and fats) equation, there were five equations in the system. The second set of FIML model involved imposition of the homogeneity restriction and reestimation of equation (4.2). In this set besides dropping the sixth equation from the system, the logarithm of the price of oils and fat is also deleted from all remaining equations. Thus only 25 price parameters and 5 income parameters are directly estimated. We shall refer to this set as the homogeneous system. The third FIML model further restricted the second one by imposing symmetry given homogeneity. This further reduces number of directly estimated price parameters to 15.

The validity of the restrictions are tested on the basis of likelihood ratio test. The log of likelihood function declines with restrictions on parameters. Table 4.10 presents the log of likelihood function for all three models by income group. Except for the average income group in the unrestricted model, log likelihood values are consistent: they decline with imposition of restriction(s). Note that π is the value of restricted log likelihood minus the value of unrestricted log likelihood and -2π is asymptotically distributed as chi-square with degrees of freedom equal to the number of restrictions (Maddala). Table 4.10 shows that, excluding the average income group for which the result is not consistent, in two out of three cases hypotheses of both homogeneity and symmetry given

Table 4.10: Comparison of Log of Likelihood

Income	Log of Likelihood Function			-2π	
Group	Unrestricted	Homogeneous	Symmetric	Homogeneous	Symmetric
Low	349.85	345.62	335.96	8.46	19.33*
Middle	430.16	421.32	407.36	17.69*	27.92*
High	351.07	340.00	334.76	22.14*	10.47
Average	69.46	1607.19	1343.21	-3075.46*	527.96*

* Statistically significant at 5 per cent.

Number of restrictions on:

Homogeneous model - 5;

Symmetric model - 10.

Critical values of Chi-square distribution with d.f. = # of restrictions:

Homogeneous model - 11.07;

Symmetric model - 18.31.

homogeneity are rejected. The log likelihood test result rejects homogeneity with greater force than F-Statistics test discussed earlier.[2] Rejection of the symmetry restriction is not surprising as in other studies (e.g. Deaton and Muellbauer 1980a, Ray 1982 and El-Eraky 1987).[3]

Analysis of Budget Share and Elasticities

Demand system parameters presented in Tables 4.1 through 4.4 are used to compute demand elasticities at the average budget share for each income group. As in the case of parameters, budget shares and elasticities are all calculated for each income group and presented in Table 4.11. The values in the table are to be interpreted as follows.

The budget share of a food group (w_i) is the expenditure on that food group divided by total expenditure on six food groups. On a priori ground, it is expected that with increasing income, budget shares of preferred foods will rise and those of less preferred ones will decline.

The marginal budget share (θ_i), also called the marginal propensity to consume, measures the proportionate

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[2] Deaton (1974) has pointed out the use of chi-square distribution which is only asymptotically true means that our results are heavily biased toward rejection. A simulation exercise by Laitinen (1978) has confirmed this claim.

[3] Reviewing test results from ten studies on demand system by various authors, Barten (1977, p.46) reports that both homogeneity and symmetry restrictions were rejected in majority of the cases.

Table 4.11: Budget Shares, Marginal Budget Shares, and Expenditure and Price Elasticities

	GRAINS & CEREALS	PULSES	VEGETABLES	MEAT	MILK	OIL & FATS
BUDGET SHARE						
Low Income	0.709	0.044	0.108	0.045	0.047	0.047
Middle Income	0.631	0.055	0.113	0.064	0.076	0.06
High Income	0.545	0.061	0.113	0.093	0.114	0.072
Average	0.654	0.051	0.111	0.06	0.068	0.056
MARGINAL BUDGET SHARE						
Low Income	0.376	0.024	0.268	0.176	0.054	0.1
Middle Income	0.253	-0.07	0.315	0.248	0.13	0.122
High Income	0.566	-0.016	0.148	0.04	0.198	0.062
Average	0.304	-0.044	0.294	0.224	0.125	0.097
EXPENDITURE ELASTICITY						
Low Income	0.531	0.546	2.48	3.931	1.152	2.136
Middle Income	0.401	-1.285	2.788	3.882	1.72	2.032
High Income	1.038	-0.258	1.308	0.43	1.736	0.86
Average	0.464	-0.866	2.651	3.730	1.844	1.732
TOTAL EXPENDITURE ELASTICITY						
Low Income	0.351	0.363	1.650	2.615	0.766	1.421
Middle Income	0.216	-0.691	1.498	2.086	0.924	1.092
High Income	0.421	-0.105	0.531	0.174	0.704	0.348
Average	0.308	-0.578	1.764	2.480	1.227	1.152
OWN PRICE ELASTICITY						
Low Income	-0.822	-1.94	-1.11	-1.353	-0.495	-0.760
Middle Income	-0.554	-0.054	-1.036	-1.072	-0.308	-0.553
High Income	-0.595	-0.866	-0.931	-0.559	0.651	-1.05
Average	-0.632	-0.281	-1.096	-1.054	-0.529	-0.69
COMPENSATED PRICE ELASTICITIES						
Low Income	-0.445	-1.915	-0.842	-1.176	-0.44	-0.66
Middle Income	-0.3	-0.125	-0.72	-0.824	-0.177	-0.431
High Income	-0.029	-0.882	-0.784	-0.519	0.849	-0.988
Average	-0.329	-0.326	-0.802	-0.831	-0.404	-0.594

Note:
Low income group - deciles 1 to 4; middle income group - deciles 5 to 9; high income group - decile 10.

response on a commodity's demand of a dollar increase in income. For example in Table 4.11 if the income a low income consumer increases by $1, he would spend 38¢ on grains and cereal products, 2¢ on pulses, and so on. Since all income must be spent $\Sigma\theta_i = 1$.

Expenditure elasticity (η_i) for a food group is the expenditure elasticity of that food group with respect to total expenditure on the six food groups. It measures the percentage effect on the demand for that food group of one per cent change in total expenditure on six food groups. Expenditure elasticities are expected to decline as total expenditure increases.

Total expenditure elasticity (η_i') for a food group is expenditure elasticity of that particular food group with respect to total expenditure on food and non-food commodities. This is derived as follows.

$$\eta_i' = \eta_i\eta$$

where η is the expenditure elasticity of total expenditure on six food groups with respect to total expenditure on food and non-food commodities. η was estimated for each income group by using Working's model. η was estimated to be .665, .538, .406 and .666 for the low, middle, high and average income groups, respectively. These figures are close to .66, the average expenditure elasticity for food in Egypt (El-Eraky 1987, p. 74).

Own price elasticity (e_{ii}) for a food group measures the percentage change in the quantity demanded of that food group in response to one per cent change in its own price. Demand for a good is called inelastic, unitary elastic and elastic if e_{ii} equals less than one, one, and greater than one, respectively. Note that own price elasticity includes both substitution effect and income effect, as discussed in Chapter II, and, for a normal good, becomes less elastic as income increases.

Compensated own price elasticity (e^*_{ii}) has similar interpretation as e_{ii}, except that it registers only substitution effect. The compensated price elasticity is smaller than the uncompensated elasticity in absolute value since $e^*_{ii} = \theta_i + e_{ii}$ and, for the normal good, the sign of the two right hand terms are opposite.

Being based on a cross-section survey, elasticities estimated in this study are to be interpreted with certain qualifications. Income and price differences arise mainly due to regional variations; seasonal differences are minor for the broad categories used in this study. Past empirical analyses have shown that cross-section data yield satisfactory estimates of income elasticities because they cover a wider dispersion of income than time series studies which only deal with averages over time. Price responsiveness may, however, be measured with less confidence. Price differences are observed with respect to spatial differences alone, and hence, limit the degrees of freedom. Moreover, intraregional cultural and taste differences affect price elasticities measured with cross-section data, and therefore, making it difficult to infer causal relationship between price and quantity demanded (Gray 1982).

Figures in Table 4.11 show that the budget share for grains and cereal products decline from .709 for the low income group to .545 for the high income group. In this food group, the budget share declines slowly because of substitution between inferior and high quality cereals. As Table 4.12 shows the Nepalese consumers prefer fine rice to coarse rice and wheat. Since fine rice costs more than coarse rice and rice in general costs more than wheat in the market place, quality and price correlate positively. The budget share of pulses slightly increases with income, but the marginal budget shares and expenditure elasticities indicate that pulses is an inferior food group.[4] The budget share of vegetables does not change much across income groups possibly because even the low income group has a sizable share due to the inclusion of root and tubers. Budget shares of meat, milk, and oils and fats increase with income indicating these foods to be preferred, as expected.

The marginal budget share and expenditure elasticity of

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[4] Both Θ_i and η_i are negative for middle, high and average income groups with the t-statistics for the β_i's ranging from -2.66 to -3.46. For the low income group, Θ_i and η_i are positive but the t-statistics of β_i is extremely low.

Table 4.12: Percentage Share of Different Grains and Cereal Products

Commodities	Income Group			
	Low	Middle	High	Average
Rice and products				
Fine	12.3	26.0	35.2	21.9
Coarse	52.3	39.9	33.9	43.8
Other	1.2	2.3	4.1	2.1
Wheat and products	26.4	21.8	17.6	23.0
Maize and products	6.9	8.0	6.6	7.5
Other grains	.9	2.0	2.6	1.7

grains and cereal products both decline with income, except for the high income group for which β_i is not statistically significant. For the high income group, β_i's are not significant also for vegetables, milk and oils and fats groups. The same is true for the low income group in the case of pulses and milk and dairy products. Excluding these cases, the results show that the marginal budget share increases with income for all preferred food groups. The results also show that expenditure elasticities do not change much by income group. This may have happened because the data used for estimation consist of cell means causing the variation in expenditure across the households to become narrower than actual.[5] This result is, however, consistent with a number of empirical studies which have "lent support to the hypothesis that income elasticity of demand for broad groups of commodities may be constant over a range of income" (Weisskoff 1971, p. 322).

The magnitude of total expenditure elasticity across income groups is more satisfactory: generally it declines with income as expected. The average elasticities show that the meat, vegetables, milk, and oils and fats are preferred foods, in this order, grains and cereal products are

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5 If η_i of a food group > 1, its budget share will increase and that of other groups will decline. To maintain the Engel aggregation condition $\Sigma_i w_i \eta_i = 1$, all elasticities have to move sympathetically. Therefore, over a wide range of expenditure, any elasticity that is much higher than 1 must decline.

necessities and pulses are inferior food. The is no other demand study for Nepal against which to compare our estimates of total expenditure elasticities. Thirteen demand studies from ten developing countries reviewed in Alderman (1986) show a wide range of elasticities. Moreover, most of these studies follow different models and methods: some are single equations while others simultaneous models. Commodity classification and functional forms are also different. However, these studies, like ours, show that generally total expenditure elasticities decline with increase in income.

All own price elasticities have negative signs, except for milk in the high income group. Own price elasticities generally decline with increasing affluence. This together with the similar pattern with respect to expenditure elasticities indicate that poor are more responsive to price and income changes than the well-off.

The compensated own price elasticity shows the pure substitution effect of a price change on the quantity demanded to be higher for the low income households. The sign of elasticities are all negative, as expected, except in the case of milk for the high income group. Since the positive sign here means that the high income group will substitute more milk if its own price goes up, the result is not intuitively correct. The difference between the own price elasticity and the compensated own price elasticity is the income term of the Slutsky's equation (discussed in Chapter II) which measures the income effect of price change. Since this term is the negative of the expenditure elasticity times the budget share, $- \eta_i w_i = - \theta_i$, its absolute value is expected to be larger for the low income consumers than for the better-off. The estimated elasticities show that for the Nepalese consumer, changes in the prices of grains and cereal products, and oils and fats cause the most and the least income effects, respectively. This is true for all income groups, although the magnitude of the effect generally declines with income.[6]

Tables 4.13 and 4.14 show uncompensated and compensated own and cross price elasticities, respectively. The positive sign of cross-elasticity indicates that the related commodity is a substitute. Negative signs indicate a complement. Cross-elasticities are not always significant or reliable. They, however, indicate the relative importance of different prices on the quantity demanded of a commodity. In Table 4.13, the negative signs in the uncompensated cross-elasticities for grains with respect to prices of pulses, meat and oils indicate that the later

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[6] Timmer et al. (1983, p. 58) argue that the income term in the Slutsky's equation offers a convenient framework for forming empirical expectations about how price elasticities for basic foods change with incomes. Since both the income elasticity and the budget share of a food commodity declines with income, even if the pure substitution component is constant across income classes, the overall price elasticity will be higher for the poor than for the better-off.

Table 4.13 : Uncompensated Price Elasticities by Income Group

Income Group	Food Group	Elasticity with respect to price of					
		Grains	Pulses	Vegetables	Meat	Milk	Oils
Low	Grains and cereal products	-.82	-.08	.06	-.05	.13	-.03
	Pulses and beans	1.25	-1.94	-.37	.76	-1.18	-1.53
	Vegetables	-.59	.44	-1.10	.26	-.96	-.12
	Meat, fish and eggs	-1.68	.57	-.26	-1.35	-1.10	.50
	Milk and dairy products	1.26	-.46	-.15	-.19	-.50	.44
	Oils and fats	-.28	.01	-.08	.21	-.20	-.76
Middle	Grains and cereal products	-.55	-.18	.05	-.10	.03	-.00
	Pulses and beans	-.24	-.05	.04	.40	.88	-.30
	Vegetables	-.99	.33	-1.04	.20	-.82	-.32
	Meat, fish and eggs	-1.62	.50	-.12	-1.07	-.50	.14
	Milk and dairy products	-.08	-.25	-.18	.15	-.30	.24
	Oils and fats	-.74	.21	-.13	.26	.06	-.55
High	Grains and cereal products	-.60	-.31	.02	-.26	-.07	.12
	Pulses and beans	-.68	-.86	-.02	.61	-.04	-.10
	Vegetables	-.14	.46	-.93	.32	-.64	-.70
	Meat, fish and eggs	-.14	.73	.08	-.56	-.28	.01
	Milk and dairy products	-1.14	.12	-.24	.12	.65	.17
	Oils and fats	-.25	.38	.08	.18	-.63	-1.05
Average	Grains and cereal products	-.63	-.14	.05	-.10	.06	-.02
	Pulses and beans	-.04	-.28	.05	.40	.60	-.50
	Vegetables	-1.06	.36	-1.10	.24	-.64	-.18
	Meat, fish and eggs	-1.76	.57	-.17	-1.05	-.52	.34
	Milk and dairy products	.15	-.37	-.18	.10	-.52	.36
	Oils and fats	-.45	.18	-.06	.23	-.04	-.69

Table 4.14 : Compensated Price Elasticities by Income Group

Income Group	Food Group	Elasticity with respect to price of Grains	Pulses	Vegetables	Meat	Milk	Oils
Low	Grains and cereal products	-.44	-.06	.12	-.02	.15	-.01
	Pulses and beans	-1.64	-1.92	-.32	.78	1.15	-1.50
	Vegetables	1.16	.56	-.84	.37	-.84	-.00
	Meat, fish and eggs	1.10	.74	.16	-1.18	-.92	.69
	Milk and dairy products	2.08	-.41	-.02	-.14	-.44	.50
	Oils and fats	1.24	.10	.15	.30	-.10	-.66
Middle	Grains and cereal products	-.3	-.16	.10	-.08	.06	.02
	Pulses and beans	-1.06	-.12	-.10	.32	.78	-.38
	Vegetables	.76	.48	-.72	.37	-.60	-.15
	Meat, fish and eggs	.82	.72	.31	-.82	-.21	.38
	Milk and dairy products	1.00	-.16	.01	.26	-.18	.34
	Oils and fats	.53	.32	.10	.38	.22	-.43
High	Grains and cereal products	-.02	-.24	.13	-.16	.04	.20
	Pulses and beans	-.82	-.88	-.06	.58	-.07	-.12
	Vegetables	.56	.54	-.78	.44	-.50	-.61
	Meat, fish and eggs	.09	.76	.12	-.52	-.24	.04
	Milk and dairy products	-.20	.23	-.04	.28	.84	.30
	Oils and fats	.22	.43	.17	.26	-.54	-.98
Average	Grains and cereal products	-.32	-.12	.10	-.07	.10	.00
	Pulses and beans	-.61	-.32	-.04	.34	.54	-.55
	Vegetables	.68	.50	-.80	.40	-.46	-.03
	Meat, fish and eggs	.68	.76	.24	-.83	-.26	.55
	Milk and dairy products	1.36	-.28	.02	.21	-.40	.47
	Oils and fats	.68	.27	.14	.33	.07	-.59

commodities are complements to grains. The positive signs of cross-elasticities of vegetables with respect to prices of pulses and meat indicate that pulses and meat are substitutes for vegetables. Both these results are consistent with observed patterns of the Nepalese diet. The magnitude of elasticities indicate the relative strength of the cross-price effect. Figures in both Tables show that, overall, the price of grains, followed by milk, have stronger influence on the demand for more food groups than any other prices.

V. POLICY AND RESEARCH IMPLICATIONS

Introduction

In a low income country like Nepal where 64 per cent of total expenditure is allocated to food, changes in food prices have a profound effect on the welfare of the people. Food price changes affect growth and income distribution. In the short run, an increase in food prices causes decline in the real income of the poor who depend on the market for their food supplies, while the real income increases for large farmers who produce for the market (Mellor 1978, Trairatvorakul 1984). Among those who buy food, the effect of a price increase is more severe on the poor than the better-off because the poor spend a larger portion of their income on food. Given the low initial level of food consumption (Table 3.5), a rise in food prices can cause great hardship and even nutritional hazard to the poor. The intermediate and long run impact of food price changes on income distribution are however more complex. They depend on, among other things, the extent to which higher market prices are translated into higher farmgate prices, the supply response of higher food prices, and the impact of higher food prices on rural wage rates and thereby on employment of the poor.[1]

Food demand parameters estimated and discussed in Chapter IV generally conform with the findings of many other studies showing higher food price and expenditure elasticities for lower income groups than those with higher incomes. This pattern of elasticities has several implications for policy a few of which are discussed below.

Higher food price elasticities imply that following a price change the poor make greater adjustments in their consumption than the better-off. Since a bulk of the poor are also food producers, the effect of a rise in food prices depends on whether the poor are net producers or net consumers (Timmer et al. 1983). There is no definite answer to this question in the Nepalese context due to lack of sufficient research. Taking the empirical evidence from India and Thailand (Mellor 1978 and Trairatvorakul 1984) as guide, one can expect an increase in food price to increase inequality. Thus, keeping food prices low is desirable from the egalitarian viewpoint. If the market clearing price of food is higher than that which policy makers will accept, the government may intervene in the market and sell specific foods at subsidized prices or distribute food entitlement (food stamps) to the poor. Such policies have several

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[1] See Timmer (1986), Part IV of Gittinger et al. (1987), Part II of Elz (1987) and Mellor and Ahmed (1988) for elaborate discussions of these and other price policy issues in the Third World.

implications including the budgetary cost, leakages of subsidized food to unintended persons, disincentive for local production and its consequences in the employment of the poor, and distortions in resource allocation. These issues will be discussed further in the next section.

An alternative to price subsidy is to provide more income to the poor so that they are able to maintain a desired level of food consumption. The mechanisms of raising the income of the poor include, among others, direct compensation to the poor, promotion of labor-intensive technology of production, and employment expansion and growth-related policies.

In Nepal foodgrain markets are free and operate with little government intervention. In the food deficit mountains and hills, due to lack of efficient means of transport, privately traded foods tend to be very expensive for poor consumers (see Table 5.1). The government distributes approximately 42,000 mt (the average during 1981/82-1985/86) of rice and wheat at subsidized prices. However, since 45 per cent of the subsidized grains is distributed in Kathmandu valley (in and around the country's capital), the public distribution system is apparently subsidizing the politically important urban consumers as well.[2]

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[2] For detailed analyses of public sector foodgrain distribution activities in Nepal, see Mudbhary (1981, 1983), APROSC (1982, 1984) and DFAMS (1984).

Table 5.1: Average Retail Price of Some Food Commodities*

Commodities	1984/85		1985/86	
	Hills	Tarai	Hills	Tarai
Paddy Coarse	4.32	2.54	3.95	3.24
Rice Coarse	6.21	4.42	6.98	5.98
Parboiled Rice	5.37	4.18	6.09	5.36
Wheat	4.07	2.69	4.55	3.28
Maize	4.40	2.86	4.63	3.02
Black Gram	12.02	10.50	12.32	12.03
Arhar	12.37	9.83	12.94	11.25
Mustard Oil	27.78	21.34	33.26	28.33
Ghee (Purified)	51.82	56.06	55.88	59.39
Mutton	32.55	30.22	38.63	37.89
Potatoes	3.44	2.93	4.46	5.06
Onion	5.16	2.90	5.26	3.66

* Prices are in Rs. per kilogram, except for mustard oil for which the prices are in Rs. per liter.

Source: DFAMS quoted in Ministry of Finance (1987a).

The main beneficiaries of the subsidized foodgrain distribution in the deficit region are reported to be the civil servants and people living in the district headquarters (DFAMS 1984). The volume of distribution is far too small to meet the deficit or to significantly influence the market price. Thus, the public food distribution program has not created a production disincentive to farmers (DFAMS 1984).

Given that the existing food prices mostly reflect the freeplay of market forces, the research question is what is an appropriate public policy to meet the basic food needs of the poor consumers in Nepal: is it a food subsidy policy or an income expansion policy or a mix of these policies.[3] The following analysis simulates the impact on the food consumption of low income consumers of each of these policies implemented independently and in different mixes.

Simulation of Effects of Income and Price Changes

The expected change in food consumption can be calculated by using the following equation.

$$Q_i = \eta_i \; x + e_{ij} \; p_j \qquad (5.1)$$

where Q_i is percentage change in the quantity demanded of food group i, x is percentage change in income

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[3] These are by no means the only policy choices. There are other, and arguably more effective policy alternatives for reduction of poverty and undernutrition, such as land reform, which fall outside the scope of this research.

(expenditure) and p_j is percentage change in the price of food group j, and η_i, and e_{ij} as defined before.

A simulation of the impact of changes in income and foodgrain prices is attempted.[4] Eight scenarios with variable rates of changes in income and/or foodgrain prices are contemplated and their effects on the consumption of different food groups are calculated using the income and price elasticities estimated in Chapter IV. The objective of the scenario analysis is to get a feel for the effect of changes in income, price, and both income and price in consumption to make generalizations about appropriate policies for meeting the basic food needs in Nepal. The levels of changes in income and the price of grains in these eight scenarios are determined arbitrarily. The required levels of price subsidy or income expansion necessary to enhance food consumption by the poor is also considered in a later part of the discussion. The results of scenarios analysis is presented in Table 5.2.

The results show a different impact of income and price changes on the consumption for all income groups. We will, however, concentrate our analysis to the impact on the consumption of the low income group. Scenarios 1 through 3 simulate the effect of an increase in the low income

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[4] Price subsidy is considered only for the foodgrains because they claim a disproportionately large share of food expenditure and thus, with appropriate policies, have the potential of contributing significantly to the improvement in nutritional status of the poor.

Table 5.2: Effect of Changes in Expenditure and Prices on Food Consumption

(Changes and effects in percentage)

INCOME GROUP	FOOD GROUP	SCENARIO 1	2	3	4	5	6	7	8
LOW	GRAINS	3.5	7.0	10.5	8.2	11.7	2.9	2.3	16.4
	PULSES	3.6	7.2	10.8	-12.5	- 8.8	13.5	23.4	-25.0
	VEGETABLES	16.5	33.0	49.5	5.9	22.4	30.0	43.6	11.8
	MEAT	26.2	52.3	78.4	16.8	43.0	43.9	61.6	33.6
	MILK	7.6	15.3	23.0	-12.6	-4.9	21.6	35.6	-25.2
	OILS	14.2	28.4	42.6	2.8	17.0	27.0	39.8	5.6
MIDDLE	GRAINS	2.2	4.3	6.4	5.5	7.6	1.6	1.0	11.0
	PULSES	-6.9	-13.8	-20.7	2.4	-4.5	15.0	-23.1	4.8
	VEGETABLES	15.0	30.0	44.9	9.9	24.8	25.0	35.0	19.8
	MEAT	20.8	41.7	62.6	16.2	37.0	33.6	46.4	32.4
	MILK	9.2	18.4	27.7	0.8	10.0	18.0	26.9	1.6
	OILS	10.9	21.8	32.8	7.4	18.3	18.1	25.4	14.8
HIGH	GRAINS	4.2	8.4	12.6	6.0	10.2	5.4	6.6	12.0
	PULSES	-1.0	-2.1	-3.2	6.8	5.8	-5.5	-10.0	13.6
	VEGETABLES	5.3	10.6	15.9	1.4	6.7	9.9	14.5	2.8
	MEAT	1.7	3.4	5.2	11.4	13.1	- 2.2	-6.2	22.8
	MILK	7.0	14.0	21.1	11.4	18.4	8.4	9.7	22.8
	OILS	3.4	7.0	10.4	2.5	5.8	5.7	7.9	5.0
AVERAGE	GRAINS	3.0	6.2	9.2	6.3	9.4	3.0	2.9	12.6
	PULSES	-5.8	-11.6	-17.3	0.4	-5.4	-11.8	-17.7	0.8
	VEGETABLES	17.6	35.2	52.9	10.6	28.2	30.0	42.3	21.2
	MEAT	24.8	49.6	74.4	17.6	42.4	40.8	56.8	35.2
	MILK	12.2	24.5	36.8	-1.5	10.8	25.2	38.3	-3.0
	OILS	11.5	23.0	34.6	4.5	16.0	20.8	30.0	9.0

Scenario	% change in total expenditure	% change in the price of grains
1	+10	None
2	+20	None
3	+30	None
4	None	-10
5	+10	-10
6	+20	+5
7	+30	+10
8	None	-20

consumers' income by 10, 20 and 30 per cent, respectively, and no change in the price of food. The results indicate that if such increments in income were to occur, demand for all six groups of food will increase. The assumption of constant prices in the face of rising demand implies a perfectly elastic supply curve. Production of grains (for humans and for livestock to produce more meat), vegetables, and oilseeds will all have to increase.

Scenarios 4 and 8 assume grain prices to decline by 10 and 20 per cent, respectively, with no change in income. This scenario simulates the effect of general price subsidy on grains amid stagnant income. The results show that the demand for grains, vegetables, meat and oils increase while those for pulses and milk decline.

A comparison of scenarios 1 and 4 or 2 and 8 which assume changes in income or grain prices of 10 and 20 per cent, respectively, shows that a decline in price of grains induces a larger increase in its consumption than an income increase of the same magnitude.[5] A rise in income, however,

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[5] Decline in grain prices is considered at the levels of 10 and 20 per cent only, unlike the increase in income which is considered at 10, 20 and 30 per cent, for the following reasons. First, the effect of a 30 per cent decline in price will simply be three times and one and a half times the effect of the decline of 10 and 20 per cent, respectively. Second, the scenario of 30 per cent increase in income (scenario 3) is considered only to compare its performance with scenario 7 in which a 30 per cent increase in income is accompanied by a 10 per cent rise in price. Finally, it was thought appropriate to limit the number of scenarios to a few to save the analysis from becoming tedious. There is, however, no strong defense against the

causes higher consumption of the preferred foods (vegetables, meat and oils) than a decline in the price of grains.

The results also show that the low income consumers are very sensitive to grain price changes, even a modest increase in the price of grains substantially affects its consumption. A comparison of scenarios 2 and 6 shows that a 5 per cent increase in the price of grains causes 58 per cent decline in its consumption. This virtually wipes out the gain in consumption due to 20 per cent increase in total expenditure. Similar comparison between scenarios 3 and 7 shows that despite a 30 per cent increase in total expenditure, grain consumption declines by 78 per cent when its price increases by 10 per cent. Such drastic reductions in consumption occur because the absolute magnitude of the own price elasticity of grains is more than double its total expenditure elasticity. Eventually the negative effect of the former is expected to dominate the positive effect of the latter.

A comparison of scenarios 3 and 5 indicates that a sufficiently large (30 per cent) growth in income may be superior to a combined smaller income growth (10 per cent) and a lower price (10 per cent) because with the former consumption of all foods are at higher levels. With such

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argument for having one or two more or less scenarios in the analysis.

growth, low income consumers can achieve both higher consumption and variety in the diet.

A serious analysis of the required changes in the price and income level to assure adequate food consumption by the poor involves several types of information which we unfortunately do not have. But since this is an important question, an effort will be made to make preliminary estimates with certain assumptions about some parameters.

Based on the existing consumption patterns, the National Planning Commission (NPC 1987) has set a target of an average of 1,964 calories per capita per day from foodgrains. Additional 286 calories are to be acquired from other foods. The amount of calories derived from foodgrains, calculated from Table 3.5 using the standard conversion factors from the Nutritive Values of Indian Foods, works out to be 1,762 calories for the poor. The foodgrain consumption of the poor thus needs to improve by 12 per cent to meet the nutritional norm. Using the own price elasticity of -0.822 and total expenditure elasticity of 0.351 for grain for the low income families (Table 4.11), a grain price subsidy of 15 per cent or an income expansion of 34 per cent is required.

Considering the average grain price of Rs. 4.42 per kilogram, the consumption target of 176 kilograms and a 15 per cent price subsidy, the amount of subsidy per person works out to Rs. 117 per annum. For a population of 7 million low income people in Nepal, the total subsidy will be Rs. 819 million. Allowing an additional 25 per cent for handling and administrative costs, the total cost would be around Rs. 1 billion, which is 20 per cent and 6.6 per cent of the regular and total budget, respectively, of the Nepalese government in 1987/88 (Ministry of Finance 1987b).

Achievement of a 34 per cent growth in income will have the same effect in grain consumption by the poor. The growth targets envisaged in the Program for Fulfillment of Basic Needs are much higher (5, 8 and 9 per cent per annum for the three five-year periods ending in the year 2000). If such growth rates are achieved, it will be possible to achieve the target foodgrain consumption in seven years. There is however, some controversy regarding the contribution of income growth to nutritional status. This we will discuss in the following paragraphs.

These results, however, do not indicate the possible magnitude of improvements in the nutritional status of the low income consumers. Many studies have indicated severe malnutrition problem among the poor in Nepal.[6] Although various environmental and socio-cultural factors such as poor sanitation, disease and weaning practices work together to cause malnutrition, inadequate calorie intake is of major

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6 See Mudbhary (1981) for a review of these studies.

significance.[7] Our results above have shown that income and price changes induce consumers to substitute between foods, and therefore, direction of change in the level of nutrients intake cannot be simply established from price and income elasticities. In recent years, this has led many economists to try to estimate calorie elasticities with respect to price and income changes (Timmer and Alderman 1979, Strauss 1981, Gray 1982, Pitt 1983, among others).

To estimate calorie elasticities, quantity of each commodity consumed is converted into calories by applying standard conversion factors. Our data is aggregated into food groups, and thus we have no basis to convert them into calories. Estimation of calorie elasticities, therefore, is an important future research topic. Estimates of such elasticities would enable us to project the percentage change in price or income required to close the calorie-gap for the poor. A review of calorie elasticities in other developing countries will, however, be useful to have a feeling of the possible ranges in which price or income need to change to meet nutritional needs of the poor. Based on household budget survey data from Bangladesh, India,

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[7] In view of Sukhatme (1970) finding indicating protein deficiency to be associated with inadequate intake of total energy in India, and the fact that micronutrient (vitamins, minerals and trace elements) tend to be supplied from secondary foods that need not be consumed in large quantities to provide a significant amount of a particular micronutrient (Timmer et al. 1983), it seems adequate to focus the attention on calorie deficiencies.

Indonesia, Morocco, Pakistan and Sri Lanka, Knudsen and Scandizzo (1979) estimated calorie income elasticities of between 0.22 (Sri Lanka) to 0.59 (Morocco) for the people at the poverty line.[8] This indicates that a 10 per cent increase in income will increase calorie intake by 2 to 6 per cent. Another study by the same authors (1982) from the same database but using a different approach yielded slightly lower estimates: between 0.18 (Sri Lanka) to 0.56 (Morocco). Strauss (1981) computed calorie availability elasticity with respect to total expenditure of 0.85 for the rural Sierra Leone. Alderman's (1986) estimates of calorie elasticities for ten countries range from 0.10 (urban Brazil) to 0.94 (rural Nigeria). His estimates for Bangladesh, Indonesia, Morocco and Sri Lanka range from 0.40 (urban Bangladesh) to 0.77 (rural Morocco), substantially higher than those estimated by Knudsen and Scandizzo (1982).

Chaudhri and Timmer (1986) working with national averages as unit of measurement, calculated income elasticity of food expenditure of over 0.6 and calorie-income elasticity of 0.15 for LDCs. The authors have explained that the estimated calorie-income elasticity is low because it refers to national averages rather than to low income consumers. Similarly, for rural south India, Behrman and Deolalikar (1987) have estimated total

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8 The expenditure level just sufficient to purchase the FAO calorie requirement.

expenditure elasticity for six food groups ranging from 0.54 (grains) to 3.27 (milk) and a calorie elasticity of 0.17. The authors use a direct approach in estimating the calorie elasticity and claim that if estimated indirectly its magnitude will be of the same order as expenditure elasticities in other studies.

These drastic differences in the magnitude of calorie elasticities estimated by different authors are, to some extent, the result of the differences in the method of estimation and levels of aggregation. Even for the poorest households, calorie-income elasticity is likely to be less than income elasticity simply because taste and variety in diet are important to all, including the poor. The order of magnitude will depend, among others, on the choices available to the consumer and the calorie density of the substitutes. Hence, situation-specific empirical studies are necessary for policy formulation.

Approaches to Strengthening Food Security of the Poor

The success of poverty removal depends on the ability to widely guarantee economic entitlement (Sen 1980). However, there is a continuing debate among development economists as to how the entitlement might be better guaranteed. There are two competing hypotheses with respect to the impact of growth on the level of poverty. The first one is the hypothesis of the Kuznets curve which postulates that in the early stages of growth there will be an increase in income inequality and thus poverty. The second hypothesis, popularly called, the "trickle-down" states that rapid growth of per capita income is associated with a reduction in poverty. Srinivasan (1985) argues that the truth of either of these hypotheses has not been established by empirical studies "either because they use data that do not indicate sufficient growth to trickle-down or because they draw inferences from cross-sectional data about dynamic processes". Bhagwati (1988) postulates that if a country can achieve such high rates of growth as those of Korea and Taiwan, even with inequitable distribution of the benefit of the growth, the poor would be much better-off. However, even if such high rates of growth were possible to emulate, in the transition period chronic food insecurity of landless rural workers, urban poor, and small and marginal farmers will remain. The long-run effects may be of little or no interest to the poor who are adversely affected in the short-run.

Our results indicate that income growth alone may not be enough to maintain the gains in consumption. If food prices are not under control, such gains will be wiped out. Achieving higher growth rates and keeping food prices low at the same time requires considerable expansion in food production through technological change. In the early stages, however, adoption of new technology by the farmers may necessitate, although distortionary (Schultz 1982), a dual pricing structure - higher producer prices and lower consumer prices for the poor - with the difference borne by the government in terms of price subsidy.[9]

However, it should be noted that a higher food price is not a necessary or sufficient condition for growth in food production. Inputs subsidy may be an alternative to higher food prices.[10] Several physical, social and administrative barriers to increased supply need to be removed (Streeten 1983). In the Nepalese context, higher prices will be effective only with improvements in several fronts, such as expansion of irrigation facilities, development of appropriate high-yielding seed varieties for irrigated and rainfed farming conditions, access to and timely availability of inputs, farm to market roads, dissemination of price information, and abolition of monopsonistic market structure. Therefore, a careful analysis of the contribution of price and non-price factors to agricultural growth is needed before developing a price policy (Chhibber 1988).

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[9] See Krishna (1982) for a persuasive argument in favor of a balanced price and technology policy for agricultural growth. The author shows that improving the terms of trade for agriculture by providing higher producer prices in the absence of induced and autonomous technological and institutional innovations will not result in growth.

[10] In fact, in many developing countries, including Nepal, chemical fertilizers, pesticides, credit and irrigation are subsidized. The problem is of ensuring equitable access for all farmers.

Principally, there are two price policy approaches to attacking chronic food insecurity of the poor in the short-run: (1) target group-oriented income transfer policies, and (2) general food price subsidies. Under the first approach specific foods are rationed to the poor at below market prices through "fair price shops". This approach is in operation in Bangladesh, India and Sri Lanka, all south Asian countries neighboring Nepal. Impact evaluation reports published by IFPRI in 1979 show these operations to be highly successful in raising nutrition and consumption levels of the poorest households (Ahmed 1979, Gavan and Chandrasekera 1979, George 1979, Kumar 1979). However, in the case of Bangladesh the program had reportedly a strong urban bias. In comparison to the general price subsidy approach, this approach costs less in terms of direct subsidies but involves greater administrative cost of identifying the beneficiaries and preventing leakages to non-target groups. The sharper the target, the higher the administrative cost per unit of beneficiaries.

Under the second approach, specific foods are sold to consumers at below market prices to protect consumers from high food prices. In general, low income consumers spending a larger proportion of their income on food are likely to be the main beneficiaries of this approach. However, if the food commodity thus subsidized is a general one consumed by people of all income strata, substantial amounts of subsidies is wasted on those who don't need it.[11] This approach involves lower administrative cost of policing the leakages, but can be an instrument of nutrition policy implementation only with a careful selection of foods to be subsidized and appropriate pricing of the subsidized commodity. The subsidized food should be the one consumed by the poor but not consumed by the rich and should be priced at a level where it not likely to be diverted to animal feed or production of alcohol. There is a growing consensus among food policy analysts that target group-oriented price policy is more cost effective and just than a general price subsidy which reduces the cost of food for everybody including the poor (Reutlinger and Selowsky 1976, Selowsky 1979, Pinstrup-Andersen 1985, Reutlinger 1985).

Conclusions

The following conclusions can be drawn from the foregoing analysis. The recommendations developed in the following paragraphs are guided by the concern to come up with viable prescriptions. They do not therefore, pretend to be positivistic, and use both widely accepted value

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11 In many developing countries such policies have resulted in financial crisis to governments, increasing food deficits and poverty due to depressed farmgate prices (Bates 1981, Ghai and Smith 1987). Usually the main beneficiaries of the cheap food are the powerful urban constituencies. Bates has observed that in tropical Africa agricultural policy has become a byproduct of political relations between governments and urban constituencies (p. 33).

judgments and assumptions of economic behavior. This effort may be called an exercise in normative economics (Mishan 1982, p. 19).

1. The roots of the food security problem in Nepal lie in low level of per capita income and its inequitable distribution. Achievement of a higher growth rate accompanied by an expansion of gainful employment of the poor should be the key concern of the planners. If the growth rates envisaged in the basic needs program (NPC 1987) is achieved, the calorie-gap for the poor can be closed even if the calorie-income elasticity is as low as 0.15.

2. Technological progress in agriculture, development of irrigation and road infrastructure and enhancement of input and output marketing efficiency will all contribute to growth, employment and food security of the poor. Keeping this accent on growth intact, during the transition period - until the fruits of growth trickle-down - public policy should concern itself with avoiding food price inflation for the poor. The choice of policies should be guided by the considerations that the interventions are well targeted and thus, cost-effective, and when the time comes can be withdrawn without much resistance from the political interest groups.

For the immediate future, Nepal should try to keep the price of grain(s) consumed by the poor low. If necessary, the prices should be subsidized. Lower grade rice and maize are examples of commodities that can be candidates for a low price policy. Such price policy should be complemented by other nutrition programs for pregnant and lactating mothers and children. The prices should be lowered gradually so that there is no sudden spurt on demand and thereby required subsidy.

3. The presence of a large proportion of small and subsistence farmers and landless workers in the rural areas complicates the price policy decisions. Due to lack of research, it is not known with any measure of confidence whether improvements in product markets or labor markets will strengthen food security of the rural poor. The rural poor are numerous and difficult to reach. They can be reached only through indirect policies. Recently, there have been noticeable progress in modelling household decision-making which looks at the linkages between product and labor markets and the impact of their interaction on production and consumption decisions of households (Singh et al. 1986). A study along this line is recommended for Nepal.

4. Finally, estimation of calorie elasticities by income group is recommended for future research to facilitate identification of commodities appropriate for subsidies. These elasticities will also provide information on the order of magnitude by which prices or income must be changed to close the nutrition gap.

VI. SUMMARY AND CONCLUSIONS

Methodology

Knowledge of food demand parameters is important for planning and forecasting production, consumption and trade in a country. For a developing country with a sizable proportion of its population consisting of poor and malnourished, reliable demand parameters facilitates policy analysis for meeting the basic food needs of the population. Despite such importance, there has been no effort to estimate a complete matrix of demand elasticities in Nepal. The main objective of this research is, therefore, to fill this gap in knowledge.

This study is based on a theoretically derived demand system, the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer. The main advantage of a demand system approach over a single commodity demand analysis is that it considers interdependency of demand for various commodities that enter a consumers basket. Typically, the consumption basket contains too many goods and services to consider separately in a demand system due to degrees of freedom problem. Moreover, such minute details are cumbersome, uninteresting and serve no purpose as would demand system parameters estimated separately for each consumer. Hence, commodities have been aggregated into food groups following a well accepted technique and six food groups have been selected for inclusion in the demand system. The AIDS models allows for a consistent aggregation across consumers so that the theory of consumer behavior can be applied to group observations.

The demand model used here is based on the assumptions of weak separability which means that the marginal rate of substitution between any two commodities, i and j, is independent of the quantity consumed of a third commodity, k, in any other group. This assumption provides the basis for the assumption of a two-stage budgeting procedure for the allocation of the consumer's rupee over groups of commodities. In our context, it is assumed that in the first stage, the consumer budgets a fixed per cent of his income to the six food groups and then, in the second stage, optimally allocates the fixed budget to the food groups based on the total budget and the relative price of each food group. Thus, a demand subsystem for food has been estimated in a theoretically plausible manner.

The AIDS demand system is considered suitable to analyze food demand pattern also because it has a semi-log functional form which implies that, price remaining constant, the budget share decreases steadily as the level of expenditure increases. This is consistent with the Engel curve. In this study, the demand system models the budget share of food group i to be dependent on the log of the level of real expenditure on the six food groups and the log of prices of each of the six food groups. There are, however, other factors such as demographic characteristics of the household, which affect budget shares on different food groups. Lack of data on such variables precluded their inclusion in the demand model. Thus, the estimated demand parameters consist of only income and price parameters.

Being a theory-based demand system, AIDS demand parameters are amenable to tests of empirical validity of the restrictions of demand theory. Conducting such tests is the second objective of the study. The demand system parameters were, therefore, tested for homogeneity and symmetry restrictions.

The study uses the data available from the national level second household budget survey conducted in two rounds by the Nepal Rastra Bank in 1984/85. The block-wise aggregated data on per capita food expenditure and prices were available for each round for all 15 blocks of the country. Thus, there were 30 data points for the estimation of the demand system parameters. For each block and round, per capita food expenditure was available by income decile. These income deciles were aggregated into three income groups: the low income group comprising deciles 1 to 4, the middle income group falling in deciles 5 to 9 and the high income group in the 10th decile. A fourth group, called the average, comprising all income deciles was also formed. Since the consumption expenditure which is being aggregated is in per capita terms, the aggregation procedure used total population in each decile as the weight. Disaggregation of demand parameters by income group was considered important for policy analysis to improve the nutritional status of the poor.

Estimate of Parameters and Policy Implication

Demand parameters for each food group were estimated by income group by ordinary least squares (OLS) and were reestimated using full information maximum likelihood to test for symmetry restriction. Both symmetry and homogeneity restrictions were rejected in two out of three cases. Such rejections are not unusual in consideration of other studies using AIDS.

The OLS demand parameters were used to calculate expenditure and price elasticities for all six food groups. Expenditure elasticities, uncompensated and compensated own and cross price elasticities are reported in Tables 4.11, 4.13 and 4.14. The first of these tables also presents budget shares and marginal budget shares for the food groups by income group. The results are generally as expected.

The change in the budget shares as we move from low to high income groups indicate grains to be necessity with large variation across the income groups. The budget share of vegetables does not vary much. Pulses are inferior goods and meat, milk and oils are preferred foods. All uncompensated and compensated own price elasticities are negative as expected a priori, except for milk in the case of high income group. Expenditure elasticities do not vary much across the income groups possibly because we have computed them using cell means which makes the variation in expenditures across households narrower than actual. Total expenditure elasticities and own price elasticities, however, generally decline with income indicating the poor to be more sensitive to income and price changes than the better-off. The results also show that changes in the prices of grains and cereal products, and oils and fats have the most and the least income effect on the Nepalese consumers. The price of grains and milk have the strongest cross-price effect on the demand for more food groups than other.

The demand elasticities were used in simulating the effect of changes in income and grain prices on the consumption of various food groups for different income groups. The analysis focussed on the problem of improving food security of the poor through price and income growth policies. The result showed that a certain percentage decline in the price of grain induces a larger positive response on grain consumption than an income increase of the same magnitude. The latter, however, causes a larger percentage increase in the demand for preferred foods -

meat, vegetables and oils - than the former.

The simulation also indicates that the poor are very sensitive to price increase and a smaller increase in the price of grain can negate the positive response of a larger increase in income. Hence, controlling food price inflation is very important for assuring food security.

From the analysis in Chapter V it is deduced that achieving a high rate of economic growth with emphasis on employment of the poor should be the key strategy of development for meeting the basic food needs of the poor. How to provide cheap food for the poor consumers without depressing production incentives is an almost universal dilemma facing policy-makers in developing countries. These seemingly conflicting objectives can be well served by a strategy which emphasizes technological change in agriculture, improvements in infrastructure, inputs and output markets, and expansion of off-farm employment opportunities.

For the short-term, the alternatives of target group-oriented income transfer policies and the general price subsidy on specific commodities were considered. The first alternative costs less in terms of direct subsidy but administrative costs are greater. Considering the problem of reaching the rural poor in the country through a target group-oriented program and the prospects of administrative mismanagement, a policy of low prices for the specific foodgrains which are the major sources of calories for poor is recommended. However, some target group-oriented nutrition intervention programs such as those for pregnant and lactating mothers and children should be continued and expanded because the general subsidies may not benefit these vulnerable groups due to intra-household food distribution biases.

Future Research Possibilities

The present research has focussed on a demand subsystem of six food groups. It does not include non-food expenditures such as those on housing, clothing, education and health care which are all important elements of a level of living. It would be interesting to see how consumers trade-off these expenditures with those on food.

Within the food demand subsystem, the present study could have been richer in policy implications if it were possible to include demographic characteristics of households in the model. For example, the number of children in the household would be expected to influence the proportion of food budget devoted to milk and households response to changes in income and prices. Thus, future research in food demand system with inclusion of demographic variables is recommended.

Conventionally, nutritional planners used the average price per calorie of a commodity as the main criteria for selecting the food to be subsidized. They assumed that faced with a severe budget constraint, all the poor consumers were interested in was to acquire a least cost diet. Many studies have shown that habit, inertia and ignorance prevents flexibility in dietary patterns and taste and variety in the diet are important also to the poor. Recent research efforts in food demand analysis have increasingly realized the need for the estimation of calorie elasticities. Knowledge of such elasticities is considered important for Nepal as well.

Finally, research on the impact of alternative farm price policies on income distribution and nutrition is recommended. Such study should be carried out in the framework of a household model including both production and consumption choices. Specifically, it should address the research issues pertaining to the importance of product markets and labor markets in the income of the households, and distribution of benefits and costs of alternative price policies at a given level of technology.

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