Demand for Major Food Items in India: An Application of QUAIDS Model

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Abstract

The estimation of the demand parameters of different food items is a complex problem in demand analysis. Typically, the analyst is interested in understanding the role of different variables like price, income and other random factors in determining the consumption basket of important food items. The popular approaches to the estimation of demand equation parameters are Linear Expenditure System (LES) developed by Stone (1954), the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980) and the combination of these two systems into a Generalized Almost Ideal Demand System (GAIDS) proposed by Ballino (1990). The present paper in this context applies the Quadratic Almost Ideal System (QUAIS) technique to the food demand system. QUAIDS model is an extended form of AIDS model, where the assumption of linearity in the expenditure function is given away. The QUAIDS Model is applied to the food items like cereals, pulses, milk, sugar, food oil, meat & chicken and vegetables. The compensated and uncompensated demand elasticities of these food items are derived. The present study found that, the square term of per capita food expenditure were found to statistically significant in all most all food items except pulses in rural area and pulses and food oil in urban area of India. The rural people are more affected by the change in the price of different food items than urban people.

Key Words

Demand Parameters, Quadratic Almost Ideal Demand System, Food Items, Consumption, India.

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1. Introduction

The basic objective of the theory of consumer behaviour is to explain how a rational consumer makes decision on – what and how much to consume, when confronted with various prices and a limited budget. However, the estimation of the demand parameters of different food items is a complex problem in demand analysis. Typically, the analyst is interested in understanding the role of different variables like price, income and other random factors in determining the consumption basket of important food items. There are several model developed for deriving the demand parameters.

The approach to estimate the parameters by single equation demand function which estimates income and price elasticities for a commodity in a constant elasticity demand equation. The use of relative prices and real income in the equation as exogenous variable makes the demand equations homogeneous of degree zero in prices and income. This approach is simple but has serious drawbacks (Sadoulet and Janvry 1995). The estimated parameters, in general, do not satisfy the requirements of demand theory, particularly the budget constraint.

Among the alternative popular approaches to the estimation of demand parameters are Linear Expenditure System (LES) developed by Stone (1954), the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980) and the combination of these two systems into a Generalized Almost Ideal Demand System (GAIDS) proposed by Ballino (1990). Other complete demand systems found in the literature but not widely used are the Rotterdam model of Theil (1976) and Barten (1969) and the translog model of Christensen, Jorgenson and Lau (1975). Each approach has certain drawbacks like, the LES model is better applied to large categories of expenditure than to individual commodities, since it does not allow for inferior goods and implies that all goods are gross complements. The econometric problem with the AIDS model is that the demand equations appear to be unrelated, since none of the endogenous quantities or budget share appear on the right-hand side of the equations. Muellbauer and Pashardes (1992) point out that most studies of demand systems use static models, which do not account for hypothesis of symmetry and homogeneity, derived from consumer theory. Thus, there is a need for a dynamic demand system which gives more realistic and econometrically viable results.

A proper estimation of the elasticities and projected direction of change is as important instrument that guides the future policy decisions. Thus, the techniques used in estimating these elasticities have to be based on a functional form that is based on realistic assumptions. The present paper in this context applies the Quadratic Almost

Ideal System Technique to the food demand system. Demand elasticity computed in this complete system explains the level of demand for the commodities by an individual given the structure of relative prices, real incomes and a set of individual characteristics such as age, type of household (expenditure groups) and geographical environment (rural or urban).

QUAIDS model is an extended form of AIDS model, where the assumption of linearity in the expenditure function is given away. The model is quadratic in per capita expenditure under the assumption that there is a non-linear relationship between income and expenditure. Several demand studies have confirmed the appropriateness of QUAIDS in modeling preferences. Abdulai (2002) applied QUAIDS to the food expenditure data from Switzerland, Moro and Sckokai (2000) to Italian food expenditure data, Banks et al. (1997) and Blundell and Robin (1999) used expenditure data on broad consumption goods from the U.K., and Fisher et al. (2001) applied the model to the U.S. aggregate consumption data, Abdulai and Aubert (2004) on Tanzanian food expenditure data, Meenkashi and Ray (1999) using Indian food expenditure data, Gould and Villarreal (2006) using food expenditure data from urban China, and Molina and Gil (2005) using aggregate consumption data from Peru.

2. Importance of the Study

The knowledge about the demand structure and consumer behaviour is essential for designing the development policies relating to improvement in nutritional status, food subsidy, sectoral and macroeconomic policy analysis. An analysis of food consumption patterns and how they are likely to shift due to change in income and relative price in particular help in assessing the food security-related policy issues in the agricultural sector.

India is one of the most developing economies of the world. The demand for food in India has increasing rapidly because of population growth, rising incomes, and various changes in the structure of population, particularly urbanization. The problem is not simply one of providing adequate supplies for the country as a whole. Especially when the government has mainly concentrated on meeting the food-grain deficit, many people, in urban areas in particular, have been facing acute shortages of milk and milk products, vegetables, fruits, meat, fish, and eggs.

3. Review of literature:

Gupta Anil (1986) had examined the aggregated consumption behavior and trend in consumer expenditure using CSO (Central Statistics Organization) estimates of Private Final Consumption Expenditure (PFCE) for the time period of 1950-51 to 1978-80 in his

The parameters of the quadratic demand system of the food group cereals, pulses, vegetables and fruits, milk, edible oil, sugar and meat, fish and eggs are estimated in the second stage. The squared terms of per capita expenditure on food are significant only for pulses and edible oil. If the parameters are insignificant then it means that the expenditure elasticities are more or less constant across the income groups. Urbanization has a negative effect on cereals, pulses and sugar consumption. The consumption of vegetables and fruits, milk and edible oil increase with urbanization. The coefficient of own price is positive and highly significant for the share of food groups. Even when price rise the households maintain the share of expenditure on the staple food in their basket.

The expenditure elasticity of food items is lower in the urban households as compared to the rural households. Urban households have higher expenditure budget as compared to the rural households. Similar pattern is also observed between different expenditure group households – poor households have higher expenditure elasticity than the rich households. The all India expenditure elasticity for cereals is low but positive. It is nearly zero for urban households while for rural households it is around 0.2.

Amita Majumdar (1980) had made the attempt to compare the performance of the Linear Expenditure System (LES) with that of Almost Ideal Demand System (AIDS) on Indian consumer expenditure data for the rural and the urban sectors separately in her paper entitled "Consumer Expenditure Pattern in India: A Comparison of the Almost Ideal Demand System and the Linear Expenditure System" This analysis thus covers the period from October 1953 – March 1954 (NSS 7^{th} round) to October 1973 – June 1974 (NSS 28^{th} round). The nine groups of items for which expenditure pattern is analysed are; (i) cereals and cereal substitute (ii) milk and milk products, (iii) edible oils, (iv) meat, fish and egg, (v) sugar etc. (vi) other food items (i.e. spices, salt, beverage, prepared food etc. (vii) clothing, (viii) fuel and light, and finally (ix) other non food items.

The analysis has been carried out at two levels of aggregation, viz., one with the item wise estimates of average per capita expenditure for all households in each round and another at a somewhat disaggregated level in which for each round estimates of average per capita expenditure for three ordinal groups of population, namely 30 per cent, the middle 40 per cent and the richest 30 per cent have been used. The comparison of the AIDS and LES has been made with particular reference to the income and price elasticities estimated from the two models. In the view of fact that the LES based estimates of the price elasticities are restricted due to the additivity of the direct utility function, the comparison with AIDS would bring out the qualities of the LES based elasticity estimates.

4. Objective

The major objective of this research study is to apply the QUAIDS model to derive the demand parameters of major food items like cereals, pulses, milk, sugar, food oil, meat and chicken and vegetables in India. Furthermore, the demand parameters which are derived from the QUAIDS model has used for calculation of the own price elasticities and cross elasticities of various food items.

5. Data

The study utilizes the secondary data for evaluating and analyzing the specific objective of the study. Data on Monthly Per Capita Expenditure (MPCE) has been collected from various round of National Sample Survey Organization (NSSO) published by GOI. The data on physical quantities on selected food items were available only from 50th round (1993-94) onwards. In the present study the data on Monthly Per Capita Consumption of various food items in monetary term and physical term had collected from 55th (1999-2000), 61st (2004-05) and 66th (2009-10) rounds. The data on various food item prices were calculated by dividing the value in monetary term of monthly per capita consumption by the value in the physical term.

6. Methodology

The present study is descriptive in nature. In this study the quadratic extension to Deaton and Muellbauer's (1980) Almost Ideal Demand model (QUAIDS) for food demand system is used. This model is quite popular and was adopted by Meenakshi and Ray (1999) for India food model, Dey (2000) for fish demand model of Bangladesh and Kumar (2004) for fish demand model in India. The specific functional form for ith item/groups is as follows;

$$S_i = a_i + \Sigma b_{ij} Ln(FP_i) + c_{oi} Ln(M/I) + c_1 i(LnM/I)^2 + d_t\ URBAN + \Sigma e_{ik} IMR_k \quad .....(1)$$

Where Fpi is the price of ith item/groups; M is per capita food consumption Expenditure, I is the Stone Geometric Price Index; *URBAN* is a binary dummy variable for urban areas. The parameters of the model (a_i, *bij, ci, di and eik*) are to estimated by imposing the homogeneity (degree zero in prices), symmetry (cross price effects are the same across the good), and adding up (all the budget shares add up to one) restrictions.

The following restrictions were econometrically imposed.

Homogeneity: .... *(i)*

Symmetry: $b_{ij} = b_{ji},\ c_{11}/c_{10} = c_{21}/c_{20} = \ldots \ldots cn_1/cn_0$ .... *(ii)*

Adding up: $\Sigma ai = 1, \quad = \quad = \quad = 0$ .... *(iii)*

The homogeneity and symmetric restrictions are imposed at the sample mean. Adding up restriction is imposed while computing the parameters of the last equation of the model, which is not included in estimation. Given the quadratic specification of the

The demand parameters of major food items in rural area which derived by using Non Linear ITSUR Model (AIDS Model) are given in the above table. The square term of per capita food expenditure had significant coefficient with all food items excepting the pulses which implies that the non linear relationship exist for these food items. The coefficient of own price has been found to be negative for cereal, pulses, milk, meat & chicken and vegetables. On the other hand it is positive for sugar and food oil. However these associations were significant only for the milk, food oil and meat & chicken. The time trend is significant for the food items like milk, sugar and meat & chicken. The coefficients of time trend is negative and significant for milk and sugar which implies that over a period of time the budget share on these items had fallen.

Table 2: Demand Parameters Derived by Using NON LINEAR ITSUR Method (Urban)

Group	Cereal	Pulses	Milk	Sugar	Food Oil	Meat & Chicken	Vegetables
Intercept	1.68***	0.33***	0.070	0.103*	0.412***	-1.278***	-0.32^{A}
Food Price (Rs./Kg.) in Logarithmic Form							
Cereal	0.053	-0.070	-0.089	-0.036	-0.083	0.223	0.002 ^{H}
Pulses	-0.070***	0.030**	0.00012	0.003	-0.020	0.038	0.022 ^{H}
Milk	-0.089	0.00012	0.083	0.035***	-0.046	-0.046	-0.029 ^{H}
Sugar	-0.036***	0.003	0.035***	0.021***	-0.012	-0.012	0.003 ^{H}
Food Oil	-0.083***	-0.020**	0.046**	-0.0136***	0.0063	0.054	0.011 ^{H}
Meat & Chicken	0.223***	0.038*	-0.046	-0.012	0.054**	-0.208**	-0.050 ^{H}
Vegetables	0.002	0.022**	-0.029	0.003	0.011	-0.050**	0.039 ^{H}
Ln (Per Capita Food Exp.)	-0.099**	-0.018	0.190***	0.031**	-0.0303*	-0.078	0.0043 ^{H}
Ln (Per Capita Food Exp. Square)	-0.063**	-0.011	-0.09**	-0.021***	-0.012	0.156***	0.041 ^{H}
Time Trend	0.0001	-0.00009	-0.00001	0.000002	0.0002*	-0.0004	0.0002^{H}
R square	0.59	0.10	0.23	0.37	0.27	0.27	

*Note: *** 0.01 Significance level, ** 0.05 Significance Level and * 0.10 Significance Level,*
'A' indicates that the Intercept had calculated by imposing Adding-up restriction,
'H' indicates that the parameters had calculated by imposing homogeneity restriction

The demand parameters which are derived by using Non Linear ITSUR Method (AIDS Model) are given in the above table. The squared term of per capita food expenditure has been found to be significant for cereal, milk, sugar and meat & chicken. The coefficient of own price is positive for all the food items excepting meat & chicken. These coefficients were significant for pulses, sugar and meat & chicken.

Table 3: Demand Parameters Derived by ITSUR (Full Non-Linear) Model (All India)

Group	Cereal	Pulses	Milk	Sugar	Food Oil	Meat & Chicken	Vegetables
Intercept	1.87***	0.230***	-0.699**	-0.081**	0.243***	-0.489***	-0.104 A
Food Price (Rs./Kg.) in Logarithmic Form							
Cereal	0.0167	-0.039***	0.0134	0.0012	-0.047***	0.0974***	-0.0432 H
Pulses	-0.039***	0.0070	0.0196	0.004	-0.0159***	0.0178**	0.0062 H
Milk	0.0134	0.0196	-0.052	0.0056	0.0500***	-0.0172	-0.0189 H
Sugar	0.0012	0.004	0.0056	0.0172***	-0.0064**	-0.0204***	-0.0013 H
Food Oil	-0.047***	-0.0159***	0.0500***	-0.0064**	0.0178***	0.0022	-0.0007 H
Meat & Chicken	0.0974***	0.0178**	-0.0172	-0.0204***	0.0022	-0.098***	0.018 H
Vegetables	-0.0432***	0.0062	-0.0189	-0.0013	-0.0007	0.018**	0.040 H
Ln (Per Capita Food Exp.)	-0.072	0.0002	0.250***	0.0571***	0.020*	-0.139***	-0.1163 H
Ln (Per Capita Food Exp. Square)	-0.112***	-0.0133*	-0.042*	-0.0171***	-0.0261***	0.116***	0.0945 H
Area	0.0544***	-0.0027	-0.120***	-0.010*	0.020***	0.0333	0.025H
Time Trend	0.0002	0.00007	-0.0008**	-0.00007	0.00031***	0.000014	0.0003H
R square	0.70	0.09	0.36	0.41	0.32	0.30	

*Note: *** 0.01 Significance level, ** 0.05 Significance Level and * 0.10 Significance Level,*
'A' indicates that the Intercept had calculated by imposing Adding-up restriction,
'H' indicates that the parameters had calculated by imposing homogeneity restriction

On the basis of above table we can say that, the demand parameters derived by using Non Linear ITSUR model (AIDS Model) is better for all the food items because the squared term of per capita food is significant for all the food items. The coefficients of urban dummy were found to be significant for cereal, milk and food oil. Over a period of time the budget share on milk and food oil has been significantly affected. The coefficients of time trend were negative for milk and positive for food oil. The own price coefficients were found to be significant for food oil, sugar and meat & chicken.

The demand parameters derived by using the Non Linear ITSUR Model (AIDS Model) were used for the calculation of own price elasticities and cross elasticities of demand for various food items. These elasticities were calculated by using Slutsky and Hicksian equations. The own and cross elasticities were calculated for different expenditure classes and for rural and urban areas and for all India level. The results of own and cross elasticities of demand for major food items are presented in following tables.

Only for milk demand the compensated and uncompensated own price elasticiteis are same for rural area. So we can say that rural people do not change the demand for milk when they are trying to maximize the utility under the condition of budget constraint or open budget.

8. Conclusion

On the basis of empirical findings it was found that, the square term of per capita food expenditure were found to statistically significant in all most all food items excepting pulses in rural area and pulses and food oil in urban area of India. The consumption pattern of pulses is not found to be linear or non-linear. Therefore other mathematical models may be applicable. However in the case of food oil, the linear model is better than the non-linear model because the single per capita term is found to be significant at 0.01% confidence level. In the rural area, the own price effects of different food items were found to be negative for cereals, pulses, milk and meat & chicken and this effect is positive for sugar and food oil. So we can say that in the consumption basket of these food items, the rural people are negatively affected by the change in the price of cereals, pulses, milk and meat & chicken. However, own price coefficients were significant only for milk and meat and chicken and these coefficients are higher than other. On the other hand, in the urban area, the own price effect of different food items were positive for all items excepting meat & chicken. These effects are significant for pulses, sugar and meat & chicken. The positive coefficients of own price in urban area implies that the urban people are maintained the budget share on the consumption of these food items even when the price is changed.

The time effect is found to be significant for milk, sugar and meat & chicken in the rural areas. This effect is negative for milk and sugar, which indicate that over a period of time the budget share on these items has decreased. However this effect is positive for meat & chicken, so we can say that the budget share on meat & chicken has increased over period of time. In the case of the urban area, the time effect is found to significant for food oil and this effect is positive. The urban people are less sensitive to prices of the food items like cereals, pulses, milk, sugar and vegetable than rural area because the own price elasticities of these food items are found to be less in the urban area than rural area. However in the consumption of food oil and meat & chicken, the sensitiveness is found to be less in the rural area than the urban area. In short, we can say that the rural people are more affected by the change in the price of different food items. When we compared our results with earlier study, the square term of per capita expenditure is found to be not statistically significant for pulses and urbanization had positive impact on cereal consumption in our study, this result is contradicting with the results obtained by Mittal Surabhi (2010).

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Appendix 1:
Uncompensated and Compensated Elasticity of Demand-Rural Area (2010)

	Uncompensated								Compensated						
Items	**C**	**P**	**M**	**S**	**O**	**NV**	**V**		**C**	**P**	**M**	**S**	**O**	**NV**	**V**
C	-0.91	0.12	0.85	0.42	0.07	0.30	-0.27		-0.84	0.14	0.88	0.43	0.09	0.33	-0.22
P	-0.31	-1.02	0.44	0.01	-0.27	0.25	0.14		-0.12	-0.98	0.53	0.04	-0.22	0.34	0.26
M	1.29	-0.09	-4.04	-0.83	-0.02	0.43	3.40		1.29	-0.09	-4.04	-0.83	-0.02	0.43	3.40
S	1.85	-0.01	-1.63	-0.76	-0.15	-0.25	3.01		1.83	-0.02	-1.65	-0.77	-0.15	-0.26	3.00
O	-0.31	-0.22	0.55	-0.08	-0.71	-0.01	0.82		-0.31	-0.22	0.55	-0.08	-0.71	-0.01	0.82
NV	-0.10	0.19	0.62	0.04	0.02	-2.02	-1.78		0.51	0.33	0.90	0.12	0.18	-1.73	-1.37
V	-0.87	0.09	0.50	0.15	0.15	0.21	-1.03		-0.43	0.19	0.70	0.21	0.26	0.42	-0.74

C= Cereals, P= Pulses, M= Milk, S= Sugar, O= Food Oil, NV= Meat & Chicken, V= Vegetable

Appendix 2:
Uncompensated and Compensated Elasticity of Demand-Urban Area (2010)

	Uncompensated								Compensated						
Items	**C**	**P**	**M**	**S**	**O**	**NV**	**V**		**C**	**P**	**M**	**S**	**O**	**NV**	**V**
C	-0.51	-0.22	-0.28	-0.07	-0.28	1.30	0.20		-0.45	-0.21	-0.25	-0.06	-0.27	1.32	0.23
P	-1.29	-0.36	0.07	0.09	-0.35	0.82	0.51		-1.18	-0.34	0.13	0.10	-0.32	0.88	0.59
M	-0.68	-0.11	-0.24	0.18	-0.52	-0.44	-0.23		-0.78	-0.13	-0.30	0.16	-0.55	-0.49	-0.30
S	-1.07	0.16	1.45	-0.20	-0.39	-0.31	0.29		-1.17	0.13	1.39	-0.22	-0.42	-0.37	0.22
O	-1.34	-0.30	0.88	-0.20	-0.84	1.02	0.28		-1.23	-0.27	0.94	-0.18	-0.80	1.08	0.35
NV	1.58	0.29	-0.66	-0.11	0.41	-3.17	-0.78		2.33	0.48	-0.25	-0.01	0.63	-2.76	-0.26
V	0.13	0.19	-0.15	0.03	0.11	-0.31	-0.63		0.45	0.27	0.02	0.08	0.20	-0.14	-0.42

C= Cereals, P= Pulses, M= Milk, S= Sugar, O= Food Oil, NV= Meat & Chicken, V= Vegetable