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ESTIMATION OF VEGETABLE DEMAND ELASTICITIES IN BANGLADESH: APPLICATION OF ALMOST IDEAL DEMAND SYSTEM MODEL

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Abstract

The study estimated vegetable demand elasticities in Bangladesh by using Almost Ideal Demand System (AIDS) model with corrected Stone price index. The study was conducted in Sherpur, Mymensingh Sadar under Mymensingh district and Ramna Thana under Dhaka Municipality. The household expenditure survey data was used in the study. The study revealed that the income (expenditure) elasticity for fresh vegetable was 0.58. The compensated and uncompensated own price elasticities indicated that all food items were price inelastic. Where estimated uncompensated own price elasticity of vegetables at the national level indicated that if the price of vegetables falls by 10% the demand for vegetables would increase by 4.09%. Of this total increase in demand, 3.61% is purely due to price effect (i.e. the substitute effect) as the compensated elasticity suggests. The estimates of cross price elasticities indicated that the substitution effects of price change were not strong. Therefore, government price intervention might not lead to considerable price repercussion in the economy.

I. Introduction

Bangladesh is a densely populated country with a density of 916 person per square kilometer. Her population increased by 1.42% in 2006 (BBS, 2006). Per capita GDP and GNI increased over time to US$ 447 and US$ 476 respectively (BBS, 2006). The agricultural sector which contributed 33.07% of GDP at the beginning of eighties reduced to 21.11% in 2006-07. The growth rate of agriculture sector which mainly comprises of mostly crop subsector was in increasing trend. The crop and vegetable sub-sectors increased by 5.03% in real terms in 2005-06. Vegetable sub-sector contributed about 3.6% to the GDP with a production area of less than 2% of the total cropped area. Although the growth rate of vegetable production decreased to 3.18% in 2004-05 from 4.66% previous year, the contribution of vegetable area to total cropped area increased during the same time(BBS, 2006). In the country, the consumption of vegetables was lower than that of their requirement. Nationally, the consumption of vegetables was 50-70g per head per day as against their requirement for 200g/head/day from nutritional point of view (Hossain, 2005). However, the per capita vegetable consumption was higher in urban areas than in rural areas (Ali, 2000).

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Vegetables provide nutrition, create employment, increase income reduce poverty and earn foreign exchange. The contribution of vegetable export to the total agricultural export jumped to 86.98% in 1996-97 from 1.69% in 1973-74. The crop sector including vegetable sub-sector alone contributed 12.28 % to GDP in 2005-06.The country had total the volume of vegetable production of 2.102 million tons during 2003-04. An estimate shows that per capita per day vegetable consumption has increased from 140.5 gm in 2000 to157 gm in 2005 (BBS, 2006). As a goal of millennium development the government is very much concerned to reduce 50% poverty by 2015. Reducing malnutrition is another goal the country is concerned with. She is very much interested to invest in vegetable sector to increase her contribution to the economy.Therefore,information on consumption pattern and elasticities of demand for vegetables is very important for different stakeholders. However, disaggregated level information will be of more value for policy planners. This study has been undertaken with that context in view.

II. SOME RECENT STUDIES AND MODEL USED

Studies on elasticities of demand for fresh vegetables in Bangladesh are very scanty. A few studies however, exists dealing with aggregated elasticity of demand for vegetables. For other commodities, a number of studies exist in Bangladesh dealing with price and income (expenditure) elasticities of demand. These include elasticities of composite food grain (Alamigir and Berlage 1973; Mahmud 1979); foods and non-food items (Ahmed, 1981; Choudhury, 1982; Bouis 1989); and food items (Pitt, 1983; Goletti, 1993, Islam 2002). With the exception of Mahmud (1979), these studies used periodic cross-section data from HES, using pooled data from quarterly survey of current economic conditions for the 1964, 1965, 1967 and 1969. Goletti (1993) estimated demand elasticities of food items based on 1988/89 HES data. Using same data set, Huq (2004) estimated elasticities of demand for potato. The estimate made by Huq (2004) is perhaps the most recent one is the area of estimation of demand for vegetables in Bangladesh.

Five of the previous studies on estimation of demand parameters used the system demand approach. Chowdhury (1982), used a method developed by Frisch (1959) which is based on additively or `want independence' assumption. A consumer's preference is said to be want independent if the marginal utility of any one good depends on the quantity of that good. This is an extreme assumption, and therefore, the Frisch's methodology is criticized because of the restrictions imposed. Ahmed (1981) used the Linear Expenditure System (LES) for estimating a complete demand system. The LES suffers from limitations of additive system. The Frisch's method and the LES imply that all goods are substitutes (they can not be complement) and none are inferior goods (Alderman 1986). Bouis (1989,1992) developed a method of estimating a food demand system based on demand for energy, variety and taste of foods. A complete matrix of demand elasticities were derived for all food and one non-food commodities by specifying utility as an explicit function of these food characteristics, which Bouis terms the Food Characteristics Demand System (FCDS). In contrast to "Frisch" method, the FCDS assumes that marginal utility from consumption of any food depends on the level of consumption of all other foods. Bouis's method requires prior knowledge elasticities to generate the matrix of demand elsticities. Bouis (1989) applied his FCDS

method to derive demand elasticities for food and non-food commodities using the 1973-74 HES data. FCDS model has also been used by Razzaque, Khondoker and Mujeri (1997) to estimate elasticities of demand for food by occupational group in Bangladesh.

The other two studies by Pitt (1983) and Goletti (1993) used a method called Tobin's Probit or Tobit to estimate the food demand system. The basic reasons for using the Tobit method to estimate the demand system was to overcome econometric problems that arise due to non-consumption or zero-value observation. The Tobit model permits a positive probability of observing non-consumption. However, Pitt (1983) showed that it is inappropriate to use Tobit in demand analysis for models that have expenditure or budget shares as dependent variables. This immediately rules out some of the most popular and recently developed demand system such as the Rotterdam model, and the Almost Ideal Demand System (AIDS).

The study by Ahmed and Shams (1994) differs from earlier in two ways, Firstly, the parameter estimates are based on primary data from three rounds of household consumption and nutrition survey conducted by the International Food Policy Research Institute over the period from September 1991 to November 1992. Secondly, First time in Bangladesh, the study applied AIDS model to estimate a complete demand system. The AIDS model was introduced by Deaton and Muellabauer (1980a,1980b), and has been widely adopted by many economist in recent years. Its popularity was attributed to its properties, which are consistent with the theory of demand. Although a few other models (such as the Rotterdam or translog model) possess many of these desirable properties, none possess all of them simultaneously. A considerable number of studies have been made using the AIDS or LA/AIDS model (Buse 1994; Wessells and Wilen 1994; Tiffin and Tiffin 1999; Eales and Unhevehr 1998: Ahmed and Shams 1994; Karagiannis, Katranidis and Velentzes, 2000).

Huq (2004) has incorporated most of the afore problems including zero consumption in estimating elasticity. Moreover, he has applied a three stage budgeting approach, first of its kind in Bangladesh. He estimated demand elasticity for potato (including vegetables) by using the HES, 2000 data. The present study is similar an approved. The study differs considerably in the of nature of data used. Monthly food expenditure data collected from three districts over one year period (2005-06) were used in this study.

III. Methodology

The present study has been made on using the AIDS model of estimating the consumer demand for vegetables considered. The model is intrinsically non-linear in its parameters, "Linear Approximate AIDS" (LA/AIDS) using the Richard Stone's share weighted price index has been widely applied to simplify the estimation process. Besides, aggregation properties, "Linear Approximate AIDS" (LA/AIDS) model has been widely estimated (Deaton and Muelbauer1980 and Moschini and Vissa, 1992). Stones demand equations were derived explicitly from consumer theory. His model had been developed by some alternative demand models. Most important demand equations, apart from the original linear expenditure system (LES), are the Rotterdam model (Theil, *et. at.* 1965, Theil, 1976 and Barten, 1969) and the translog model (Christensen, *et al.*, 1975 and Jorgenson and Lau, 1975).Deaton and Muelbauer (1980a) developed a model, called the AIDS model. Their model is of comparable

generality to the Rotterdam Translog models and has considerable advantages over the both. Buse's(1994) reveals 23 empirical application between 1980 and 1991 that used LA/AIDS specification instead of nonlinear AIDS in applied agricultural economics studies. Recent application such as Moschini (1992) and Eales and unnevelh (1993) have been introduced some variations of "Linear Approximate AIDS" (LA/AIDS) specification. Linear Approximate AIDS (LA/AIDS) is attractive for its relative case of estimation, and the case with which the classical restriction were imposed and /or tested. For the estimating the vegetable demand elasticities the AIDS model were used.

IV. Empirical Model Specification, Estimation and Data

Model Specification

The AIDS model is specified in the following budget share form:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln\left(\frac{X}{P}\right) + \mu_t \qquad \text{.....(1)}$$

where, w_i = the budget share of the i^{th} commodity (i.e., $w_i = P_iQ_i/X$), P_j = the price of the j^{th} commodity; X = the total household expenditure on all commodities in the system being analyzed; P= a price index for the group; μ_t = the residuals and assumed to have zero mean and constant variance; α_i, β_i and γ_{ij} are parameters.

The price index (P) defined by:

$$\ln P = \alpha_0 + \sum_j \alpha_j \ln P_j + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln P_i \ln P_j \qquad \text{.....(2)}$$

Equation (1) is the AIDS demand functions are budget share form.

The restrictions on the parameters of the AIDS equation (1) are:

$$\sum_i \alpha_i = 1, \sum_i \beta_i = 0, \sum_j \gamma_{ij} = 0, \textit{Adding} - \textit{up condtions}, \textit{Engel Aggregation}) \text{ --- (3)}$$

$$\sum_j \gamma_{ij} = 0 \quad (\textit{Homogeneity condtition}) \text{ ..... (4)}$$

$$\gamma_{ij} = \gamma_{ji} \quad (\textit{Symmetry conditions}) \text{ ..... (5)}$$

Price elasticity is calculated in two ways: uncompensated elasticity that contains both price and income effects, and compensated elasticity which includes only price effects. The derivations of elasticity formula for the AIDS model are found in Green and Alston (1990), and Buse (1994).

The price index from equation (2) makes equation (1) a non-linear estimation, raising estimation difficulties. While it is not particularly difficult to estimate this non-linear system since the first order conditions for likelihood maximization are linear in α and γ given β and vice versa, there might be some difficulty in situations where individual prices are closely collinear. Therefore, it adequate to approximate P as proportional to some known index P^*.To avoids non-linear estimation, many empirical studies use Stone (1953) price index (P*) instead of P, as suggested by Deaton and Muellbauer (1980 p.16):

$$LnP^{*} = \sum_{j} w_j \ln P_j \quad \text{---------- (6)}$$

The model that uses Stone's geometric price index is called the "Linear Approximate AIDS" (LA/AIDS) following Blanciforti and Green (1983).

The use of the Stone price index has been shown to be inappropriate as it makes the estimated parameters inconsistent (Prashardes, 1993; Buse,1992;Moschini, 1995). Moschini attributes this problem to the fact that the Stones' Price Index does not satisfy what Diewert (1987) calls the commensurability property and suggests that the problem might be solved by using a price index that satisfies this property. Moschini suggests several other price indices that satisfy this property, which might be used to keep the specification of the almost ideal demand system linear. He also shows that these indices perform like the Translog index in a Monte Carlo experiment. To keep the specification of the demand system linear, the price index that Moschini calls the corrected Stones' Index has been used which might be written as:

$$\ln P = \sum w_i \ln\left(\frac{P_i}{P_i^0}\right) \quad \text{.....(7)}$$

Household demand for goods not only depends on prices income but also on other socioeconomic and demographic factors. Ray (1979 pp.595-602) explicitly incorporated family size (m) in the AIDS model. The resulting LA version of the AIDS is

$$w_i = \alpha_i + \sum_{j} \gamma_{ij} \ln P_j + \beta_i \ln\left(\frac{X}{P^{*}}\right) + \mu_t + \theta_i \ln m \quad \text{..... (8); Where, x (=X/m) is}$$

per capita household expenditure and θ_i denotes the effect of family size on budget share in addition to the effect of per capita real household expenditure (x/p*).

Expenditure and price elasticities in AIDS model were specified as in the Appendix 8 for the derivation of the elasticity and selection criteria details. The expenditure elasticity, η_i, and uncompensated (Marshallian) own and cross price elasticities, ε_{ij}, are:

$$\eta_i = 1 + \beta_i / w_i \quad \text{.....(9)}$$

$$\varepsilon_{ij} = -\delta_{ij} + (\gamma_{ij} - \beta_i w_j) / w_i \quad \text{.....(10)}$$

where, δ_{ij} is Kronecker delta, which takes the value of one for own price elasticity and zero for cross price elasticity. The budget share of the jth commodity, w_j, is used as weight in Stone's price index in equation (6). Once the expenditure and uncompensated price elasticities are estimated, compensated (Hicksian) own and cross price elasticities were computed using the Slutsky equation in elasticity form:

$$\varepsilon_{ij} = \varepsilon_{ij}^{H} - w_j \eta_i \quad \text{..... (11)}$$

or $\varepsilon_{ij}^{H} = \varepsilon_{ij} + w_j \eta_i$

$$\text{or} \quad \varepsilon_{ij}^{H} = -\delta_{ij} + \left(\gamma_{ij} / w_i \right) + w_j$$

where ε_{ij}^{H} is the compensated (Hicksian) price elasticity. (Deaton and Muellbauer, 1980 Baharumshah, 1993; Ahmed and Shams, 1994; Moschini, 1995 and Asche *et.al.*, 1998).

Estimation Procedures

Besides the price and income, the important factor affecting household consumption is its size and composition. Although the family size is incorporated in equation (8), calculation of expenditure per capita might be misleading because it does not take into account the age and sex composition of different households. Therefore, expenditure per Adult Equivalent Unit (AEU) is calculated in this study to adjust for the differences in age and sex composition of household. Nutritional scales seem to be appropriate to compute adults' equivalents, because food constitutes the major share of household expenditure. Each family member is indicated as a fraction of an adult male equivalent consumption unit based on the calorie requirements recommended by James and Schoield (1990) for the less developed countries' rural population. The AEU approach used in this study is a refinement to the per capita expenditure approach, and is similar to the food-based scales proposed by Prais and Houthakker (1971).

Appendix Table 9 presented the estimated adult equivalent consumption units. In equation (8), per capita expenditure (x) is replaced by per adult equivalent expenditure, and family size m is replaced by adult equivalent family size. The Stone's geometric price index (P^*) in equation (6) is used to deflate the expenditure of the ith households. The analysis is based on year round survey data collected over a period of one year. The price index is constructed for each household by multiplying the log of price of the jth good faced by the average budget share of the jth goods for all households in that round. The price index (P^*) is obtained by summing the product over all commodity.

Adjusting for adult equivalent, equation (8) is estimated for each commodity groups using the Ordinary Least Squares (OLS) method. The demand elasticities are estimated from the estimated parameters using the elasticity formulas in equation (9), (10) and (11) and t- test is carried out to investigate the hypotheses.

Sample size and Sources of Data

Multi-stage sampling techniques were followed to collect data for demand analysis of the study. The household demand was estimated for both rural and urban areas. The total sample of Household Expenditure Survey (HES) was 550 households which were distributed as 300 for rural and 250 for urban households. Three hundred rural households were randomly selected from three Upazilas like Nalitabari, Nakla and Sherpur sadar upazila of Sherpur district. The distributions of urban households were 150 from Mymensingh municipality and 100 from Ramna Thana under Dhaka municipality areas. These 100 samples under each urban area were again being subdivided into 50 as slum and 50 as non-slum households. A year-round survey started in July 2005 and ended in August 2006. Two enumerators were

employed to collect data and used to visit every weekend and fill up the consumption information of the past week.

Selection of Food Items

Given the available data, for LA/AIDS model 43 food commodities were considered. Food commodities were specifically aggregated into non-food, vegetables, rice, pulse and other cereal, spices, milk and milk product, fruits and fish and meat. The food and non-food groups are as follows:

Vegetables Leafy vegetables, brinjal, potato, tomato, pumpkin and other vegetables	Pulse and other cereals Wheat and wheat flower , pulses, *moosor*, *khesari*, gram and others	Milk and related products Milk, milk powder, sugar, sweet, *gur*, biscuit and others
Spices Onion, chili, turmeric, salt, oil, garlic and others	Fruits Mango, jackfruit, banana, guava, litchi, miscellaneous	Fish and meat Mutton, beef, chicken, egg, fish (fresh and saline water, dry fish) and others
Rice Rice only	Non-food All non-food items	

Statistical Procedure

The LA/AIDS models were estimated using Seeming Unrelated Regression (SUR). The SUR ensures consistent and asymptotically efficiently estimates. The parameter estimates in LA/AIDS were estimated using the SUR model available in PROC MODEL in the Shazam package with adding up, homogeneity and symmetry restriction imposed.

V. Results and Discussion

Impact of changes of expenditure, prices and non-economic factors on household demand for vegetables are analyzed by using LA/AIDS model results of analysis were discussed in the following sub-heading:

Income Effect on Consumption Patterns

Table 1 shows the shares of households' expenditures of different items. The household expenditures were used in the analysis as a proxy for income for two reasons. Firstly, based on the permanent income hypothesis, Friedman (1957) argued that expenditures are likely to reflect permanent income and hence a better determinant of consumption behaviour. Secondly, data on expenditures are generally more reliable than income data. Table 1 also compares the results with national average. The budget shares of vegetables, pulses and other cereal, milk and milk products and fruits were found higher compared with national average. Rural households were found to allocate highest 30% of their total expenditure on rice followed by 20% on fish and meat, 19% on non-food items and 6.15 on spices. They spent only 13% on vegetables. Urban households spent less for rice (24%), fish and meat (19), vegetable (12.61), non-food (11%) and more for the rest food items, e.g., milk and milk products (10%), pulses and cereals (8%) fruits and spices (9%) compared with rural households. These results indicated that urban households spent more for high value foods.

For the entire sample, about 85% of total household expenditure were spent on food. The estimate showed the overwhelming dominance of expenditure on rice, fish & meat and vegetables in total household expenditures. On an average, vegetables account for 13% of total expenditure, implying a very little diversity in diet. Islam (2002) found average budget share for vegetables 13.5% (12.4% for rural and 15.8% for urban). Ahmed and Shams (1994) found this share to be 4.5%.Chowdhury (1982) obtained average budget share for vegetables as 2.519%. Shahabuddin and Zohir (1995) also found the same shares for major food items. The budget share for vegetables was higher than that of earlier studies meaning that consumers, especially, rural consumers were spending high percent of income on vegetables.

Table 1. Major household food expenditure patterns in Bangladesh in 2005-2006

Commodities	Average Budget share (percent)			National average
	Rural	Urban	Pooled	
Non-food	18.83	11.07	14.95	11.548
Vegetables	13.34	12.61	12.98	12.18
Rice	30.25	24.13	27.19	35.10
Pulses and other cereals	4.15	7.90	6.03	2.92
Spices	6.15	9.45	7.80	10.84
Milk and milk products	1.71	10.09	5.90	3.95
Fruit	2.60	9.15	5.88	2.97
Fish and meat	19.67	18.90	19.29	20.50
Total expenditure	100.00	100.00	100.00	100.00

Source: Field survey data, 2005-2006

The marginal budget shares of rural area were 42% for fish and meat, 20% for rice, 14% for non-food items and 8% for spices (Table 2). The corresponding shares of urban areas were 39% for fish and meat, 15% for rice, 10% for milk and related products and 9% for non-food items. The marginal budget share of vegetables was estimated at 8% for rural, 7% for urban and 7% for both. Islam (2002) found marginal budget share for vegetables as 14.5% (14.9% for rural and 12.7% for urban). Ahmed and Shams (1994) estimated marginal budget share 4.7%.

Table 2. **Marginal budget share (marginal propensity to consume) for major household items in Bangladesh in 2005-2006**

Commodity	Marginal Budget Share		
	Rural	Urban	Pooled
Non-Food	13.71	8.96	11.33
Vegetables	7.94	6.79	7.37
Rice	20.32	15.12	17.72
Pulses and other cereals	3.05	6.92	4.98
Spices	8.83	7.51	8.17
Milk and milk products	1.98	9.85	5.92
Fruit	2.10	5.99	4.05
Fish and meat	42.07	38.86	40.47
Total expenditure	100.00	100.00	100.00

Source: Field survey data, 2005-2006

Based on `sign' and value of expenditure (income) elasticity a commodity was identified as superior, inferior, necessary or luxury. The expenditure (income) elasticity of demand might be interpreted as the percentage change in quantity demanded when expenditure (income) changes by one per cent, other factors held constant. The expenditure (income) elasticity of vegetables for all areas (urban and rural) was estimated at 0.583, suggesting that a 10% increase in household expenditure (income) would increase the demand for vegetables by 5.83 % (Table 3). For rural and urban areas they were respectively 0.595 and 0.531> which indicate that a 10% increase in total expenditure is associated with an increase in consumption of 5.95% in rural area and 5.31% in urban area. The expenditure (income) elasticities for nonfood, pulses and cereals were higher for urban households. In contrast, for vegetables, rice, spices, milk and related products, fruits and fish & meat the elasticities were greater for rural households. So, any policy for increasing the income of the rural people is likely to enhance the diversity in a high quality diet,

Table 3. Expenditure (income) elasticity in demand for major households' food items in Bangladesh

Commodity	Expenditure elasticity		
	Rural	Urban	Polled
Non-Food	0.72790**	0.75716**	0.72756**
Vegetables	0.59584**	0.53118**	0.58251 **
Rice	0.67249**	0.62660**	0.65213 **
Pulses and other cereals	0.73341**	0.87497**	0.82626**
Spices	0.95131**	0.73318**	0.86137**
Milk and milk products	0.93691**	0.91291**	0.91652 **
Fruit	0.80895**	0.61388**	0.65594**
Fish and meat	2.13889**	2.02425**	2.07857 **

The expenditure (income) elasticity was calculated by using the formula: $I = 1+ \beta i/ wi$

**= highly significant at 1% level, Source: Field survey data, 2005-2006

On average, almost all the food items had positive income elasticity of demand implying that they were normal goods. However, only fish and meat expenditure (income) elasticity was elastic and hence they were considered as a luxury, while all other food items were income inelastic meaning that those were necessary items. Expenditure (income) elasticity obtained for different food items indicated that if the household income increase, demand for different food items also increases. With fixed supply of vegetables, an upward shift of demand curve would cause rise in market prices of vegetables. Since the own-price elasticity of vegetables is less than unity, it was anticipated that the increased in price due to the shift of demand curves for vegetables would result in a decrease in demand by less than proportionate price.

Ahmed and Shams (1994) estimated expenditure elasticity for vegetables and rice at 1.05 and 0.68, respectively by applying AIDS model. Ali (2002) estimated expenditure elasticity for vegetables and cereal at 0.70 and 0.78, respectively. Chowdhury (1982) obtained expenditure elasticity for vegetables as 0.40. Hyeon (1994) found expenditure elasticity for

canned vegetable, frozen vegetables and fresh vegetables at *1.1398; 0.6578* and *1.08141* respectively by applying AIDS model. Islam *(2002)* also estimated expenditure elasticity of vegetables was *1.07*. Nadeem and Akhter *(1990)* found expenditure elasticity of vegetable to be *1.2159* for rural and *0.7614* for urban areas.The expenditure elasticities of vegetables estimated by Murshid *et al.,(2007, p.4)* and by applying LA/AIDS model were *0.82* for rural and *0.77* for urban areas in Bangladesh. Nadeem and Akhter *(1990)*, Ahmed and Shams *(1994)*, Hyeon *(1994)* and Islam (2002) found vegetables as luxury commodities in their studies. Conversely, Murshid; Ali, Chowdhury's studies and the present study found vegetables as necessary commodity because of the changes in the food habits of Bangladeshi people and their awareness of the nutritive values of vegetables.

Impact of Family Size on Food Consumption

Estimated coefficients of major food demand system for rural, urban and Bangladesh (pooled) as a whole estimated by using Linear Approximation Almost Ideal Demand System (LA/AIDS) model are presented in appendix Table 5 though *7*. The negative sign and significance of the coefficient of household size implies that per capita food expenditure decrease with the increase of household size. In the case of rural households foods demand system the calculated *63* coefficients out of *88* were statistically significant. On the other hand, *69* coefficients out of *88* were statistically significant for urban area. In the case of Bangladesh, *74* coefficients were statistically significant.

Response in Demand to Changes in Prices

The own price elasticity of a product is expected to have a negative sign, according to economic theory, indicating the negative slope of the demand curve. Uncompensated elasticities of demand refer to changes in the quantity of major household food items demanded as a result of changes in prices in absence of any compensation in terms of either price or income change. Compensated elasticity of demand for major household food items refers to that portion of total change in the quantity of household food items demanded which is compensated by price changes. One of the allowances for price compensated to total change in the quantity demand (of the uncompensated elasticities) is made; the remaining is the income effect. That is, price effect plus income effects equal total effect. Table 4 presents the estimated uncompensated and compensated own price elasticities of demand for major food and non-food items. All own-price elasticities of food items (uncompensated and compensated) display appropriate negative signs indicating the negative relationship between price of a normal commodity and its demand. A substantial difference between compensated and uncompensated own price elasticities is observed indicating a substantial effect of income. Own price elasticities of all foods and non-food items are significant. The estimates suggested that households were quite responsive to change in prices while adjusting their consumption of corresponding commodities. In comparing the elasticities between rural and urban households, rural households were found relatively more responsive to change in price of milk and related products and fish and meat compared to urban households when adjusting their expenditure. The uncompensated own-price elasticity of milk and related products and fish and meat were *-0.61* to *-0.91*, respectively indicating that milk and related product and

fish and meat are sensitive to prices (Table 4). Islam (2002) observed similar findings in his study. The compensated and uncompensated own price elasticities indicate that all foods (except milk and milk product for rural and fish & meat for rural and urban areas) items are price inelastic.

The uncompensated own-price elasticities consisted of two component effects, i.e., price or substitute effect and income effect. The estimated uncompensated own price elasticity of demand for fresh vegetables at the national level indicates that if the price of vegetables falls by 10% the demand for vegetables would increase by 4.08%. Of this total increase in demand, 3.61 % is purely due to price effect (i.e. the substitute effect) as the compensated elasticity suggests. The income effect of the price falls accounts for the remaining *0.47%* increase in vegetables food demand due to the increase in real income, if the absolute amount of money income remains unchanged. If the per capita income increased by 10% accompanied by a 10% fall in vegetables price, demand for vegetables would increase by 9.92%. The increase in per capita income represents a shift in the vegetable demand curve that normally leads to an increase in vegetable price, which is not desirable in a country like Bangladesh, where majority of the people belong to the low-income group and are dependent on markets. The estimation of resulting equilibrium level of vegetable consumption would require the information on supply elasticity of vegetables.

The estimates of uncompensated and compensated own price elasticities in Table *4* reveal that except for rice and vegetables, the income effect of change in prices was very little for different food items. This was so because most food items had very small shares in household expenditure (income).Hence their price changes had minimal effects on real income. In case of rice income effect due to change in price is very high owing to its large share in the household expenditure (Tablel). Compensated own price elasticities were in general lower than the uncompensated elasticities. This implied that the price responsiveness of the different food types was dependent on income, in that, when income was held constant (i.e., income is not a constant in the decision process), consumers tend to be less responsive to food prices.

Table 4. Own price elasticity of demand for major food consumption in Bangladesh

Commodity	Rural		Urban		Pooled	
	Uncompensated	Compensated	Uncompensated	Compensated	Uncompensated	Compensated
Non-Food	-0.58770	-0.45062	-0.67569	-0.55881	-0.65790	-0.53092
Vegetables	-0.65459	-0.53141	-0.71983	-0.63761	-0.69674	-0.57137
Rice	-0.45974	-0.49629	-0.72733	-0.57612	-0.59610	-0.53123
Pulses and other cereals	-0.20724	0.17679	-0.64724	-0.57798	-0.35960	-0.30975
Spices	-0.48527	-0.39314	-0.21099	-0.16118	-0.52466	-0.45369
Milk and milk products	-0.18926	-0.17247	-0.37915	-0.28702	-0.60639	-0.55193
Fruit	-0.04961	-0.02791	-0.82796	-0.76806	-0.18101	-0.14021
Fish and meat	-2.42363	-2.00206	-1.93197	-1.48897	-0.90638	-0.47409

Chowdhury (1982) estimated direct demand elasticity with respect to price which was 0.167 for vegetables. Ahmed and Shams (1994) found uncompensated and compensa elasticities of vegetables to be -0.77and -0.72 respectively. Islam (2002) found them to 0.55 and-0.41.Murshid *et. al.* (2007) found uncompensated and compensated elasticity vegetables as -0.52 and -0.63 for rural areas while -0.28 and -0.48 for urban areas. The earli studies found vegetables elasticities inelastic. The present study resembled the earlier studies

Cross-price Elasticity

Cross price elasticity measures the responsiveness of the demand for one good to change in price of another (Petersen, 2005). A negative cross price elasticity indicates that the two products considered are compliments and positive cross elasticity indicates that the two products under consideration are substitute. Generally cross price elasticity of demand f major households' food items referred to changes in quantity demanded of single food results of changes in prices of other foods. Cross-price elasticities of the enti uncompensated and compensated price elasticity matrices of pooled observation are presented in Table 5 and 6. Rural and urban cross-price elasticities were also shown in Appendix Tables 1 to 4. The uncompensated cross-price elasticity provides the "gross" cross effects that include both the substitution and the income effect. The compensated cross-price elasticities represent the pure price effects (that is, only the substitution effect) or the net effects of pric change on demand. The positive sign of uncompensated cross-price elasticity of demand for vegetables due to price change in rice that the two goods are substitute. That is, the fall in rice price would result to a decrease in demand for vegetables. A 10% fall in rice price would decrease demand for vegetables 0.34% (Table 5). The compensated cross-price elasticity effect on demand for vegetable was positive, indicating that the two goods are complementary i.e., a fall in rice price would reduce the demand for vegetables. A 10% decrease of rice price would reduce the demand for vegetables 0.87% (Table 6). Thug, an increase in real income due to the fall of rice price would contribute to an increase in demand for vegetables by 0.05%.

The positive sign of uncompensated cross-price elasticity of demand for vegetable, due to price change in pulses and cereals shows that the two goods are substitutes. The estimates indicate that the change in pulses and other cereal price had strong and statistically significant effect on vegetables, as the cross price elasticity was 0.109 indicating that a 10% fall in pulses and other cereal prices cause decline in vegetable consumption by 1.09%. The compensated cross price elasticity of pulses and other cereals to vegetables i.e. the net effects of pulses and other cereals price change on demand for vegetables, indicate that if the price of pulses and other cereals falls by 10%, the households would decrease their demand for vegetables by 0.42%. The first decrease in demand for vegetables by 1.09% is the effect of fall in pulses and other cereals price and increase of real income. The second decrease in demand for vegetables of 0.42 % is the pure price effect arising from the fall in pulses and other cereals price only. Thus the relationship between vegetables and pulses and other cereals are net substitute. The increase in real income due to the fall in pulses and other cereals prices (the income effect) induces the consumers to increase their demand for vegetables by 0.67%.

Fish & meat and vegetables were found complementary relationships with one another. The relationships (in elasticity forms) were statistically significant. A 10% fall in fish and meat price would result in a *2.48%* increase in demand for vegetable (Table 5). The increase in real income due to the lower fish and meat price contributed 0.432% increase in demand for vegetables. For non-food, spices, milk and related product and fruits to vegetable, the cross price elasticities were also negative which means they were competitive to one another (Table 5).

Some cross-price elasticities change the '+' or '-' signs between their uncompensated and compensated forms. The negative sign of the uncompensated cross-price elasticity of demand for vegetables (-0.00061) due to fall in spices i.e., the total effect of a change in spices, price on demand for vegetables suggested that vegetables and spices were "gross" complements (Appendix-1 and Table 5). However, the compensated cross-price elasticity (0.06934) was positive i.e., indicating vegetables and spices are "net" substitute (Appendix-1 and Table *6)*. The uncompensated cross price elasticities are more ambiguous. However, the strong expenditure effects clearly play a role in the change. The compensated cross price elasticities most appropriate when information about substitution possibilities is wanted. The uncompensated and compensated cross-price elasticities between rural and urban households are shown in Appendices Tables 1 to *2*.

Tables 5. Uncompensated own and cross price elasticities of major food and non-food items in Bangladesh

Price of	Demand for							
	Non-Food	Vegetables	Rice	Pulses and other cereal	Spices	Milk and milk products	Fruits	Fish and meat
Non-Food	0.65790	-0.67168	-0.20877	-1.39899	-0.51483	-0.48523	-0.17735	0.21190
Vegetables	-0.05541	-0.40867	-0.14561	0.41561	-0.27850	-0.10145	-0.38699	-0.32243
Rice	-0.06321	0.03419	-0.10610	-0.07719	-0.30439	-0.03322	-0.39491	-0.10233
Pulses and other cereal	-0.08219	0.10866	-0.00323	-0.35960	-0.22671	-0.00227	-0.41935	0.01840
Spices	-0.03976	-0.00061	-0.02372	0.00681	-0.52466	-0.13183	0.18164	-0.02862
Milk and milk products	-0.02743	0.00984	-0.00180	0.00501	-0.00660	-0.60639	0.27552	-0.00471
Fruits	-0.00899	-0.00720	-0.02349	0.01913	0.01285	0.02184	-0.18101	-0.00421
Fish and meat	0.25616	-0.24859	-0.04041	-0.05863	-0.00574	0.02376	0.01394	-0.90638

Table 6. Compensated own and cross price elasticities of major food and non-food items in Bangladesh

	Demand for							
Price of	Non-Food	Vegetables	Rice	Pulses and other cereal	Spices	Milk and milk products	Fruits	Fish and meat
Non-Food	-0.53092	-0.61260	-0.01093	-1.35509	-0.45488	-0.44199	-0.13210	0.363
Vegetables	0.04626	-0.57137	0.01279	0.45076	-0.23051	-0.06684	-0.35075	-0.201
Rice	0.05061	0.08714	-0.53723	-0.03784	-0.25066	0.00553	-0.35435	0.033
Pulses and other cereal	0.06202	0.04156	0.22145	-0.30975	-0.15863	0.04682	-0.36795	0.19
Spices	0.11058	0.06934	0.21051	0.05879	-0.45369	-0.08065	0.23522	0.1505
Milk and milk products	0.13254	0.08426	0.24743	0.06032	0.06892	-0.55193	0.33253	0.18590
Fruits	0.10549	0.04607	0.15487	0.05871	0.06690	0.06082	-0.14021	0.13221
Fish and meat	0.61895	-0.07980	0.52480	0.06679	0.16553	0.14727	0.14323	-0.47409

VI. A COMPARISON WITH RESULTS FROM OTHER STUDIES

Different studies revealed that elasticieis of composite foodgrains, disaggregated demand parameters of vegetables probably have the most important use in food policy analysis in Bangladesh, although some (Pitt, 1983;Bouis,1992; Ahmed and Hossain,1990; Goletti,1993; Ail,2002;Ahmed and Shams,1994 and Huq,2004) estimated the elasticities of demand for food grains, they were strict to desegregate the estimates into rice, wheat, fish and vegetables elasticities. Table 7 presented a comparison between the elasticity estimates obtained from the current study and the estimates from other studies. Out of four elasticities are above unity, indicating that the demand of vegetables is elastic. Chowdhury (1982), Ali,(2002) and Huq's (2004) studies revealed that elasticity of vegetables was inelastic implying that vegetables were necessary goods. The present study supports the results.

Table 7. Comparison of expenditure and own price elasticities of current study with those of other studies

Researchers	Year	Country	Model	Commodity		Expenditure elasticity	Own price elasticity	
							Uncompensated	Compensated
Ahmed and Shams	1994	Bangladesh	AIDS	Vegetables		1.31	-0.77	-0.72
				Rice		0.68	-0.45	-0.12
Chowdhury	1982	Bangladesh	Log-linear	Vegetables		0.40	-0.16	-
				Rice		0.81	-0.55	-
Ali	2002	Bangladesh	AIDS	Vegetables		0.70	-0.26	-
				Rice		0.78	-0.79	-
Islam	2002	Bangladesh	AIDS	Rural	Vegetables	1.20	-0.65	-0.50
					Rice	0.68	-0.62	-0.26
				Urban	Vegetables	0.80	-0.68	-0.55
					Rice	0.62	-0.57	-0.36
				Pooled	Vegetables	0.65	-0.55	-0.41
					Rice	1.07	-0.58	-0.28
Hwan and Rae	1984	Korea	AIDS	Rural	Vegetable	1.21	-0.99	-
					Rice	0.24	-0.32	-
				Urban	Vegetables	0.76	-0.92	-
					Rice	0. 6	-0.59	-
Hyeon	1994	Korea	AIDS	Canned vegetable		1.13	-0.74	-
				Frozen vegetable		0.65	-0.19	-
				Fresh vegetable		1.081	-0.027	-
Huq	2004	Bangladesh	AIDS	Potato		0.63	-0.88	-0.85
				Brinjal		0.18	-0.83	-0.83
				Leafy vegetable		0.15	-0.86	-0.86
				Other vegetables		0.93	-0.87	-0.82
						0.95	-0.87	-0.37
Murshid *et al*	2007	Bangladesh	LA/AIDS	Rural	Vegetables	0.82	-0.52	-0.63
					Rice	0.70	-0.61	-0.37
				Urban	Vegetables	0 77	-0.28	-0.48
					Rice	0.59	-0.58	-0.47
Awal	2007	Bangladesh	LA/AIDS	Rural	Vegetables	0.59	-0.65	-0.53
					Rice	0.67	-0.45	-0.49
				Urban	Vegetables	0.53	-0.71	-0.63
					Rice	0.62	-0.72	-0.57
				Pooled	vegetables	0.58	-0.69	-0.57
					Rice	.0.65	-0.59	-0.53

VII. CONCLUSION

Estimation of demand parameters in Bangladesh is available from number of studies. A few of these studies used methodologies that are computationally simple but often based on very restrictive assumptions. Elasticities of the previous studies are mostly based on secondary data from HES. The most recent estimates of demand parameters are based on 2000 Household Expenditure Survey data. The present study applies the AIDS model in estimating a complete demand system. The estimates of demand parameters are based on primary data from Household Expenditure Survey (HES), conducted in 2005-06.

Rural households were found to allocate the highest 30% of their total expenditure on rice followed by 20% on fish and meat, 19% on non-food items and 6% on spices. They spent

only 13% for vegetables. Urban households spent less for rice (24%), fish and meat (1 vegetables (12.98%) and non-food (11%) and more for the rest food items e.g. milk and product (10%), fruits and spices (9%) and pulse and other cereal (8%) compared with counterparts. The study revealed that urban households spent more for high quality food rural people spent less percent on fish and meat. About 85% of their household expendi was spent on food, showing an overwhelming dominance of expenditure on rice, fish vegetables. The vegetables accounted for 13% of total expenditures. The expendi (income) elasticity of demand for vegetables are 0.582, suggesting that a 10 % increase - household expenditure (income) would increase the demand for vegetables by 5.82%. expenditure (income) elasticity of demand for non-food (0.757), pulse and other ce (0.874) were higher for urban households but for vegetables (0.595), rice (0.672), spioaa (0.951), milk and milk products (0.936), fruits (0.808) and fish and meat (2.138) they were higher for rural households, implying that policy for increasing the income of the rural people' is likely to enhance the diversity in a high quality diet. '

Fish and meat were found to be strongly elastic in expenditure, while other food items I were inelastic. Vegetables, which were the major concern of the present study, emerged as a necessary commodity. Any increase in total household expenditure (income) would accompany an increase in expenditure on vegetables with less than proportionate increase u total expenditure. This indicates that increase in average total household expenditure (income) would lead to an increase in demand for vegetables at lower extent.

Compensated, uncompensated and expenditure ealsticities were calculated, with the majority of them being statistically significant. The uncompensated and uncompensated own ' price elasticities indicated that the demand for all food items were inelastic. For vegetables, the cross prices effect had no clear direction and a relatively low degree of complementary and substitutability existed with other food commodities. Polices could, therefore, be undertaken only on the basis of the market condition of vegetables. Cross price elasticities of other food items also indicated that substitution effects of price were not quite strong. Therefore, government, price intervention might not lead to considerable price repercussions ' in the economy of Bangladesh. Adequate steps have to be taken to increase demand for vegetables in domestic and foreign markets. Domestic demand should be increased by strengthening publicity through mass media. Involvement of political leader, nutrition ' specialists and renowned artists would be helpful in this regard. For foreign demand. cultivation of high yielding variety should be expanded.

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Appendix Table 1. Uncompensated own and cross price elasticities of major food and non-food items in rural areas of Bangladesh

i Demand for f Price of	Non-Food	Vegetables	Rice	Pulses and other	Spices	Milk and milk products	Fruits	Fish and tneat
Non-Food	-0.58770	-0.71658	-0.35432	-2.84065	-0.59548	-1.37242	-1.89994	0.34231
Vegetables	-0.08733	-0.65459	0.08361	0.47250	-0.03232	0.53446	0.36151	-0.21512
Rice	-0.11167	0.03721	-0.45974	0.29228	0.03662	0.64242	0.60444	-0.G2802
Pulses and other	-0.11614	0.02121	0.01225	-0.20724	-0.01867	0.68986	0.09943	0.01174
Spices	-0.05402	0.00018	-0.00419	0.00183	-0.48527	0.82395	0.43128	-0.03788
Milk and milk	-0.02396	0.01015	0.01131	0.00284	0.01553	-0.18926	0.81032	0.00683
Fruits	-0.05936	0.00417	0.00093	0.00795	000791	0.02251	-0.04961	-0.00869
fish and meat	0.42252	-0.15856	-004984	-0.04189	0.00822	0.02602	0.37798	-2.42363

Appendix Table 2. Compensated own and cross price elasticities of major food and nonfood items in rural areas of Bangladesh

Demand for Price of	Non-Food	Vegetables	Rice	Pulses and other cereal	Spices	Milk and milk products	Fruits	Meat and Fish
Non-Food	-0.45062	-0.62273	-0.13411	-2.81042	-0.52499	-1.35938	-1.88042	0.48578
Vegetables	0.02489	.0.53141	0.26387	0.49724	0.02539	0.54513	0.37749	-0.097G8
Rice	0.01498	0.12391	-0.25629	0.32021	0.02851	0.65447	0.62248	-0.49548
Pulses and other cereal	0.02198	0.11576	0.23413	-0.17679	0.05236	0.70300	0.11910	0.15629
Spices	0.12514	012283	0.28361	0.04133	-0.39314	0.84100	0.45G80	0.149G2
Milk and milk products	0.15249	0.13095	0.29475	0.04174	0.10626	-0.17247	0.83545	0.19149
Fruits	0.09299	0.10847	0.24566	0.04154	0.08626	0.03700	-0.02791	0.15075
fish and meat	0.82534	0.11721	0.59723	0.04692	0.21537	0.06434	0.43535	-2.00206

Appendix Table 3. Uncompensated own and cross price elasticities of major food and non-food items in urban areas of Bangladesh

Demand for								
Price of	Non-Food	Vegetables	Rice	Pulses and other cereal	Spices	Milk and milk products	Fruits	Fish and meat
Non-Food	-0.67569	-1.52912	-0.04663	-0.28125	-0.34238	-0.22554	-0.09962	0.09301
Vegetables	-0.05120	-0.71983	-0.07042	-0.09934	-0.20861	-0.20640	-0.03903	0.01791
Rice	-0.02215	0.00582	-0.72733	-0.01112	-0.05608	-0.12049	0.01555	-0.01201
Cereal and others	-0.02118	-0.00039	-0.00072	-0.64724	-0.02098	-0.03467	001577	-0.00110
Spices	-0.02321	-0.00794	-0.00500	0.02099	-0.21099	-0.04682	0.07863	-0.01736
Milk and milk products	-0.02204	-0.01144	-0.01294	0.00650	0.00380	-0.37915	0.02212	-0.00920
Fruits	-0.00999	0.00507	-0.00070	0.03063	0.01551	0.00571	-0.82796	-0.01785
fish and meat	0.11715	0.04298	0.02016	-0.07907	0.01067	0.01430	001878	-1.93197

Appendix Table 4. Compensated own and cross price elasticities of major food and nonfood items in urban areas of Bangladesh

Demand for								
Food item	Non-Food	Vegetables	Rice	Cereal and others	Spices	Milk and milk products	Fruits	Fish and meat
Non-Food	-0.55881	-1.50477	0.12886	-0.22369	-0.29297	-0.15215	-0.02867	0.25215
Vegetables	-003342	-0.63761	0.05776	-0.05729	-0.17252	-0.15279	001280	0.13416
Rice	0.12906	0.02680	-0.57612	0.03848	-0.01351	-0.05725	007669	0.12512
Pulses and other cereal	0.04808	0.02890	0.21043	-0.57798	0.03847	0.05364	0.10115	0.19039
Spices	002660	0.01660	0.17194	0.07903	-0.16118	0.02718	0.15018	0.14309
Milk and milk products	0.07010	0.01912	0.20737	0.07877	0.06583	-0.28702	0.11120	0.19059
Fruits	0.04991	0.02562	0.14745	0.07922	0.05722	0.06767	-0.76806	0.11650
Meat and Fish	0.56015	0.11075	050866	0.08117	0.14821	0.21860	0.21631	-1.48897

Appendix Table 5. Estimated coefficient of the LA/AIDS food demand system in rural areas of Bangladesh

Food item	Non-Food	Vegetables	Rice	Pulses and other cereal	Spices	Milk and milk products	Fruits	Fish and meat
Constant	-0.00797** (0.00054)	-0.00794** (0.00103)	-0.00463 (0.00834)	-0.00089 (0.00336)	-0.00039 (0.00170)	0.00029 (0.00132)	0.00019 (0.00184)	0.02133 (0.01814)
Non-Food	0.06799** (0.00230)	-0.09337** (0.00705)	-0.12585** (0.00794)	-0.11809** (0.00888)	-0.05856** (0.00689)	-0.02480** (0.00613)	-0.06061** (0.00700)	0.41328** (0.06919)
Vegetables	-0.09337** (0.00705)	0.20661** (0.00119)	0.02498** (0.00822)	0.01952** (0.004154)	-0.00374 (0.00234)	0.00943** (0.00205)	0.00309 (0.00243)	-0.16652** (0.02745)
Rice	-0.12585** (0.00794)	0.02498** (0.00823)	0.13347** (0.01100)	0.01191** (0.00461)	-0.00497* (0.00263)	0.01116** (0.00221)	0.00070 (0.00274)	-0.51400** (0.03938)
Pulses and other cereal	-0.11809** (0.00889)	0.01953^{S} (0.00415)	0.01191* (0.00461)	0.04840** (0.00615)	-0.00200 (0.00338)	0.01231** (0.00294)	0.00054 (0.00329)	0.02739 (0.03343)
Spices	-0.05856** (0.00689)	-0.00373 (0.00234)	-0.00497 (0.00263)	-0.00200 (0.00338)	0.04939** (0.00556)	0.01465** (0.00432)	0.00661* (0.00357)	-0.00137 (0.02870)
Milk and milk products	-0.02480** (0.00614)	0.00943** (0.00205)	0.01116** (0.00221)	0.01231** (0.00294)	0.01465** (0.00432)	-0.05716** (0.00717)	0.02082** (0.00341)	0.01358^{NS} (0.02825)
Fruits	-0.06061** (0.00701)	0.00309** (0.00243)	0.00071 (0.00274)	0.00053 (0.00329)	0.00660 (0.00357)	0.02081** (0.00341)	0.02743** (0.00413)	0.00141 (0.02660)
Fish and meat	0.41329** (0.03881)	-0.16653** (0.01996)	-0.05143* (0.02004)	0.02739* (0.01109)	-0.00137 (0.00316)	0.01358** (0.00487)	0.00142 (0.00651)	-0.23635** (0.10444)
Stone price	-0.051245** (0.0009826)	-0.052109** (0.0017111)	-0.09908** (0.0001432)	-0.01107** (0.0000594)	-0.0047154** (0.0003168)	-0.0011304** (0.0002651)	-0.0051245** (0.0003369)	0.2244743** (0.005104)
Family size	0.01307** (0.00164)	-0.00748^{S} (0.00297)	0.01306** (0.00240)	-0.00271** (0.00100)	-0.00020 (0.00053)	-0.00137** (0.00026)	0.00108 (0.00055)	0.012853* (0.00935)
R^2	0.68810	0.4939	0.3190	0.0824	0.0382	0.1506	0.1014	
Mean of Dependent variable	0.00199	0.00144	0.00064	0.00012	0.00011	0.00010001	0.00004	

Note : Figures in the parenthesis indicate standard error of the coefficients. ** = Highly significant at 1 % level, * = Significant at 5 % level, Source: Field survey data, 2005-2006.

Appendix Table 6. Estimated coefficient of the LA/AIDS food demand system in urban areas of Bangladesh

Food item	Non-Food	Vegetables	Rice	Pulses and other cereal	Spices	Milk and milk products	Fruits	Fish and Meat
Constant	0.00536 (0.00861)	-0.00493 (0.00513)	-0.00119** (0.00047)	0.00036** (0.00002)	-0.00080** (0.00001)	-0.00116** (0.00023)	-0.00002 (0.00095)	0.00232 (0.01541)
Non-Food	0.04508** (-0.00516)	-0.05169** (0.00907)	-0.02573** (0.00758)	-0.02235** (0.00510)	-0.02422** (0.00383)	-0.02353** (0.00472)	-0.01143** (0.00200)	0.11389** (0.02310)
Vegetables	-0.05169** (0.00907)	0.09387** (0.01039)	-0.01702** (0.00584)	-0.00788 (0.00466)	-0.01437** (0.00369)	-0.02099** (0.00462)	-0.00416* (0.00196)	0.02226** (0.00165)
Rice	-0.02573** (0.00758)	-0.01702** (0.00584)	0.04405** (0.00680)	-0.00118 (0.0091)	-0.05249* (0.02646)	-0.01331** (0.0032)	-0.00105 (0.00144)	-0.01934** (0.00139)
Pulses and other cereal	-0.22351** (0.00510)	-0.07881** (0.00466)	-0.00101 (0.00339)	0.07140** (0.0032)	-0.00189 (0.00331)	-0.00387* 0.003791)	0.00069 (0.00179)	0.00918** (0.00088)
Spices	-0.02422** (0.00383)	-0.01437** (0.00369)	-0.00524* (0.00264)	-0.00976 (0.0013)	0.05237** (0.0060)	-0.00505 (0.00417)	0.00694* (0.00308)	-0.00853** (0.00068)
Milk and milk products	-0.02353** (0.00472)	-0.02099** (0.00462)	-0.01331** (0.00324)	-0.00387 (0.00379)	-0.00505 (0.00417)	0.06177** (0.00628)	0.00108 (0.00237)	0.00391** (0.00083)
Fruits	-0.01143** (0.00200)	-0.00416$^{\delta}$ (0.00196)	-0.00105 (0.00144)	0.00069 (0.00179)	0.00694* (0.00308)	0.00108 (0.00237)	0.01311** (0.00477)	-0.00516 (0.00357)
Fish and meat	0.11389** (0.02310)	0.02226** (0.00165)	0.01934** (0.00139)	0.00918** (0.00088)	-0.00853** (0.00068)	0.00391** (0.00083)	-0.0051 (0.00357)	-0.15490** (0.02497)
Stone price	-0.043856** (0.0002117)	-0.015694** (0.001293)	-0.090109** (0.0001241)	-0.009897** (0.0006413)	-0.01813** (0.0004834)	-0.00879** (0.000595)	-0.037678** (0.002535)	0.224154** (0.005306)
Family size	0.01063** (0.00423)	0.05886** (0.00256)	-0.00875** (0.00023)	0.01161** (0.00124)	0.00635** (0.00092)	0.01493** (0.00115)	0.00029 (0.00048)	0.09392** (0.01081)
R^2	0.7143	0.3019	0.1046	0.0588	0.0643	0.1680	0.8924	
Mean of Dependent variable	0.00405	0.00040	0.00024	0.00012	0.00069	0.00016	00.00001	

Note: Figures in the parenthesis indicate standard error of the coefficients. ** = Highly significant at 1 % level, * = Significant at 5 % level, Source: Field survey data, 2005-2006.

Appendix Table 7. Estimated coefficient of the LA/AIDS food demand system of Bangladesh (pooled)

Food item	Non-Food	Vegetables	Rice	Pulses and other cereal	Spices	Milk and milk products	Fruits	Fish and Meat
Constant	-0.00444** (0.00078)	0.02383** (0.00274)	0.01644** (0.00226)	-0.00082 (0.00920)	-0.00173** (0.00040)	0.00107** (0.00035)	0.00298** (0.00066)	-0.03368 ** (0.01642)
Non-Food	0.05140** (0.00147)	-0.05841** (0.00748)	-0.07328** (0.00771)	-0.08442** (0.00965)	-0.04281** (0.00708)	-0.02963** (0.00609)	-0.01129** (0.00081)	-0.21423** (0.01737)
Vegetables	-0.05841** (0.00748)	0.04326** (0.02367)	-0.04012** (0.01572)	0.02507** (0.00834)	-0.02312** (0.00413)	-0.06400** (0.00036)	-0.02419** (0.00649)	-0.30542** (0.03401)
Rice	-0.07328** (0.00771)	-0.04012** (0.00157)	0.21735** (0.02137)	-0.04675 (0.00866)	-0.02568** (0.00424)	-0.00321 (0.00371)	-0.02498** (0.00657)	-0.04538** (0.00326)
Pulses and other cereal	-0.08442** (0.00965)	0.02507** (0.00834)	-0.04675 (0.00866)	0.07839** (0.01280)	-0.01881** (0.00607)	0.00041 (0.00507)	-0.02617** (0.00757)	0.03103** (0.00190)
Spices	-0.04281** (0.00708)	-0.02312** (0.00413)	-0.25687** (0.00424)	-0.01881** (0.00607)	0.11884** (0.01159)	-0.08210 (0.00590)	0.01117 (0.06455)	-0.01136** (0.00995))
Milk and milk products	-0.02963** (0.00609)	-0.00640** (0.00036)	-0.00321 (0.00371)	-0.000411 (0.00507)	-0.08210 (0.00590)	0.02309** (0.00591)	0.01704** (0.00529)	0.00773** (0.00089)
Fruits	-0.01129** (0.00081)	-0.02419** (0.00649)	-0.02498** (0.00657)	-0.02617** (0.00757)	0.01117 (0.00645)	0.01704** (0.00529)	0.04961** (0.00899)	0.00882 (0.01373)
Fish and meat	-0.21423** (0.01737)	-0.30542** (0.03401)	-0.04538** (0.00326)	0.03103** (0.00190)	-0.01136** (0.00995)	0.00773** (0.00089)	0.00882 (0.01373)	0.06612** (0.01893)
Stone price	-0.051245** (0.0009826)	-0.052109** (0.0017111)	-0.09908** (0.0001432)	-0.01107** (0.0000594)	-0.0047154** (0.0003168)	-0.0011304** (0.0002651)	-0.0051245** (0.0003369)	0.2244743** (0.005104)
Family size	0.00391** (0.00019)	0.014120** (0.00610)	-0.01454** (0.00508)	-0.00346** (0.00021)	0.00464** (0.00010)	-0.00081** (0.00009)	0.000621** (0.00001)	0.004481 (0.01178)
R^2	0.6881	0.3791	0.1718	0.0615	0.1303	0.0246	0.0012	
Mean of Dependent variable	0.00303	0.00283	0.02363	0.00030	0.00026	-0.00013	0.00010	

Note: Figures in the parenthesis indicate standard error of the coefficients. ** = Highly significant at 1 % level, * = Significant at 5 % level, Source: Field survey data, 2005-2006,

Appendix Table 8. Derivation of elasticities from LA/AIDS model
Derivation of Price Elasticity

In the linear approximate AIDS model, the demand function for the i[th] commodity is

$$w_i = \alpha_i + \beta_i(\ln x - \sum_j w_j \ln P_j) + \sum_j \gamma_{ij} \ln P_j + \theta_i \ln m \qquad (1)$$

$$or\ p_i q_i = x(\alpha_i + \beta_i(\ln x - \sum_j w_j \ln P_j) + \sum_j \gamma_{ij} \ln P_j + \theta_i \ln m)$$

The left hand side of (1) gives the expenditure share of i[th] commodity ($w = p_i q / x$). Expressing (1) in expenditure form and differencing with respect to price of j[th] commodity gives

$$\frac{\delta e_i}{\delta p_j} = \frac{-\beta_i x w_j}{P_j} + \frac{x\gamma_{ij}}{P_j} \qquad (2)$$

where $e_i = p_i q_i$ or per capita household expenditure on i[th] commodity. Multiplying (2) by $\frac{p_j}{e_i}$ gives the price elasticity of demand in expenditure form

$$\frac{\delta e_i}{\delta p_j} \times \frac{p_j}{e_i} = \frac{-\beta_i x w_j}{P_j} \times \frac{p_j}{e_i} + \frac{x\gamma_{ij}}{P_j} \times \frac{p_j}{e_i}$$

$$\varepsilon_{ij} = \frac{-\beta_i x w_j}{e_i} + \gamma_{ij} \frac{x}{e_i}$$

$$\text{or} \quad \varepsilon_{ij} = \frac{x}{e_i}(-\beta_i w_j + \gamma_{ij})$$

where $w_i = \frac{p_i q_i}{x}$ or $w^{-1} = \frac{x}{p_i q_i} = \frac{x}{e_i}$

$$\therefore \varepsilon_{ij} = w_i^{-1}(\gamma_{ij} - \beta_i W_j) \qquad (3)$$

Again we know that $e_i = p_i q_i$

With the log transformation $e_i (= p_i \times q_i)$ becomes

$$\ln e_i = \ln p_i + \ln q_i \qquad (4)$$

Differencing (4) with respect to $\ln P_j$ gives

$$\varepsilon_{ij} = \frac{\delta \ln e_i}{\delta \ln P_j} = \frac{\delta \ln P_i}{\delta \ln P_j} + \frac{\delta \ln q_i}{\delta \ln P_j} \qquad (5)$$

or $$\frac{\delta \ln q_i}{\delta \ln P_j} = \varepsilon_{ij} - \frac{\delta \ln e_i}{\delta \ln P_j}$$

From (3) and (5) the price elasticity of demand for i[th] commodity is derived as

$$\text{or} \quad \frac{\delta \ln q_i}{\delta \ln P_j} = w_i^{-1}(\gamma_{ij} - \beta_i W_j) - \delta_{ij} \qquad (6)$$

where $\delta_{ij} = \frac{\delta \ln e_i}{\delta \ln P_j}$ is the Kronecker delta which takes the value of one for own price elasticity (when $i = j$) and zero for cross elasticity (when $i \pm j$)

Derived expenditure elasticity

We know that marginal budget share is:

$$MBS_i = \frac{\delta e_i}{\delta x} = \alpha_i + \beta_i + \beta_i (\ln x - \sum_j w_j \ln P_j + \theta_i \ln m \qquad (7)$$

$$\textit{or} \quad MBS_i = \frac{\delta e_i}{\delta x} = \beta_i + w_i$$

Where MBS_i is the marginal budget share spent on the commodity.

Since the average budget share of the i[th] commodity (ABS_i) is simply the left hand side of the demand function for the i[th] commodity, i.e.,

$$ABS_i = w_i \qquad (8)$$

Since $w_i = \frac{e_i}{x}$, the expenditure elasticity of the i[th] commodity were derived as on

$$\varepsilon_i = \frac{MBS_i}{ABS_i} = \left(\frac{\delta e_i}{\delta x}\right) \div \left(\frac{x}{e_i}\right) = (\beta_i + w_i) \div w_i$$

$$\therefore \varepsilon_i = \frac{MBS_i}{ABS_i} = 1 + \frac{\beta_i}{w_i}.$$

Own price elasticity

Differencing equation (1) with respect to δx gives

$$\frac{\delta q_i}{\delta x} = -\frac{x}{p_i^2}\left(\alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \frac{x}{p}\right) + \delta_{ii} \frac{x}{p_i^2} - \beta_i \frac{x w_i}{p_i^2}$$

$$\therefore \quad E_{ii} = -1 + \frac{\delta_{ii}}{w_i} - \beta_i$$

Cross- price elasticity

Differencing equation (1) with respect to δp_j gives

$$\frac{\delta q_i}{\delta p_j} = \gamma_{ii} \frac{x}{p_i} \frac{1}{p_j} - c_i \frac{x}{p_i}\left(\frac{w_j}{p_j}\right), \text{ and } \quad E_{ii} = \frac{\gamma_{ii}}{w_i} - \frac{c_i}{w_i} w_j$$

$$\text{or} \quad E_{ii} = w_i^{-1}\left(\gamma_{ij} - \beta_i w_j\right)$$

Appendix Table 9. Adult equivalent consumption units according to age and sex

Age	Male	Female
(Years)	(adult equivalent consumption units)	
0+	0.25	0.25
1+	0.37	0.36
2+	0.42	0.40
3+	0.46	0.43
4+	0.49	0.46
5+	0.53	0.48
6+	0.56	0.49
7+	0.58	0.49
8+	0.58	0.49
9+	0.58	0.49
10+	0.70	0.64
11+	0.71	0.64
12+	0.73	0.66
13+	0.77	0.68
14+	0.81	0.70
15+	0.85	0.70
16+	0.89	0.72
17+	0.92	0.75
18-29+	1.03	0.82
30-59+	1.03	0.83
>60	0.68	0.61
Adult	1.00	0.61

Source: A. U. Ahmed, 1994. pp. 6-7