Estimating Demand Elasticities for Aggregate Food Groups using QUAIDS and Pooled HIES Data

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Abstract

Over the time there have been many changes in world's as well as Pakistan's economy. Pakistan faces the pacing urbanization and despite being an agrarian country, it is a net importer of many agricultural products. There are many determinants of changing consumption patterns like income variation, price change, population change and urbanization. Prices especially have shown remarkable variation resulting in food inflation. The aim of this research is to estimate the demand elasticities of the selected food groups using a panel of four Household Integrated Economic Survey Data sets. Two stage budgeting framework has been adopted for estimating per capita food expenditures in Pakistan at the first stage over the analysis period. The second stage has utilized Quadratic Almost Ideal Demand System (QUAIDS) for the estimation of budget shares of each food group which is used further to calculate the elasticities. All the expenditure elasticities are almost equal to unity representing one to one relationship between the food groups' demand and expenditures on them with the changing income. All own price Marshallian elasticities are negatively signed as per expectations. The demand for all the taken food groups is inelastic with respect to price. All the selected food groups behave to be normal goods as the expenditures' elasticities for all is positive. Majority of the Hicksian cross price elasticities are positively signed representing food groups to be substitutes of each other. Hicksian elasticities just take price effect into account. Compensated own price elasticities for all of the selected food groups bear expected negative sign. As all the food groups, have proved to be inelastic with respect to the prices, government needs to carefully design its taxation and pricing policies so that the most vulnerable section of the society is not affected badly.

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Introduction

It is a reality that Pakistan is basically an agrarian country. This sector brings in a huge amount of foreign exchange for Pakistan. Despite being an agrarian country, it is a net importer of many agricultural products. Over the time there have been many changes in world's as well as Pakistan's economy. The consumption patterns are changing. There are many factors which have caused consumption patterns to change, but the most important is the growth in income. This growth in income has caused a shift in consumption to more expensive and exorbitant food commodities during the past few decades (Haq & Arshad, 2010).

There are many other determinants of changing consumption patterns like price change, population change and urbanization etc[1]. Prices especially have shown remarkable variation resulting in food inflation. Between November 2007 and February 2008, there was a 20% increase in wheat prices[2].

One-third people in Pakistan live below the food poverty line (USDA, 2009). Additional 22 million people can be pauperized during the coming four years if this trend of price surge continues and no action is taken by the government to replenish their purchasing power (BNU, 2008). In this situation, there are increased chances

[1] http://www.fao.org/docrep/005/ac911e/ac911e05.htm
[2] http://content.time.com/time/world/article/0,8599,1717596,00.html

of massive school dropouts, child malnutrition and mortality (UN, Inter Agency Mission Assessment 2008).

Apart from income and price effects, certain structural factors are very crucial in determining the consumption basket of households of a country. Huang and Bouis (2001) suggested broader range of food available, diet westernization, time constraint for urban women, lower caloric requirement and absence of high opportunity cost of selling own production for high priced food from retailers (in urban areas), as the main factors altering the patterns of food demand as urbanization proceeds.

Hence analyzing the consumption basket of households for a long term, examining the determinants that cause such changes, estimating demand elasticities which elucidate the demand level by individual consumers with the specified structure of relative prices in the economy, real income and individual attributes, is very crucial. (Mittal, 2006).

Keeping all this in view, the objective of the current study is to estimate for the presence of such shifts in Pakistan and the associated price elasticities of demand. These shifts in food demand are experienced throughout the world (Huang and Bouis2001 and Mittal 2006). Though in limited quantum, but earlier studies also prove for the prevalence of such shifts in Pakistan as well (Burki 1997 and Aziz & Malik, 2006).

Material and Methods

This study has utilized a pooled data set of the four Household Integrated Economic Survey (HIES) data sets for the years, 1985-86, 1993-94, 2001-02 and 2007-08.

The food commodities have been aggregated into the eight food groups. Which include Cereals, milk and milk products named Milks here, pulses, sugar and sugar products, here named together as Sugars, vegetables and fruits named Vegfruit here, cooking oils and ghee named Oils, meat fish and egg named MFE and other food items named Other foods here. The food commodities in each of the eight food groups are the same as given in HIES data sets of the respective years. Very important to mention is the fact that the HIES 1985-86 and HIES 1993-94 are much different from the HIES 2001-02 and HIES 2007-08. Many of the quantities for the commodities had not been given in the former data. The quantities were essentially needed for finding the prices with the HIES data.

The price statistics for the respective years were taken from the Pakistan Bureau of Statistics. The missing quantities for the food items were with little approximation assigned to those items and households on the basis of those price statistics. Another issue was the difference in the units in which the quantities were reported in the earlier and the later data sets. For instance, the beverages' and Vinegar's quantity had been given in bottles in 1993-94 HIES. The internet, and a small survey from those consumers which consumed these in 1993-94 and in 2007-08 as well, were taken aid of to convert the bottles into litres. For fulfilling adding up restriction and budget constraint, the other food items' group has been included. It has a wide range of goods from condiments and spices to readymade food items

and bakery products etc. The results of this group are not reported here in the results as the interpretation for such a diverse and large group will not bear any real implication.

The study employs Quadratic Almost Ideal Demand system (QUAIDS) for the estimation of budget shares and the elasticities finally. QUAIDS given by Banks et al. (1997) is derived from indirect utility function having the following form

$$\ln v(p,I) = [\{\frac{\ln I - \ln a(p)}{b(p)}\}^{-1} + \lambda(p)]^{-1} \quad (1)$$

Where a(p) and b(p) are given by following equations

$$a(p) = \alpha_0 + \sum_{n=1}^{N} \alpha_n \ln p_n + \frac{1}{2} \sum_{n=1}^{N} \sum_{l=1}^{n} \gamma_{nl}^{*} \ln p_n \ln p_l \quad (2)$$

$$b(p) = \beta_o \prod_{n=1}^{N} p_n^{\beta_n} \quad (3)$$

and

$$\lambda(p) = \sum_{n=1}^{N} \lambda_n \ln p_n \quad (4)$$

Using Roy's identity, the QUAIDs' expenditure shares are given by

$$w_n = \alpha_n + \sum_{i=1}^{N} \gamma_{ni} \ln p_n + \beta_n \ln\left[\frac{I}{a(p)}\right] + \frac{\lambda_n}{b(p)}\left[\ln(\frac{I}{b(p)})\right]^2 \quad (5)$$

The resultant model is hence Quadratic in total expenditures. This is a rank three demand system (Banks et al. 1997). Where, "the RANK M of any demand system is the maximum

dimension of the function space spanned by the Engel curves of the demand system" (Lewbel, 1991).

Demand systems have been estimated by many systems throughout the world and in Pakistan. Deaton and Muellbauer (1980) gave Almost Ideal Demand system (AIDS). AIDS is a complete demand system which satisfies axiom of choice and aggregates over consumers perfectly. Many of AIDS' properties were present in other models as well but none combined all (Deaton and Muellbauer, 1980).

For estimation of food demand and its changes and responsiveness to various factors, numerous demand systems and numerous extensions of AIDS have been used in literature. Like in recent years, Cranfield et al. (1998) used An Implicitly Directly Additive Demand System (AIDADS), Huang and Bouis (2001) and Farooq and Ali (2002) estimated AIDS, Burki (1997), Aziz and Malik (2006) and Nazli et al. (2008) employed LA-AIDS.

Problem with AIDS is this that the demand equations are unrelated as none of the endogenous quantities are on the right-hand side of equations. Since the budget constraints should be satisfied by the dependent variables, error terms are correlated across equations (Mittal, 2006).

Zellner (1962) developed the method for Seemingly Unrelated Regressions (SUR) which can be used to Estimate AIDs and provides more efficient estimates (Aziz and Malik, 2006).

Many adaptations for AIDS are being employed throughout world and this research has used Quadratic Almost Ideal Demand System (QUAIDS) given and used by Banks et al. (1997).

QUAIDS was infact developed by Blundell et al. (1993) but refinements were made by Banks et al. (1997). This model is an extension of AIDS. The model has been employed in several studies because of many of its features. Goods can be necessities as well as luxuries at different income levels which is not permitted by Translog and AIDS (Ibid). Is affords greater flexibility due to being rank three (Ibid). Cranfield et al. (2003), put forth that in general the results from in- and out-of sample evaluations prioritize a demand system of rank three over those containing ranks two. Macro-aggregates like tobacco and beverages, food, recreation, housing and transport depict the behaviour of consumption that is best explained by a demand system having rank-three (Soregaroli et al., 2002). Above all, it permits for the Engel curvature and the systems that do not account for it give misleading and misguiding estimates of welfare variations resultant upon tax modifications (Banks et al. 1997).

Estimation is divided in two levels. Ordinary Least Square (OLS) estimation at the first level is carried out to estimate for the per capita food expenditures. At the Second stage, seemingly unrelated regressions are employed following Zellner (1962).

Since estimating all the equations together yields singular error covariance matrix, one equation is deleted from the demand system to proceed further. The parameters of deleted equation are recovered from parameters of other equations through restrictions on them. In

1969, Barten introduced Iterated Seemingly Unrelated Regressions (ITSUR) which produces same results, no matter which equation is deleted (Mittal, 2006).

The analysis has employed a two-stage budgeting framework where Ordinary Least Squares has been used to estimate per capita food expenditures at the very first stage. A very similar methodology has been adopted by the first two authors in estimating the structural shifts in the demand for selected food groups in Pakistan (Ullah and Fatimah, 2016). This is given as follows

$$LN\,(f) = \alpha + \gamma_1 \ln\,(pf) + \gamma_2 \ln\,(pnf) + \beta_0 \ln(Yp) + \beta_1 \ln(Yp)^2 + \sum \theta_j K + \delta oi\ D \quad (6)$$

Where

f = Per capita expenditures on food

Yp = Per capita total expenditures

$(Yp)^2$ = Per capita total expenditures' square

Pf = Household specific price index for food

Pnf = price index for non-food

K = Ratio of adults in households, family size and urban dummy

D = Years' Dummy

Household specific price index for food is calculated by taking geometric mean of prices of food commodities ($\sum W_i \ln P_i$). Where W_i depicts the ith item's share in whole food expenditures and $\ln P_i$ is the natural log of ith item's price (Dey *et al.* 2008).

At the stage two, QUAIDS has been estimated for finding the budget shares of combined food groups utilizing the equation.

$$S_i = \alpha_i + \sum_j b_{ij} Ln\,(FP_i) + c_{io} Ln(M/I) + c_{1i} Ln(M/I)^2 + d_i urban + e_i\ D \quad (7)$$

Employing ITSUR, eight different equations have been estimated, having the functional forms of equation (2) each for the eight budget shares of eight food groups.

Where

S_i = Estimated share of ith food group in total food expenditures, for all i=1,2,….8

FP_i = price for ith group, for all i=1,2,….,8

M/I = Estimated per capita food expenditure from stage one, deflated by stone's geometric price index.

I= Stone's Geometric Price Index

Urban = Binary dummy for urban areas

D = Years' Dummies used to reflect tastes and preferences

Stone's Geometric Price Index = $\ln I = \Sigma w_i \ln p$

Where

W_i= The budget shares of individual food group in total food expenditures

Lnp = Natural log of the prices of individual food groups

Model parameters are estimated by imposing the Homogeneity, Symmetry and adding-up restrictions for all the eight equations.

Homogeneity: $\sum_{J=1}^{n} b_{ij} = 0$ (8)

Symmetry:

$$b_{ij} = b_{ji}, c_{11}/c_{10} = c_{21}/c_{20} = \ldots\ldots\ldots = c_{n1}/c_{no}; \quad (9)$$

Adding Up: $$\sum a_i = 1, \sum_i c_{io} = \sum_i b_{ij} = \sum_i di = 0 \quad (10)$$

The first two restrictions have been estimated at the sample mean whereas the last adding up restriction is imposed in calculating the of last equation's parameters. The last equation

was deleted to prevent singularity issue. These predicted budget shares are then used in calculating the compensated and uncompensated price elasticities of demand.

Elasticity Calculation

"A price elasticity is the measure of the percent change in the quantity demanded of good i from a 1-percent change in the price of good j. When i is equal (not equal) to j, the price elasticity is referred to as an own-price (cross price) elasticity of demand" (Regmi & Seale, 2010). The determination of elasticity is served by a multitude of determinants like substitutes' availability, household income, consumers' preferences, expected price change duration, and the good's share in the household's income. (Tatiana et al. 2010).

Whenever, the price of good changes, two main effects are observed. If the price of a good rises, the demand for that good decreases relative to all the other goods consumed, as the good has become expensive relative to the other goods. This can be termed as substitution effect. The consumer decreases the demand for the good whose relative price has risen. With the rise in the price a good, the real income of the consumer declines and the consumer is left with lesser purchasing and hence his overall consumption declines as well. This is the income effect. On the basis of these two effects, elasticities can be categorized into compensated and uncompensated elasticities.

Uncompensated elasticity, also known as the Marshallian Elasticity include both the income and the substitution effects of price change, whereas the Compensated Elasticity, also termed as the Hicksian Elasticity involves only the substation effect of the price change. The level of utility is taken to be constant in computing the Hicksian price elasticity of demand. If the elasticity is less than one, equal to one or greater than one, the good is said to inelastic, unit elastic or elastic respectively.

All the elasticities for the taken food groups are found following Blundell et al. 1993 and Mittal (2006).

Expenditure elasticity (η_i) for food demand is found by

$$\eta i = [(c_{io} + 2c_{i1}\text{Ln}(F))/Si] + 1 \quad (11)$$

Here, cio = Coefficient of natural log of expenditures, obtained at second stage

c_{i1} = Coefficient of natural log of expenditures' square, obtained at second stage

F = Total per capita food expenditures, estimated at the first stage of two stage frameworks.

S_i = the expenditure share of ith group, predicted at the second stage

Uncompensated price elasticity (ξ_{ij}) is found by

$$\xi_{ij} = [b_{ij}/S_i] - [c_{i0} + 2c_{i1}\text{Ln}(F)]\,[S_j/S_i] - K_{ij} \quad (12)$$

Where

K_{ij} = Kronecker delta, $K_{ij}=1$ for own price elasticity and $K_{ij} = 0$ for cross price elasticity.

S_i = Estimated share of ith item, b_{ij}= Coefficient of natural log of price of ith group.

For own price elasticity, i=j and hence $S_i=S_j$

Own and cross price compensated elasticities are computed using Slutsky's equation in elasticity form.

$$\xi^h_{ij} = \xi_{ij} + s_j\eta_i \quad (13)$$

ξ_{ij} = Uncompensated own price elasticity if Hicksian own price elasticity is to be calculated and uncompensated cross price elasticity if Hicksian cross price elasticity is to be calculated.

Results and Discussion

As the main objective is the elasticities' estimation and analysis based on those elasticities, the results of first two stages have been reported in the appendix. Those results also confirm for the changing food consumption preferences of the households in Pakistan over the selected period of analysis. The table 1 and table 2 reports the uncompensated and compensated elasticity estimates.

Table.1 Expenditure and Uncompensated Price Elasticity of Demand With Respect to Prices

Groups	Expenditure	Cereals	Pulses	MFE	Milks	Oils	Sugars	Vegfruit
Cereals	0.99	-0.853	-0.006	-0.03	-0.02	0.01	-0.01	-0.03
Pulses	0.99	-0.05	-0.40	-0.14	-0.11	-0.11	-011	-0.08
MFE	1.00	-0.100	-0.05	-0.415	-0.12	-0.04	-0.09	-0.12
Milks	1.00	-0.05	-0.02	-0.062	-0.834	-0.03	0.002	-0.04
Oils	0.99	0.01	-0.04	-0.04	-0.05	-0.72	-0.072	-0.10
Sugars	0.99	-0.04	-0.05	-0.11	0.02	-0.10	-0.598	-0.06
Vegfruit	0.99	-0.07	-0.02	-0.10	-0.06	-0.09	-0.04	-0.588

Table. 2 Compensated price Elasticity of Demand

Groups	Cereals	Pulses	MFE	Milks	Oils	Sugars	Vegfruit
Cereals	-0.65	0.03	0.09	0.18	0.11	0.07	0.09
Pulses	0.16	-0.35	-0.03	0.12	0.02	0.05	0.04
MFE	0.11	-0.02	-0.29	0.04	0.04	-0.04	-0.02
Milks	0.19	0.02	0.05	-0.61	0.07	0.07	0.08
Oils	0.24	0.01	0.07	0.15	-0.70	0.01	0.02
Sugars	0.22	0.02	-0.02	0.23	0.02	-0.58	0.09
Vegfruit	0.17	0.01	0.01	0.14	0.01	0.05	-0.45

All own price Marshallian elasticities are negatively signed as per expectations. This result is same as obtained by the other prominent researchers on food demand in Pakistan (Aziz & Malik 2006 and Nazli et al. 2008). The magnitude of the Marshallian own price elasticity for the meat fish and egg group is almost the same as obtained for meat by Nazli et al. (2008). Some of the Marshallian cross price elasticities are positively signed but majority of these are negatively signed. The demand for all the taken food groups is inelastic with respect to price. All the selected food groups behave to be normal goods as the expenditures' elasticities for all is positive.

Majority of the Hicksian cross price elasticities are positively signed representing food groups to be substitutes of each other. Hicksian elasticities just take price effect into account. Compensated own price elasticities for all of the selected food groups bear expected negative sign. Aziz and Malik (2006) obtained a positively signed compensated

own price elasticity for mutton while Burki (1997), found a positively signed compensated own price elasticity for rice.

The inelastic nature of all the selected food groups indicates the significance of any price change for the consumer that can worsen, in case of price surge or improve in case of decline in prices, the welfare of the consumer. Also, the expenditures' elasticity of all the selected food groups is one or very near to it. Hence the rise in income will result approximately in the rise in expenditures on one to one basis. This may consequently decrease the welfare of net buyers whose real income has declined with the price rise.

The price elasticity results are somewhat compatible with Aziz and Malik (2006). Though their analysis was limited to meat group but all the price elasticities were less than one. Comparison of this study is difficult with other studies in Pakistan on food demand. This is so because other studies had not employed Almost Ideal Demand System with quadratic specification. Also, such pooled data estimation of HIES data sets for detection of structural changes and hence the calculation of elasticities, has never been carried out on food groups in Pakistan.

Conclusion

Food consumption patterns are changing in Pakistan with the changing urbanization level and other things like changing wealth level and population characteristics. These changes can further affect the price levels and the welfare of the people positively or negatively. As all the food groups, have proved to be inelastic with respect to the prices, government needs to carefully design its taxation and pricing policies so that the most vulnerable section of the society is not adversely affected. Approximately one third of the people in Pakistan

live below the food poverty line. A policy neutral to the financial status of all the segments of the society can be very detrimental for the economy.

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