AN EMPIRICAL STUDY OF FOOD DEMAND IN THE NORTH WEST FRONTIER PROVINCE, PAKISTAN

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ABSTRACT

The paper estimates own and cross price compensated and uncompensated elasticities and expenditure elasticities for North West Frontier Province using socio-economic and demographic factors flexible LA-AIDS model using HIES 2004-05 data. All the estimated models were statistically significant. The demand for wheat, fruits, vegetables, milk and cooking oil were inelastic while elastic for rice, meat and other food. All the commodities were normal while rice, fruits, meat and other food products were found to be expenditure elastic as compared to wheat, vegetables, milk and cooking oil. Hicksian own and cross price elasticities closely followed the Marshallian elasticities.

Key Words: Demand Elasticities, Expenditure Elasticities, AIDS, Food Demand

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INTRODUCTION

Household Integrated Economic Surveys (HIES) are regularly conducted in Pakistan to collect detailed information on the quantity and expenditure of food consumed and on the economic and socioeconomic and demographic characteristics of households. This rich database offers researchers unique opportunities and challenges in analyzing food demands and related policy issues. Although food expenditure account for one-half of the household income in Pakistan, very little is known about the demand and income elasticities of food commodities especially for North-West Frontier Province (N-WFP). Demand elasticities play a central role in the analysis of domestic and trade policies yet estimates of the elasticities are not available across the different regions of the country. For example, computable general equilibrium models designed to address multi-lateral trade flows require price and expenditure (or income) elasticities, while analysis of domestic policies such as taxes require demand elasticity estimates.

Most of the earlier studies used time series data to estimate demand elasticities which may be inadequate, because these studies use average consumer behaviour rather than the individual behaviour of the households of interest. Therefore, estimating cross-section demand relationships from household survey data in order to obtain elasticities distinguished by household characteristics is of interest (Haung and Lin, 1987). This study provides estimates of the own and cross price compensated and uncompensated demand and expenditure elasticities for N-W.F.P of Pakistan. The study uses the Linear Approximate Almost Ideal Demand System (LA-AIDS) to estimate own and cross price compensated and uncompensated demand and expenditure elasticities of food commodities for N-W.F.P. The analysis include eight food commodities: (i) wheat mainly consisting of wheat flour; (ii) rice including all kinds of rice consumed; (iii) fruits; (iv) vegetables; (v) milk; (vi) cooking oil; (vii) meat (beef, mutton, and poultry); and (viii) other food (mainly include other pulses, tea, readymade food, condiments, spices and sugar). The fruit, vegetable, and milk categories consist mainly of fresh products.

MATERIALS AND METHODS

Theoretical Model and Estimation

The paper uses Linear Approximation of Almost Ideal Demand System (LA-AIDS) to estimate demand and expenditure elasticities. The AIDS model is selected for estimation because it automatically satisfies the aggregation restriction, and with simple parametric restrictions, homogeneity and symmetry can be imposed (Moschini, 1998). Deaton and Muellbauer (1980a, 1980b) used Price Independent Generalized Logarithmic (PIGLOG) preferences to derive Almost Ideal Demand System (AIDS). Deaton and Muellbauer (1980a) assumed expenditure function, $c(u,p)$ where u represents the utility level and p the price vector. The expenditure function based on PIGLOG is given as:

$$\ln c(u,p) = (1-u)\ln\{a(p)\} + u\ln\{b(p)\} \quad (1)$$

Where u lies between 0 (subsistence) and 1 (bliss) and $a(p)$ and $b(p)$ are homogenous of degree (HOD) one in prices. For the purpose of flexibility, $ln\{a(p)\}$ and $ln\{b(p)\}$ are expressed as:

$$\ln\{a(p)\} = a_0 + \sum_k a_k \ln(p_k) + \frac{1}{2}\sum_k\sum_j \beta^*_{kj} \ln p_k \ln p_j \quad (2)$$

and

$$\ln\{b(p)\} = \ln\{a(p)\} + \beta_0 \prod_k p_k^{\beta_k} \quad (3)$$

Substituting, equations 2 and 3 in 1 yields:

$$\ln c(u,p) = a_0 + \sum_k a_k \ln(p_k) + \frac{1}{2}\sum_k\sum_j \beta^*_{kj} \ln p_k \ln p_j + u\beta_0 \prod_k p_k^{\beta_k} \quad (4)$$

Where α_i, β_i, and β^*_{kj} are parameters and $c(u,p)$ is HOD one in prices. The homogeneity condition holds if $\sum_i \alpha_i = 1$, $\sum_j \beta^*_{kj} = \sum_k \beta^*_{kj} = \sum_j \beta_j = 0$. Equation (4) is differentiated with respect to price to get compensated demand function and budget share (w_i). The AIDS demand equation in budget shares with prices and utility is given as:

$$w_i = \alpha_i + \sum_j \beta_{ij} \ln p_j + \beta_i u \beta_0 \prod_k p_k^{\beta_k} \quad (5)$$

Solving for u and substituting back into equation (5) yields:

$$w_i = \alpha_i + \sum_j \beta_{ij} \ln p_j + \beta_i \frac{x}{P} \quad (6)$$

Where $x=lnc(u,p)$ and P is the price index given as $\ln(P) = \alpha_0 + \sum_k \alpha_k \ln(p_k) + \frac{1}{2}\sum_k \sum_j \beta^*_{kj} \ln p_k \ln p_j$. Adding up is satisfied by $\sum_i \alpha_i = 1$, $\sum_i \beta_i = 0$, $\sum_i \beta_{ij} = 0$; homogeneity is satisfied if $\sum_j \beta_{ij} = 0$ and symmetry is satisfied if $\beta_{ij} = \beta_{ji}$. However, $ln(p)$ could not be calculated due to unobservable utility and hence it is approximated as $\ln(P^*) = \sum_j w_j \ln(p_j)$ and the final estimable equation becomes:

$$w_i = \alpha_i + \sum_j \beta_{ij} \ln p_j + \beta_i \frac{x}{P^*} \quad (7)$$

This is the Linear Approximate (LA) of AIDS and has been extensively used in consumer analysis and the elasticities estimated using LA-AIDS are very similar from those estimated using AIDS. Household specific socioeconomic and demographic (briefly socioeconomic) characteristics, s to give

$$w_i = \alpha_i + \sum_j \beta_{ij} \ln p_j + \beta_i \frac{x}{P^*} + \theta s \quad (8)$$

The socioeconomic characteristics include household size measured as the number of household members; a dummy variable for literacy of the household head; dummy variables representing employment of the household head (self-employed, farmer, employee). Binary variables are equal to one when the phenomenon exists and zero otherwise, for example, literacy equals one when the household is literate, otherwise zero. The Marshallian (uncompensated),

Hicksian (compensated) and expenditure elasticities are derived from the estimated LA-AIDS using the relationships given in equations (9) to (11). The Marshallian (ε_{ij}^{M}) price elasticity for good *i* with respect to good *j* is given by:

$$\varepsilon_{ij}^{M} = \frac{\beta_{ij} - \beta_i w_j}{w_i} - \delta_{ij} \qquad (9)$$

The Hicksian (ε_{ij}^{H}) price elasticity for good *i* with respect to good *j* is given as:

$$\varepsilon_{ij}^{H} = \frac{\beta_{ij}}{w_i} + w_j - \delta_{ij} \qquad (10)$$

The expenditure elasticity (e_i) is derived as:

$$e_i = \frac{\beta_i}{w_i} + 1 \qquad (11)$$

where δ_{ij} is Kronecker delta and equals 1 for own price and 0 for cross-price elasticities. In the case of missing prices of the food products were substituted for mean prices (Cox and Wohlgenant, 1986).

Data

Household Integrated Economic Survey (HIES) 2004/2005 is used in this study. The survey is conducted as a part of the Pakistan Social and Living Standards Measurement (PSLM) project. The data involves a sample of 14,708 households taken from the PSLM survey. The main objective of the HIES is to derive poverty indicators. A two-stage stratified random sample design was adopted to select the households. In the first stage, 1,045 primary sampling units (enumeration blocks) were selected in the urban and rural areas of all four Pakistan provinces. In the second stage, the sample of 14,708 households was randomly selected from these primary sampling units. Using a random systematic sampling scheme with a random start, either 16 or 12 households were selected from each primary sampling unit (GoP, 2006). For this study 2894 cases of the North-West Frontier Province were selected for the analysis. The HIES collects data on household characteristics, consumption patterns, household income by source, and social indicators.

RESULTS AND DISCUSSION

Seemingly Unrelated Regression (SUR) (Zellner, 1963) is used to estimate the system of LA-AIDS equations. Imposing the restriction of additivity on the demand function makes the variance and covariance matrix singular and any one of the equations needs to be taken-off of the system to estimate the LA-AIDS. The coefficients for the dropped equation are derived using the theoretical restrictions imposed on the demand system. However, the derived parameters of the dropped equation are invariant to which equation is dropped.

Table I presents results of the estimated model. The table shows that all the estimated equations included in the system are statistically significant as indicated by the statistically significant chi-square statistics. The statistically significant chi-square tests reject the hypothesis that the combined effect of all the variables included in the model is statistically zero. The goodness of fit measure ranges from 0.05 for milk to 0.22 for fruits indicating that 5 and 22 percent of the variations in the dependent variables for milk and fruits are explained by the variation in the exogenous variables.

Estimates of the uncompensated (Marshallian) own price and cross price and expenditure elasticities are given in Table II. These elasticities are estimated at sample means. The table shows that all the estimated own price uncompensated elasticities are negative and statistically significant at 99 percent level. The uncompensated own price elasticities shows inverse relationship between price and quantity demand i.e. as price of the commodity increases its demand decreases. The estimated uncompensated own price elasticities ranges from −0.494 for cooking oil to −1.73 for rice. Demands for rice and meat are price elastic indicating that a small change in the price will lead to a more than proportionate change in quantity demand. Demand for cooking oil is surprisingly inelastic indicating that a change in cooking oil price will cause less than proportionate change in cooking oil demand. The inelastic demand of cooking oil may be due to the inclusion of other similar products such as ghee in the cooking oil category.

Table I. ***Parameter Estimates of the LA-AIDS Model for North West Frontier Province, Pakistan***

Explanatory Variable	Wheat	Rice	Fruits	Vegetables	Milk	Cooking Oil	Meat	Other Food
Log of Price of Wheat	0.089	-0.031	-0.018	-0.022	-0.039	-0.038	0.033	0.025
	(0.013)***	(0.004)***	(0.004)***	(0.004)***	(0.008)***	(0.006)***	(0.007)***	(0.004)***
Log of Price of Rice	-0.031	-0.017	0.015	0.008	0.006	-0.003	0.016	0.006
	(0.004)***	(0.002)***	(0.002)***	(0.002)***	(0.003)**	(0.002)	(0.003)***	(0.002)***
Log of Price of Milk	-0.039	0.006	-0.001	-0.015	0.070	-0.007	-0.013	0.000
	(0.008)***	(0.003)*	(0.003)	(0.004)***	(0.009)***	(0.004)	(0.005)**	(0.003)
Log of Price of Fruits	-0.018	0.015	0.017	0.002	-0.001	0.003	-0.003	-0.016
	(0.004)***	(0.002)***	(0.002)***	(0.002)	(0.003)	(0.002)	(0.003)	(0.001)***
Log of Price of Vegetables	-0.022	0.008	0.002	0.038	-0.015	-0.010	0.005	-0.006
	(0.004)***	(0.002)***	(0.002)	(0.003)***	(0.004)***	(0.003)***	(0.003)	(0.002)**
Log of Price of Cooking Oil	-0.038	-0.003	0.003	-0.010	-0.007	0.047	0.012	-0.003
	(0.006)***	(0.002)	(0.002)	(0.003)***	(0.004)	(0.006)***	(0.004)**	(0.002)*
Log of Price of Meat	0.033	0.016	-0.003	0.005	-0.013	0.012	-0.039	-0.011
	(0.007)***	(0.003)***	(0.003)	(0.003)	(0.005)**	(0.004)**	(0.007)***	(0.003)***
Log of Price of Other Food	0.025	0.006	-0.016	-0.006	0.000	-0.003	-0.011	0.005
	(0.004)***	(0.002)***	(0.001)***	(0.002)**	(0.003)	(0.002)**	(0.003)***	(0.003)
Log of Food Expenditure	-0.015	0.017	0.003	-0.012	0.015	-0.036	0.001	0.028
	(0.005)**	(0.002)***	(0.002)*	(0.002)***	(0.004)***	(0.002)***	(0.003)	(0.004)***
Household Size	0.002	0.000	-0.001	-0.001	-0.002	0.002	0.001	-0.002
	(0.000)***	(0.000)*	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)**	(0.000)***
Dummy for Literacy	-0.025	0.003	0.011	0.000	0.000	0.003	0.024	-0.016
	(0.003)***	(0.001)**	(0.001)***	(0.002)	(0.003)	(0.002)**	(0.002)***	(0.003)***
Agriculture as Profession	-0.017	0.002	-0.009	0.002	0.024	-0.014	-0.016	0.028
	(0.004)***	(0.002)	(0.001)***	(0.002)	(0.004)***	(0.002)***	(0.003)***	(0.003)***
Public/Private Employment	0.009	0.007	-0.007	0.001	-0.002	-0.007	-0.011	0.011
	(0.004)**	(0.002)***	(0.001)***	(0.002)	(0.004)	(0.002)***	(0.003)***	(0.003)***
Self-employment	0.003	0.005	-0.004	-0.002	0.000	-0.004	0.003	-0.001
	(0.005)	(0.002)**	(0.002)***	(0.002)	(0.004)	(0.002)**	(0.003)	(0.004)
Household location (Urban/Rural)	-0.019	-0.007	0.011	-0.002	0.009	0.001	0.026	-0.019
	(0.004)***	(0.002)***	(0.001)***	(0.002)	(0.004)**	(0.002)	(0.003)***	(0.003)***
Number of Observations	2,894	2,894	2,894	2,894	2,894	2,894	2,894	2,894
R-Squared	0.13	0.09	0.22	0.09	0.05	0.13	0.15	0.12
Chi	494.7***	361.0***	797.0***	358.6***	163.6***	487.3***	473.3***	392.0***

*, ** and *** indicate significance at 90, 95 and 99 percent level, respectively.

Expenditure elasticities for the eight food products are also given in Table II. All of the expenditure elasticities are positive suggesting that all goods are normal. The estimated expenditure elasticities range from 0.678 for wheat to 1.703 for rice. Out of eight food commodities, expenditure elasticities for half of the food commodities (rice, fruits, meat and other food products) are greater than one implying that these food commodities are luxuries while the other four products (wheat, milk, vegetables and cooking oil) are necessities in N-WFP. Table II also presents the Marshallian cross price elasticities. Out of the 32 cross-price elasticities, 15 are negative indicating that commodities are complements while 17 are positive implying that food products are substitutes. However, all the

cross-price elasticities are inelastic. The compensated own-price elasticities are generally lower but similar to the uncompensated own-price elasticities.

Table II. ***Estimated Uncompensated Own Price and Cross Price Elasticities and Expenditure Elasticities***

	Wheat	Rice	Fruits	Vegetables	Milk	Cooking Oil	Meat	Other Food	Expenditure Elasticities
Wheat	-0.624	-0.109	-0.056	-0.074	-0.143	-0.139	0.148	0.119	0.678
	(0.053)***	(0.017)***	(0.016)***	(0.019)***	(0.033)***	(0.025)***	(0.029)***	(0.016)***	(0.020)***
Rice		-1.730	0.619	0.310	0.218	-0.162	0.678	0.238	1.703
		(0.102)***	(0.065)***	(0.082)***	(0.133)	(0.103)	(0.124)***	(0.067)***	(0.080)***
Fruits			-0.510	0.058	-0.024	0.092	0.434	-0.476	1.083
			(0.058)***	(0.052)	(0.081)	(0.067)	(0.045)***	(0.040)***	(0.047)***
Vegetables				-0.626	-0.132	-0.088	0.061	-0.042	0.891
				(0.029)***	(0.035)***	(0.026)***	(0.032)**	(0.017)**	(0.021)***
Milk					-0.584	-0.057	-0.097	-0.015	0.789
					(0.054)***	(0.026)**	(0.034)**	(0.020)	(0.026)***
Cooking Oil						-0.494	-0.119	0.132	0.989
						(0.060)***	(0.031)***	(0.045)**	(0.022)***
Meat							-1.434	0.002	1.007
							(0.077)***	(0.019)	(0.038)***
Other Food								-1.006	1.127
								(0.014)***	(0.017)***

Table III. ***Estimated Compensated (Hicksian) Own Price and Cross Price Elasticities***

	Wheat	Rice	Fruits	Vegetables	Milk	Cooking Oil	Meat	Other Food
Wheat	-0.392	-0.100	-0.037	0.016	0.004	-0.054	0.224	0.325
	(0.053)***	(0.016)***	(0.015)**	(0.018)	(0.033)	(0.024)**	(0.029)***	(0.017)***
Rice		-1.690	0.670	0.432	0.397	-0.045	0.786	0.476
		(0.102)***	(0.065)***	(0.082)***	(0.133)**	(0.103)	(0.124)***	(0.068)***
Fruits			-0.473	0.166	0.141	0.195	0.461	-0.252
			(0.058)***	(0.051)***	(0.081)**	(0.067)**	(0.045)***	(0.040)***
Vegetables				-0.532	0.018	0.001	0.141	0.168
				(0.029)***	(0.034)	(0.026)	(0.032)***	(0.017)***
Milk					-0.407	0.057	0.009	0.221
					(0.053)***	(0.026)**	(0.034)	(0.021)***
Cooking Oil						-0.431	0.233	0.103
						(0.060)***	(0.045)***	(0.032)***
Meat							-1.342	0.187
							(0.077)***	(0.019)***
Other Food								-0.757
								(0.015)***

*, ** and *** indicate significance at 90, 95 and 99 percent level, respectively.

CONCLUSION

The paper estimates own and cross price compensated and uncompensated elasticities and expenditure elasticities using LA-AIDS model. Socio-economic and demographic factors were included in the estimated LA-AIDS model. Estimation uses Household Integrated Economic Survey conducted in 2004-05. Hence, a number of socio-economic characteristics were controlled while elasticities were derived. All the estimated models were statistically significant. The demand for wheat, fruits, vegetables, milk and cooking oil were inelastic while elastic for rice, meat and other food. All the commodities were normal while rice, fruits, meat and other food products were found to be expenditure elastic as compared to wheat, vegetables, milk and cooking oil. Hicksian own and cross price elasticities were in the same ball park as the Marshallian elasticities.

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