Bangladesh J. Agric. Econ. XV, 1 (June 1992) 83-94

Research Note

TEST OF HOMOGENEITY CONDITION IN THE DEMAND FOR SELECTED FOOD ITEMS IN BANGLADESH

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I. INTRODUCTION

The maximization of a utility function subject to a budget constraint implies a number of restrictions on the parameters of a demand function. The three basic restrictions are the homogeneity restriction, symmetry restriction and aggregation or adding-up restriction. Another related and rather fundamental restriction is the negativity restriction which requires that the own-price substitution effect is negative. For a normal good,the total effect of a price change has to be negative. This is the basic law of demand which says that quantity demanded of a commodity varies inversely with the price level.

Demand equations are estimated using two distinct approaches: single equation estimation dealing with a particular commodity or commodity group (s) and simultaneous estimation of complete systems containing demand equations of the exhaustive sets of commodities. The complete system approach has obviously a sounder theoretical base. According to the Neoclassical theory of consumer behaviour the utility maximising consumer's demand for a commodity depends on the price of all commodities available to him and the total income at his disposal. However, data limitations make it almost impossible to include all prices in the empirical demand equations. The explanatory variables are generally restricted to own price, the prices of a limited number of close substitutes and/or complements and an income variable.

These limitations lead to specification of demand equations in a relatively *ad hoc* manner without having much regard to any well defined

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utility function. Such specification reduces the implications of the underlying theory of consumer behaviour and hence the relevance of the restrictions mentioned above.

The *ad hoc* specification of the demand function does not altogether rule out the possibility of imposition of restrictions as restrictions can separately be imposed in the parameters. However, of the three general restrictions mentioned above, symmetry and aggregation are the cross-equation restrictions which require estimation of the complete system of equations before they can be tested. For single equation estimation, the only restriction that can be made use of is the homogeneity restriction (Thomas 1987, P. 48).

This paper makes a modest attempt to test the homogeneity restriction in respect of demand for selected food items in Bangladesh from an *ad hoc* specification of the demand model, making use of the nationwide Household Expenditure Survey data of 1981-82. Section II outlines the theory and the model for estimation of the parameters. Some results are presented in section III and the final section contains some concluding remarks.

II. THE THEORY, MODEL AND DATA

The homogeneity condition states that the demand function is homogeneous of degree zero in prices and income. This condition holds when the sum of all own and cross-price elasticities of a particular commodity becomes equal to minus its income elasticity (Phlips 1974,P.35). This implies that people do not suffer from money illusion in making purchase of the commodity. In order for the homogeneity condition to be operational, it has to be expressed as a restriction on the derivatives of the demand function.

Euler's theorem states that if a function $z = z(x,y)$ is homogeneous of degree π ,then

$$x.\delta z/\delta x + y.\delta z/\delta y = \pi z \qquad \ldots\ \ldots\ \ldots\ (1)$$

Thus given that the demand function is $q_1 = f(P_1, P_2, P_3, Y)$, application of the theorem gives

$$p_1.\delta q_1/\delta p_1 + p_2.\delta q_1/\delta p_2 + p_3.\delta q_1/\delta p_3 + y.\delta q_1/\delta y = 0 \ldots \ldots \ldots \quad (2)$$

A more generalized form of the restriction can be expressed as

$$\Sigma j\ p_j.\delta q_i/\delta p_j = y.\delta q_i/\delta y = 0 \quad \ldots \ldots \ldots (3)$$

$(i, j = 1 \ldots \ldots \ldots \ldots \ldots n)$

In terms of elasticities, the restriction becomes:

$$\Sigma j\ p_j/q_i.\delta q_i/\delta p_j = -y/q_i.\delta q_i/\delta y \quad \ldots \ldots \ldots (4)$$

A test for validity of the restriction requires estimation of the relevant parameters from a properly specified demand function. As has been mentioned, demand for a particular commodity is typically explained by its own price and prices of related goods. Besides, some demographic and sociocultural factors also exert considerable influence on the demand for a commodity. Having taken the possible relevant factors into account, the general demand model for the selected food items was specified as follows:

$$Q_i = f(p_i, p_j, Y, Y^2, H, \pi) \ldots \ldots \ldots \ldots \quad (5)$$

where ,

Q_i = per capita quantity of the ith food item consumed during a given time period,

p_i = price per unit of the ith food. ,

p_j = price per unit of the jth food,

Y = per capita income during a given time period,

Y^2 = square term of per capita income,

H = size of the household,

π = composition (proportion of adult members) of the household.

Six food items - rice, wheat , potato, pulses, fish and edible oil -were selected for analysis. These six items accounted for 90 per cent of total expenditure on all foods. In addition, estimates were also obtained for foodgrain where foodgrain quantity represented the quantities of rice and wheat and foodgrain price was the weighted average of rice and wheat prices.

A number of alternative functional forms were tried and double log was found to be the most preferred one[1]. The empirical model finally chosen was as follows:

$$
\begin{aligned}
LnQ &= \alpha + \beta LnPo + \delta_1 LnXP_1 + \delta_2 LnXP_2 + \delta_3 LnXP_3 \\
&+ \delta_4 LnXP_4 + \delta_5 LnXP_5 + \delta_6 LnXP_6 + \Theta LnY \\
&+ \phi (LnY)^2 + \varepsilon LnH + \sigma Ln\pi \;\ldots\ldots\ldots\ldots\ldots \quad (6)
\end{aligned}
$$

where Po represented the own-price of the food items. The cross-price terms were expressed as XP such that XP_1, XP_2, XP_3, XP_4, XP_5 and XP_6 represented price per kilogram of rice, wheat, potato, pulses, fish and edible oil respectively. The Ln referred to the natural log of the variables, and α, β, δ, Θ, ϕ, ε and σ were the parameters to be estimated.

The data used for the study were obtained from the nationwide Household Expenditure Survey, 1981-82 conducted by the Bangladesh Bureau of Statistics (BBS). The data obtained from the BBS were in semi processed form and represented information pertaining to selected food consumption of the average of households in each district separately for six income classes each in rural and urban locations[2].

Since a sample observation represented the average of households in a district in each of the six income classes, and since the actual number of households corresponding to each observation were not the same, all regressions were weighted by the square root of the number of households corresponding to each observation in each category of households, as a partial measure against heteroscedasticity (see Talukder 1990 for details).

III. TEST OF HOMOGENEITY CONDITION

The empirical estimates of the food demand model for rural, urban and all households in Bangladesh are presented in Appendix Tables A-I, A-2 and A-3 respectively. In the estimation for pooled rural-urban samples, urban dummy (U) to reflect change in the intercept was used. Since the estimates are from double-log model, the coefficients can be directly read as the elasticity values. However, since the income variable had its quadratic term, income elasticity was obtained as $\eta_y = \Theta + 2\phi LnY$ following equation 6.

As is evident from the Appendix Tables, all own-price coefficients, except for pulses in the urban samples, had their expected sign and most of them were statistically significant. The income elasticities of all food items were positive except that of wheat for which income elasticity was negative for rural, urban and all households in Bangladesh. Although the sign and magnitude of the individual elasticity values are of crucial importance in a demand analysis, our interest here is not in the values of the individual coefficients, but in their net interaction effects to meet the homogeneity condition.

The relevant own-price, cross-price and income coefficients of Tables A-1, A-2 and A-3 have been summarized and presented in Table 1. It appears that for the major staple item rice, the homogeneity condition approximately holds when estimates are derived for all households in Bangladesh. For wheat, the homogeneity condition holds only for rural households. For other food items, the condition holds neither for rural nor for urban and hence for all households in Bangladesh.

A closer look at Table 1 would reveal that although for the major staple rice the homogeneity condition approximately holds for all households, the sum of the elasticity values differ markedly between rural and urban households. Given the values of the own- price and income elasticities, the sign and magnitude of the sum of elasticities of rice would have been almost similar for the two classes of households in absence of the influence of the cross-price terms. As would be evident from Table1 and also from Tables A-1, A-2 and A-3, the net impact of prices of related goods on the demand for rice was higher for urban than for rural households. Consequently, sum of the elasticities for rice differed markedly between rural and urban households. In the aggregate, the negative sum for rural households were almost offset by the positive sum for urban households resulting in approximately zero sum of own, cross-price and income elasticities of demand for rice for all households in Bangladesh.

Table 1. Test of Homogeneity Condition of Food Demand Parameters in Bangladesh.

Food items	Own-price elasticity η_i	Cross-price elasticities $\Sigma\eta_{ij}$	Income elasticity η_y	Sum of the elasticities $\eta_i+\Sigma\eta_{ij}+\eta_y$
		Rural Households		
Foodgrain	-0.550	-0.040	0.410	0.189
Rice	-0.796	0.041	0.620	-0.135
Wheat	-0.389	1.990	-1.597	0.004
Potatoes	-1.243	-0.885	1.451	-0.677
Pulses	-1.118	0.590	1.522	0.994
Fish	-0.686	0.352	1.346	1.012
Oil	-0.735	0.214	1.039	0.518
		Urban Households		
Foodgrain	-0.522	-0.050	0.245	0.327
Rice	-0.413	0.343	0.318	0.248
Wheat	-1.716	-1.690	-0.349	-3.755
Potatoes	-1.628	0.081	0.809	-0.738
Pulses	0.427	-	1.257	1.684
Fish	-0.738	0.377	1.098	0.737
Oil	-1.162	0.048	0.793	-0.321
		All Households		
Foodgrain	-0.564	0.028	0.353	-0.183
Rice	-0.735	0.160	0.508	-0.067
Wheat	-0.885	1.527	-1.165	-0.523
Potatoes	-1.266	-0.774	1.229	-0.811
Pulses	-1.038	0.571	1.445	0.978
Fish	-0.698	0.308	1.216	0.826
Oil	-0.876	0.225	0.940	0.289

Note: The estimates presented in this table in respect of rural, urban and all households are based on information available in Tables A-1, A-2 and A-3 respectively.

IV. CONCLUSIONS

The results obtained from the study indicate that the homogeneity condition does not hold in the demand for majority of the selected food items considered here, This is not very unexpected in the single equation estimation, and estimation with many sophisticated models also rejected the homogeneity restriction (Barten 1969, Byron 1970, Deaton 1974, Deaton and Muellbauer 1980). However, for the major staple rice, the condition approximately holds for all households and for wheat, it holds for the rural households. Thus to the extent that people take their purchase decision on the basis of change in their real income, it can be concluded that the average people of Bangladesh do not suffer from money illusion in making purchase of the staple food.

Notes

1. The details of the specification of the model and choice of the functional form can be seen in Talukder 1990.

2. There were 67 district locations separately in the rural and urban category. Thus assuming that each rural and urban location of 67 districts represented a unit of observation in each of the six income calsses, the total number of observations comprising all locations and all income classes would be obtained at 67 x 2 x 6 = 804. However, some of the observations did not fall in certain income groups and also most of the information corresponding to some observations were missing. Having accounted for these factors, total number of observations were reduced to 661 households. Again, a series of regression diagnostics with these samples (see Talukder 1990 for details) revealed that some of the observations were'outliers' and therefore were dropped from the data sets. Finally, the total number of observations comprising all locations and all income classes were obtained at 652 representative households of which 380 were rural and 272 were urban.

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Table A-1. Coefficient Estimates of the Food Demand Models (Double-log), Rural Households: N = 380.

Variables	Equations: Per capita calories from food						
	Food-grain	Rice	Wheat	Potato	Pulses	Fish	Oil
Constant	-3.813	-8.394	-0.639*	-21.564	-27.378	-19.531	-7.861
	(-4.010)	(7.735)	(-0.081)	(-3.730)	(-4.448)	(-6.199)	(-2.709)
$\ln\pi$	0.320	0.092*	1.234	-0.249	-0.113*	-0.006*	-0.035*
	(3.929)	(1.002)	(1.859)	(-0.506)	(-0.214)	(-0.024)	(-0.142)
$\ln P_o$	-0.550	-0.796	-0.389*	-1.243	-1.118	-0.686	-0.735
	(-6.196)	(-8.701)	(-0.867)	(-12.688)	(-7.345)	(-8.352)	(-5.403)
$\ln XP_1$			3.581	-1.094		0.484	
			(5.356)	(-2.283)		(1.853)	
$\ln XP_2$		-0.034*					
		(-0.561)					
$\ln XP_3$					0.274	-0.132	0.153
					(2.574)	(-2.484)	(3.076)
$\ln XP_4$	-0.005*		-0.319				
	(-0.221)		(-1.671)				
$\ln XP_5$				0.209*	0.316		0.061*
				(1.288)	(1.946(		(0.801)
$\ln XP_6$	-0.035*	0.075*	-1.272				
	(-0.807)	(1.501)	(-3.514)				
$\ln Y$	2.476	4.055	1.551*	7.912	8.790	6.672	2.184
	(6.755)	(9.868)	(0.520)	(3.690)	(3.690)	(5.571)	(1.998)
$\ln^2 Y$	-0.203	-0.336	-0.308*	-0.632	-0.711	-0.521	-0.112*
	(-5.807)	(-8.546)	(-1.080)	(-3.004)	(-3.120)	(-4.549)	(-1.043)
$\ln H$	0.130	0.069	0.442	-0.159*	0.325	-0.212	-0.225
	(6.341)	(2.998)	(2.651)	(-1.250)	(2.378)	(-3.059)	(-3.490)
R^2	0.680	0.754	0.252	0.398	0.494	0.495	0.491
$\bar{R}^2$	0.674	0.750	0.236	0.387	0.485	0.485	0.482
F	113.30	163.62	15.64	35.19	52.07	52.18	51.44

Note: Figures in the parentheses are t-values
*The coefficients were not significant at 0.05 level.

Table A-2. Coefficient Estimates of the Food Demand Models (Double-log), Urban Households: N = 272.

Variables	Equations: Per capita calories from food						
	Food-grain	Rice	Wheat	Potato	Pulses	Fish	Oil
Constant	-0.747	-4.288	18.886	-7.913	-21.781	-13.112	-6.674
	(-0.749)	(-3.626)	(2.748)	(-1.776)	(-4.909)	(-4.727)	(-2.538)
$\ln\pi$	0.322	0.288	0.459*	-0.027*	0.445*	-0.645	0.025*
	(3.779)	(2.794)	(-0.779)	(-0.068)	(1.136)	(-2.602)	(0.111)
$\ln P_o$	-0.522	-0.413	-1.716	-1.628	0.427*	-0.738	-1.162
	(-4.712)	(-2.958)	(-3.904)	(7-.276)	(1.110)	(-6.534)	(-9.539)
$\ln XP_1$			1.480	-0.608*		0.148*	
			(1.832)	(-1.128)		(0.443)	
$\ln XP_2$		0.112*					
		(1.473)					
$\ln XP_3$						0.229*	-0.237
						(1.648)	(-1.843)
$\ln XP_4$	-0.177		-1.875				
	(-2.024)		(-3.165)				
$\ln XP_5$				0.689			0.285
				(3.801)			(2.730)
$\ln XP_6$	0.127	0.231	-1.295				
	(2.771)	(4.229)	(-4.122)				
$\ln Y$	1.343	2.105	-3.137*	2.564*	5.896	4.144	2.365
	(3.855)	(5.042)	(-1.315)	(1.589)	(3.727)	(4.122)	(2.534)
$\ln^2 Y$	-0.102	-0.166	0.259*	-0.163*	-0.431	-0.283	-0.146
	(-3.270)	(-4.424)	(1.202)	(-1.117)	(-3.014)	(-3.116)	(-1.730)
$\ln H$	0.051	0.052	-0.079*	-0.042*	0.074*	-0.026*	-0.035*
	(2.645)	(2.247)	(-0.587)	(-0.462)	(0.842)	(-0.455)	(-0.680)
R^2	0.397	0.432	0.162	0.368	0.463	0.541	0.614
$\bar{R}^2$	0.381	0.417	0.136	0.351	0.453	0.528	0.604
F	24.83	28.670	6.37	21.98	45.89	44.45	60.06

Note : Figures in the parentheses are t-values
*The coefficients were not significant at 0.05 level.

Table A-3. Coefficient Estimates of the Food Demand Models (Double-log), All Households: N = 652.

Variables	Equations: Per capita calories from food						
	Food-grain	Rice	Wheat	Potato	Pulses	Fish	Oil
Constant	-3.706	-7.590	13.384	-17.219	24.748	-16.475	-8.337
	(-6.053)	-(10.589)	(2.737)	(-4.944)	(-6.806)	(-8.408)	(-4.625)
$\ln\pi$	0.296	0.155	0.923	0.159	0.057	-0.169	0.101
	(4.900)	(2.272)	(1.942)	(-0.461)	(0.159)	(-0.884)	(0.060)
$\ln P_o$	-0.564	-0.735	-0.885	-1.266	-1.038	-0.698	-0.876
	(-8.150)	(-9.742)	(-2.665)	(-15.814)	(-8.350)	(-10.756)	(-9.110)
$\ln XP_1$			3.224	-1.071		0.425	
			(6.195)	(-2.963)		(2.091)	
$\ln XP_2$		0.012*					
		(0.261)					
$\ln XP_3$					0.284	-0.117	0.124
					(3.314)	(-2.596)	(2.956)
$\ln XP_4$	-0.008*		-0.347				
	(-0.407)		(-2.114)				
$\ln XP_5$				0.297	0.287		0.101
				(3.314)	(2.342)		(1.670)
$\ln XP_6$	0.036*	0.148	-1.350				
	(1.105)	(3.936)	(-5.259)				
$\ln Y$	2.369	3.622	-3.578	6.203	7.745	5.490	2.549
	(10.240)	(13.684)	(-1.974)	(4.789)	(5.592)	(7.535)	(3.749)
$\ln^2 Y$	-0.193	-2.298	0.231*	-0.476	-0.603	-0.409	-0.154
	(-8.956)	(-12.011)	(1.361)	(-3.930)	(-4.633)	(-6.004)	(-2.417)
$\ln H$	0.110	0.075	0.184*	-0.098*	0.214	-0.146	-0.150
	(7.594)	(4.502)	(1.615)	(-1.181)	(2.415)	(-3.107)	(-3.428)
R^2	0.616	0.694	0.218	0.385	0.538	0.501	0.638
$\bar{R}^2$	0.612	0.690	0.207	0.378	0.532	0.485	0.634
F	129.35	182.58	19.90	50.46	93.592	80.83	142.00

Note: Figures in the parentheses are t-values
*The coefficients were not significant at 0.05 level.