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EXAMINING FRUIT DEMAND ELASTICITIES IN PAKISTAN

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Abstract

Research background: Income and prices are important factors that determine and decide households consumption decisions and behavior.
Purpose and research methodology: This paper aims to examine fruits' demand elasticities in Pakistan by using the Linear Approximate Almost Ideal Demand System (LA/AIDS). For this purpose, data from the Household Integrated Economic Survey (HIES) 2018–2019 part of Pakistan Living Standard and Measurement is used for the selected fruits.
Results: Marshallian, Hicksian, and expenditures elasticities were calculated through the estimated parameter from the Linear Approximate Almost Ideal demand system. The results show that all the estimated expenditure elasticities of the selected fruits for Pakistan are positive. The magnitude of expenditure elasticities for bananas, malta, apple, grapes, watermelon, plum, and almonds, is less than unity, and are thus categorized as normal food items. The estimated uncompensated own price demand elasticities for all fruits are less than unity (inelastic) for Pakistan and thus categorized as necessities. Based on the cross-price uncompensated demand elasticities eighteen fruits are reported as gross complements and three fruits are gross substitutes. Most of the fruits are categorized as neutral fruits having no cross-price effect on each other's demand as their estimated elasticities are closer to zero**.** Only apples with grapes and almonds are found to be notable substitutes. As most of the price elasticities of fruits are inelastic, any change in their price would result in a massive increase in expenditure on these fruits. As a result, the government may adopt policies for the stabilization of fruit prices to meet the minimal daily food requirements of the lower segments of society.
Novelty: This study is an attempt to estimate demand elasticities for individual fruit as very little research is available in the study area for individual commodities.

Keywords: fruits, LA/AIDS, Expenditures elasticities, Marshallian elasticities, Hicksian elasticities, Pakistan

JEL classification: D12, Q02, Q10, Q11

Introduction

Fruit production plays a pivotal role in both economic development, particularly in agriculture and trade and in the well-being of the consumers by providing essential nutrients and dietary diversity. The cultivation of various types of fruit creates jobs and stimulates rural economies (Baidya, Sethy, 2020).

The United Nations, Food and Agriculture Organization (FAO), and World Health Organization (WHO) have been leading the global initiative "Promotion of Fruits and Vegetables for Health" (PROFAV) to create awareness about the benefits of fruits and vegetable production, supply and consumption to improve people's health- and farmers' income (WHO, FAO, 2004). The per capita production and consumption of fruits can be used to assess the standard of living of people in a country (Bairwa *et al*., 2012). In Pakistan, per capita consumption of vegetables and fruits is very less against a minimum requirement of about 400g/day, or 5 servings of 80g (Wang *et al*., 2014). For the beneficial impact on public health, fruit consumption must be encouraged as it supports the bodily as well as the mental health of people. At present Pakistan is ranked in the top ten producers of fruits in the world. Pakistan has a large range of varieties of fruit in its basket and accounts for 13 percent of the world's total fruit production. Due to its various agro-climatic conditions, the country is home to a wide variety of fruits. Pakistan is the largest producer of citrus fruits, mango, and banana. Citrus fruits have a major share in area and production which is about 24 percent & 35 percent respectively, followed by mangoes with a receptive share of 21 percent & 24 percent. The production of fruits in Pakistan declined from 779.948 thousand tons in 2017–2018 to 746.628 thousand tons in 2018–2019 while the productivity of fruits decreased from 7048.234 thousand tons per hectare in 2017–2018 to 696.3577 thousand tons per hectare in 2018–2019 (Government of Pakistan, 2020). Fruit exports in 2018–2019 was 1.60 million tons while in 2019–2020, it is 1.80 million tons which shows an increase of 13 percent as compared to last year. Citrus fruits and mangoes are Pakistan's biggest export items, and they are well-known across the world. Because of the limited production of globally popular fruits such as apples, bananas, grapes, oranges, and strawberries, the local market demand is hardly met, and export opportunities have been reduced further (Government of Pakistan, 2020). The demand for fruits is highly affected by income. As income increases, so does the demand for fruit, although the total expenditure share allocated for fruits is less. This implies that the demand for fruits is less at the low-income level because the priority of low-income households is the fulfillment of basic energy to avoid hunger. Fruits are an expensive source of energy which is a major obstacle for low income households (Ruel *et al*., 2005).

For economists, an important area of research is food consumption for the last decade. Consumer demand for fruits is an important feature in shaping various agricultural and food price policies. Changes in per capita income and fruit prices are influential factors for consumers in fruit demand (Ullah, Jan, 2016). Growth in the demand for fruits and vegetables has been witnessed by increasing promotions and awareness of healthy diets. Family income is growing in Pakistan which is expected to increase the demand for fruits, likewise. Historically, income and population have been two major sources of consumption growth. The total need for fruits is determined by the number of people, while their ability to pay for various types is determined by their income.

The nation's progress and development may be gauged by how much it consumes, which is done by measuring how well off everyone is overall and how much they can afford to spend on various necessities of life. Actually, consumption activity might be viewed as the foundation of all supply and demand, and all forms of investment revolve either directly or indirectly around it. The main purpose of this paper is to examine the fruit consumption pattern in Pakistan using data from the Household Integrate Economic Survey (HIES) for the years 2018–2019. To achieve this, we used the Linear Approximate Almost Ideal Demand System (LA/AIDS) model, which was originally developed by (Deaton, Muelbauer, 1980). Specifically, this study sets out to accomplish two key objectives, firstly it aims to analyze fruit consumption behaviour in Pakistan and Estimate the parameters of the LA/AIDS model to understand how various factors affect fruit consumption. Secondly, it calculates compensated, uncompensated and expenditure elasticities to assess the responsiveness of fruit consumption to changes in price and income. The recent review shows that the majority of researchers' used fruits as a group in their studies. In this paper an attempt is made to provide a comprehensive analysis of individual fruit consumption patterns in Pakistan, especially using a well-established demand model like LA/AIDS. By filling this gap, the paper contributes to a deeper understanding of consumer preferences and behaviour regarding fruit consumption in the context of Pakistan's economy.

Understanding the relationship between household consumption and income provides an insight into consumer behavior since estimates of fruit purchasing power are needed to build a better fruit policy to determine households' priorities. To target the aggregate demand, determine the challenges and possibilities facing the agricultural sector in the nation, and estimate the fruit demand of every household is crucial. To provide policy options and produce informed policy judgments, such research is of utmost importance.

1. Review of the literature

Haider and Zaidi (2017) conducted research over several years in Pakistan, spanning from 2000–2001 and 2013–2014. They reviewed household consumption patterns based on eleven composite food groups by using the Quadratic Almost Ideal Demand System (QAIDS) to analyze variation in household responses to change in income and prices. Notably, despite an increase in food supply and per capita income, the study found that the average adult calorie intake in Pakistan remained below the recommended benchmark, raising concern about issues such as child undernutrition. Karim *et al.* (2018) conducted research in a specific village, Kabal, in the Swat district, Pakistan to analyze per capita food consumption and poverty. They determined the daily consumption pattern of various food items, household food expenditure, calorie intake and poverty levels among surveyed households. Their findings revealed that on average households were above the poverty line based on calorie intake, with variations among households. Naz *et al*. (2018) examined the impact of static and dynamic welfare on food prices in rural Pakistan households using data from three waves of the Pakistan Rural Household Survey (2001, 2004, 2010). They employed the Quadratic Almost Ideal Demand System model to estimate demand functions for eight food groups. The study indicated that grains had inelastic expenditure elasticity, and most food groups exhibited negative own-price elasticities, emphasizing the importance of expenditure increases for maintaining welfare level. Ashagidigbi *et al*. (2019) explored factors influencing the low demand for fruits and vegetables, highlighting their significance in nutrition, focusing on Nigeria. Data from secondary sources were analyzed using the Quadratic Almost Ideal Demand System (QAIDS) model. The study revealed the urban household spent more on fruits and vegetables than rural households. Additionally, it identified how raising fruit prices negatively affected vegetable consumption and highlighted demographic factors, such as gender and age, influencing consumption patterns. Obayelu *et al*. (2019) addressed the issue of fruit demand among Nigerian university students, emphasizing the importance of fruits for a healthy lifestyle and learning abilities. They collected data through a questionnaire and employed the Quadratic Almost Ideal Demand System model to analyze fruit demand among students of the University of Ibadan. The study found that expenditure elasticities for selected fruit categorized them as luxury or necessity goods, and cross-price elasticities indicated complementary or substitution among fruits. The study recommended increasing students' stipends to boost fruit demand. Naheed, Hussain (2020) conducted research in Pakistan to analyze the country's structural changes resulting from economic shifts and changing domestic conditions. They highlighted malnutrition as a significant impediment to human development and economic progress in developing nations like Pakistan. Food demand elasticity was emphasized as a crucial measure of food significance. The study also addressed the risk of starvation, particularly among children and mothers, due to resource constraints, limited food access, family size and dietary habits. Its objective was to estimate spending capabilities and economic implications using price elasticity projections for forecasting Pakistan's future food demand. Sadiq *et al.* (2021) explored the demand for imported fruits in Saudi Arabia over 38 years, using FAO and UNCTAD data. Applying the Linear Approximate Almost Ideal Demand System (LA/AIDS) model, the study categorized fruits as normal goods, necessities or luxuries. It emphasized the impact of income changes on fruit demand and recommended boosting local fruit production to reduce dependence on imports and mitigate marketing shocks. Mustafa *et al.* (2022) examined consumer demand for fruits and vegetables in both urban and rural Bangladesh, with a focus on the response to changes in income and prices. Despite government efforts to promote healthier eating, daily intake remains below the recommended level. Using the Quadratic Almost Ideal Demand System (QAIDS) model, the study found out that income level significantly influences consumption patterns. In urban areas, higher income leads to increasing spending on meat, fish, fruits and milk rather than vegetables. The study highlighted the need for tailored public campaigns to encourage fruit and vegetable consumption, considering socioeconomic and cultural diversity. Neelima *et al.* (2023) estimated the demand for key fruits in Andhra Pradesh's district Guntur. Utilizing household level data and the working-Leser and Linear Approximate Almost Ideal Demand System (LA/AIDS) models, the research identifies expenditure patterns and price elasticities for various fruits. The study classified fruits as being luxury or necessity goods and reveals the role of income in consumption. It also uncovers fruit substitutes and complements, offering practical suggestions to stimulate local fruit demand.

2. Theoretical modeling and data

Using the estimated coefficient from the LA/AIDS model, we estimated compensated, uncompensated own/cross price and expenditure elasticities. The LA/AIDS provides the first-order estimation of the expenditure function and satisfies the axioms of consumer choices and allows for investigating interdependence among products.

2.1. Specification and Estimation of the LA/AIDS

Deaton and Muelbauer (1980) derived LA/AIDS from a flexible expenditure function with Price Independent Generalized Logarithmic preference to derive. It automatically meets the aggregate restriction, with simple parametric constraints like symmetry and homogeneity. The LA/AIDS system in its budget share form is given as:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln\left(x / p\right) + \mu_i \tag{1}$$

where α_i, β_i and γ_i are the parameters that need to be estimated. w_i is the *ith* good budget share, p_j is the *jth* good price and *x* represents the total expenditure. *P* is an aggregate Price Index and is defined by;

$$\ln P = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j \tag{2}$$

where $$\gamma_{ij} = \frac{1}{2}\left(\gamma^*_{ij} + \gamma^*_{ji}\right) = \gamma_{ji} \text{ for two goods } i \text{ and } j \tag{3}$$

By using the price index in equation 2 the price coefficients for w_i, in the AIDS model is non-linear, As a result, a complex non-linear system is created. Deaton and Muellbauer (1980) suggested that the price index (P) be replaced by Stone's price index P^* of the form to linearize the connection.

$$\ln P^* = \sum_i w_i \ln p_i \tag{4}$$

The linear approximate AIDS "LA/AIDS" model is the one that uses Stone's pricing index. Because prices will never be exactly collinear, the unit of measurement error will always exist when using the Stone index (see Alston, Foster, Green, 1994; Moschini, 1995; Asche and Wessells, 1997). To overcome the measurement errors a Laspeyres pricing index can be used as suggested by (Moschini, 1995). By replacing a mean budget share $\overline{w}_i$ by w_i Equation 1, generates the log-linear analog of the Laspeyres price index.

$$\ln\left(P^L\right) = \sum_i \overline{w}_i \ln\left(P_i\right) \tag{5}$$

LA/AIDS model with the Laspeyres price index as follows:

$$w_i = a^{**} + \sum_k \delta_{ik}\eta_k + \sum_j \gamma_{ij} \ln\left(P_j\right) + \beta_i\left(\ln\left(x\right) - \sum_j \overline{w}_j \ln\left(P_j\right)\right) + \mu_i^{**} \tag{6}$$

$$a^{**} = \alpha_i - \beta_i\left(\alpha_0 - \sum_j \overline{w}_j \ln\left(\overline{P}_j\right)\right) \tag{7}$$

where w_i is the i_{th} good budget (expenditure) share; δ_{ik} is the vector of parameters. η_k is a matrix of socioeconomic variables, Household size, determined by the number of people living in a household; age; marital status; and rural and urban regions are all socioeconomic characteristics;

p_j is the j_{th} good nominal price,

$\ln X$ is total expenditure,

$\ln p_i$ is the translog price index,

μ_i is the random or error term, and

α_i, β_i and γ_i are the parameters that need to be estimated.

2.2. Derivation of demand elasticity for the LA/AIDS model

Elasticity derivations for the LA/AIDS models have been extensively researched and recorded. Taking the derivative of Equation 10 with respect to ln(x) as suggested by (Buse, 1994) and Green and Alston (1990), the expenditure elasticity e_i may be calculated as follows:

$$e_i = 1 + \left(\frac{1}{w_i}\right)\left(\frac{\partial w_i}{\partial \ln(x)}\right) = 1 + \left(\frac{\beta_i}{w_i}\right) \tag{8}$$

Price elasticity can be determined in two ways: uncompensated elasticity, which takes into account both price and income effects, and compensated elasticity, which only takes into account price effect. By taking the derivative with respect to lnp_j, uncompensated cross- (j ≠ i) and own- (j = i) price elasticities, $e_{ij}^{LA/AIDS}$, can be calculated as follows:

$$e_{ij}^{LA/AIDS} = -\,\delta_{ij}\left(\frac{i}{w_i}\right)\left(\frac{\partial w_i}{\partial p_j}\right) = -\,\delta_{ij} + \left(\frac{\gamma_{ij}}{\overline{w}_i}\right) - \left(\frac{\beta_i}{\overline{w}_i}\right)\overline{w}_j \qquad \forall_i, j = 1, ..., n \tag{9}$$

where δ_{ij} is the Kronecker delta and it is equal to one for own price and zero for cross-price elasticities.

The compensated price elasticities, $s_{ij}^{LA/AIDS}$, is as follows:

$$s_{ij}^{LA/AIDS} = e_{ij} + e_i w_j = -\delta_{ij} + \left(\frac{\gamma_{ij}}{\overline{w}_j}\right) + \overline{w}_j \qquad \forall_i, j = 1, ..., n \tag{10}$$

2.3. Theoretical consistency

The parameters of the AIDS model can be restricted in the following ways:

The following parameter constraints are implied by adding up.

$$\sum_{i=1}^{n}\alpha_i = 1 \sum_{i=1}^{n}\beta_i = 0 \sum_{i=1}^{n}\gamma_{ij} = 0 \tag{11}$$

Homogeneity requires that,

$$\sum_{i=1}^{n}\gamma_{ij} = 0 \tag{12}$$

Symmetry is satisfied for two goods i and j if

$$\gamma_{ij} = \gamma_{ji} \tag{13}$$

Negativity is not introduced automatically, but it can be tested by measuring all compensated own-price elasticities.

To estimate a sequence of own-price and cross-price elasticities, a specified Seeming Unrelated Regression (SUR) model is employed. The SUR ensures that estimates are consistent and asymptotically efficient. With adding up, homogeneity, and symmetry restrictions imposed, the parameters of LA/AIDS were calculated using the seemingly unrelated regression of (Zellner, 1963) model included to estimate the system of equations in Stata 16. In STATA-16, the SUR Estimation command includes a robust option (by default) for estimating the standard errors that make adjustments in the estimates and overcome some of the flaws in the data itself. Such robust standard errors can deal effectively with a collection of minor concerns, such as minor problems about normality, heteroskedasticity, or some observations that exhibit large residuals. Further, the reasonably large sample size (>100) used in this study relaxes the normality assumption (Gujrati, 2004, pp. 135–136). However, in cross-sectional data (such as household level surveys) empirical observations with low R^2 and good F-statistics are accepted (Gujrati, 2004, pp. 286–287; World Bank, 2005, p. 133). The problem of missing price data is related to zero consumption. As households with zero consumption provide no information on either expenditures or quantities, no unit values (prices) can be derived for these households. In order to keep these (missing) observations in the analysis, missing prices were replaced by average prices (Cox, Wohlgenant, 1986; Chern *et al.*, 2003, pp. 1–81).

3. Results

This section presents and discusses the food consumption patterns and results from the LA/AIDS model estimation for the selected fruit budget shares. The empirical results from the Seemingly Unrelated Regression of the specified demand function shows that all estimated coefficients agree with a priori theoretical expectation.

Table 1 shows the average income per household and monthly consumption expenditures per household in Pakistan. The overall average family income was Rs. 41545 and the average amount spent on food was Rs. 37159.

Table 1. Average monthly income and consumption expenditure per household

Average monthly income (rupees)	Average monthly consumption (rupees)
41,545	37,159

Source: HIES (2018–2019).

Estimates of the structural parameters for the LA/AIDS model are shown in Table 2. The parameters satisfy the adding up, homogeneity, and symmetry restrictions. Overall it can also be seen from the estimated results that a reasonable number of coefficients of the explanatory variables are significant at the 99 percent level of significance.

3.1. Total fruits expenditure

Table 2 shows the calculated total expenditure coefficients; the total fruits expenditure variable is significantly related to all of the model's expenditure shares. For a percent increase in total fruit expenses, the expenditure coefficients indicate how a fruit's budget share changes. For example, with a 1% rise in overall fruit expenditures, the budget share of banana and Plum, apricot, and guava increases by 0.0481 and 0.0226, respectively, while the budget share of malta (0.0320), apple (0.0752), grapes (0.0185), watermelon (0.0248) and almond, walnut, pistachio & kaju (0.0213) reduces. Apple is the most responsive to changes in the consumer's fruit budget as the estimated apple coefficient is the highest among the fruits. The positive value of the total expenditures coefficient shows that with increasing consumer budget allocations for bananas, plums, apricot, and guava, increasing total fruit expenditure has been accompanied.

3.2. Price variables

Own price. As is evident from Table 2, for Pakistan the calculated coefficients of own price variables are significant. Own price coefficients are positive for all of the fruits, indicating that when the own prices of these fruits increase, so does the consumer budget allocation for each fruit. Malik *et al.* (2014) also found a positive coefficient for 9 food groups, while Ullah *et al*. (2018) found the same positive pattern for the estimated food groups. Apple has the highest coefficient of 0.2070, showing that it is the most responsive to changes in its price, while almond, walnut, pistachio, and kaju have the lowest coefficient of 0.0969, indicating that they are the least responsive to own price change.

Cross price. Estimates of the cross-price coefficients show that there is a significant relation between the price of banana to the price of malta, apple, grapes, watermelon, plum, apricot & guava and almond, walnut, pistachio, kaju budget shares and vice versa. The negative coefficient of malta (–0.0438), apple (–0.0029), grapes (–0.0531), watermelon (–0.0263), plum, apricot & guava (–0.0255), and almond, walnut, pistachio, Kaju (–0.0204) implies that a 1% decrease in banana price will result in a decrease in the budget shares of these fruits.

As indicated by the cross-price coefficient the price of malta is significantly related to all fruits. The Positive values of banana, plum, apricot, and guava show that a 1% increase in the price of malta will increase their budget shares by 0.0438 and 0.0319, respectively.

As revealed by the estimates of the cross price coefficient, there is also a significant association between the budget share of all fruits and the price of apples. For example, the budget share of Malta, grapes, watermelon, and almond, walnut, pistachio, kaju will fall by 0.0566, 0.0258, 0.0462, and 0.0124 respectively, if the price of apple rises by 1%. While the positive value of banana (0.0329), and plum, apricot & guava (0.0328) means that their budget share will increase with a percent increase in apple price.

Between the price of apples and the budget share of all fruits, a significant relationship is shown. Bananas are highly sensitive to the price change in grapes indicated by their highest value (0.0263). The findings also show that a percent increase in the price of grapes reduces the budget share of malta, apple, watermelon, and almond, walnut, pistachio, kaju by 0.0195, 0.0258, 0.0168, and 0.0144, respectively.

Table 2 further shows that the price of watermelon and the budget shares of all other fruits are also significantly related. The calculated coefficients for banana and plum, apricot, and guava are positive, showing that the budget share will increase by 0.0531 and 0.0217, respectively, with a percent increase in watermelon/melon price. While the negative value of malta, apple and almond, walnut, pistachio, and kaju shows that their budget share will reduce with a percent increase in watermelon price.

Demographic and dummy variables. Among the demographic variables family size, age, marital status, dummies representing Punjab, Sindh, Khyber Pakhtunkhwa (KP), and urban/rural regions were included in the model and are discussed as follows:

For urban households, there is no significant relationship between bananas, malta, grapes, and watermelon. In comparison to rural homes, urban households spend more on plums, apricot, and guava and less on apples, almond, walnut, pistachio, and Kaju. When compared to the reference province of Baluchistan, all three provinces had higher fruit consumption. However, there is no significant difference in the consumption of plums in Punjab and Khyber Pakhtunkhwa, as well as malta and grapes in Sindh. The findings suggest that as individuals become older, they consume more fruit, with the exception of bananas, grapes, almonds, walnut, pistachio, and kaju. The marital status of the households shows that there is a significant variation in the expenditure for all the selected fruits. When a couple gets married, the consumption of all fruits rises. With the rise in family size, there is a considerable increase in the consumption of all fruits except almonds (insignificant).

Table 2. Estimated parameters of the LA/AIDS model for Pakistan

Explanatory variable	Banana	Malta	Apple	Grapes	Watermelon	Plum/ apricot	Almond/ walnut
lbp	0.2023*** (0.0025)	–0.0438*** (0.0011)	–0.0329*** (0.0015)	–0.0263*** (0.0008)	–0.0531*** (0.0010)	–0.0255*** (0.0009)	–0.0204*** (0.0008)
lmmkp	0.0438*** (0.0011)	0.1940*** (0.0010)	–0.0566*** (0.0009)	–0.0195*** (0.0004)	–0.0204*** (0.0006)	0.0319*** (0.0006)	–0.0216*** (0.0005)
lap	0.0329*** (0.0015)	–0.0566*** (0.0009)	0.2070*** (0.0016)	–0.0258*** (0.0006)	–0.0462*** (0.0008)	0.0328*** (0.0007)	–0.0124*** (0.0007)
lgp	0.0263*** (0.0008)	–0.0195*** (0.0004)	–0.0258*** (0.0006)	0.1179*** (0.0004)	–0.0168*** (0.0004)	0.0149*** (0.0004)	–0.0144*** (0.0003)
lwmp	0.0531*** (0.0010)	–0.0204*** (0.0006)	–0.0462*** (0.0008)	–0.0168*** (0.0004)	0.1740*** (0.0007)	0.0217*** (0.0005)	–0.0157*** (0.0004)
laagp	0.0255*** (0.0009)	–0.0319*** (0.0006)	–0.0328*** (0.0007)	–0.0149*** (0.0004)	–0.0217*** (0.0005)	0.1391*** (0.0007)	–0.0120*** 0.0004
lawpkp	0.0204*** (0.0008)	–0.0216*** (0.0005)	–0.0124*** (0.0007)	–0.0144*** (0.0003)	–0.0157*** (0.0004)	0.0120*** (0.0004)	0.0969*** (0.0006)
ltfruit	0.0481*** (0.0001)	–0.0320*** (0.0001)	–0.0752*** (0.0001)	–0.0185*** (0.00006)	–0.0248*** (0.0001)	0.0226*** (0.00009)	–0.0213*** (0.0010)
lage_class	0.0036 (0.0010)	0.0032*** (0.0008)	0.0076*** (0.0009)	**0.0017 (0.0004)**	0.0036*** (0.0006)	0.0026*** (0.0005)	0.0011 (0.0004)
lhh_size	0.0303*** (0.0018)	0.0076*** (0.0014)	0.0284*** (0.0017)	–0.00004*** (0.0007)	0.0064*** (0.0011)	0.0047*** (0.0010)	**0.0015 (0.0008)**
marital_status	0.0100*** (0.0023)	0.0076*** (0.0017)	0.0240*** (0.0021)	0.0047*** (0.0009)	0.0098*** (0.0014)	0.0045*** (0.0012)	0.0070*** (0.0010)
_cons	0.0463	0.1582	0.0243	0.1273	0.3313	0.1426	0.1697
No. of obser-vation	24,809	24,809	24,809	24,809	24,809	24,809	24,809
R-squared	0.7904	0.7904	0.9007	0.8373	0.8107	0.8041	0.7968
Chi	95770.77	110780.45	234267.85	132987.95	117530.15	103814.75	101395.71

*** represents significance level at 99%, ** significance level at 95% and * significance level at 90%. Standard errors are given in the parenthesis.

Description of the data set is available in appendix 1.

Source: author's estimations using HIES (2018–2019).

3.3. Uncompensated own and cross-price elasticities

The uncompensated own-price elasticities are reported in Table 3. All fruits' price elasticity was of the appropriate sign. The majority of fruits have inelastic uncompensated own price elasticity of demand, ranging from 0.0278 for Watermelon to 0.5204 for Apple. The price elasticities for fruits like banana, malta, grapes, plum, apricot & guava and almond, walnuts, pistachio & kaju were 0.449, 0.2089, 0.0747, 0.0835, and 0.3387 respectively.

Table 3 also illustrates Pakistan's uncompensated cross-price elasticities; the results are statistically significant indicating substitution or complementary relationships among different fruits. When a household's relative disposable income rises or falls, the majority of them will likely decide how much of that shift will be spent/cut on saving and expenditures. The household will first select how much of the disposable income will be saved and how much will be spent on goods and services. Positive cross-price elasticities indicate substitutes, while negative cross-price elasticities indicate gross complements.

Table 3. Estimated own and cross price uncompensated (Marshallian) elasticities for Pakistan, 2018–2019

Explanatory variable	Banana	Malta	Apple	Grapes	Watermelon	Plum/ apricot	Almond/ walnut
Banana	**–0.4255*****	–0.0660***	–0.0376***	–0.0203***	–0.0900***	–0.0183***	–0.0051
Malta		**–0.2066*****	–0.1902***	–0.0445***	–0.0479***	–0.0931***	–0.0528***
Apple			**–0.5098*****	0.0234***	–0.0172***	0.0094***	0.0502***
Grapes				**–0.1163*****	–0.1052***	–0.0910***	–0.0872***
Watermelon					**–0.0617*****	–0.0892***	–0.0577***
Plum/apricot						**–0.1257*****	–0.0513***
Almond/walnut							**–0.2911*****

*** represents significance level at 99%, ** significance level at 95% and * significance level at 90%.

Source: author's estimations using HIES (2018–2019).

The cross price elasticity of uncompensated demand for bananas in relation to the prices of malta, apple, grapes, watermelon, plum, apricot & guava, almond, walnut, pistachio, and kaju has a negative sign, indicating gross complements with values of 0.0660, 0.0376, 0.0203, 0.0900, 0.0183 and 0.0051 respectively.

For all fruits, the cross-price elasticity of demand for malta is negative. Apple (0.01902) had the highest cross-price elasticity, followed by plum, apricot & guava (0.0931), almond, walnut, pistachio, and kaju (0.0528), watermelon (0.0479), and grapes (0.0445), all of which showed complementary relationships. Apple demand has negative uncompensated cross-price elasticities with respect to the prices of watermelon (0.0172), suggesting gross complements. Grapes (0.0234), plum, apricot & guava (0.0094), almond, walnut, pistachio, and kaju (0.0502) are categorized as gross substitutes as all have positive cross-price effects on fruit demand.

The cross-price elasticities of uncompensated demand for watermelon, plum, apricot & guava, almond, walnut, pistachio, and kaju were negative with respect to the price of grapes and their range varies from 0.0872 (for almond, walnut, pistachio, Kaju) to 0.1052 (for watermelon).

Table 3 also shows that watermelon and plum, apricot & guava have a negative relation with the remaining fruits which shows a complementary relationship between them.

These results are consistent with the findings of (Lin *et al.*, 2009; Sobekova, 2012; Jalil, Khan 2018; Ashagidigbi *et al.*, 2019; Obayelu *et al.*, 2019; Sadiq *et al.*, 2021; Neelima *et al.*, 2023).

3.4. Compensated own and cross-price elasticities

For all fruits, the own price elasticity of compensated demand is price inelastic ranging from 0.0239 for malta to 0.2213 for almond, walnut, pistachio, and kaju as shown in Table 4. The own price elasticity of compensated demand for fruits such as banana (0.0926), apples (0.0716), grapes (0.0482), watermelon (0.1481), plum, apricot and guava (0.0655) were inelastic, during the survey period. The estimated uncompensated own price elasticity of demand for banana, malta, apple, grapes, watermelon, plum, apricot & guava, and almond, walnut, pistachio, kaju suggests that if the price of these fruits falls by 10%, demand will increase by 0.892, 0.161, 0.859, 0.014, 1.039, 0.150, 1.715 percent, respectively. As the compensated elasticity implies, 4.25, 2.06, 5.09, 1.16, 0.61, 1.25, 2.91 of the total increase in demand was purely due to the price effect (i.e. the substitution effect). The remaining 3.35 (i.e. 0.892 – 4.25 percent = 3.35), 1.89, 4.23, 1.146, 0.879, –1.1, –1.19, are accounted for banana, malta, apple, grapes, watermelon, plum, apricot & guava, and almond, walnut, pistachio, kaju by the income effect of price falls.

Table 4 shows that the compensated cross-price elasticities are statistically significant, just like the uncompensated cross-price elasticities. All of the compensated demand cross-price elasticities have a positive sign, implying substitutes.

Table 4. Estimated own and cross price compensated (Hicksian) elasticities for Pakistan, 2018–2019

Explanatory variable	Banana	Malta	Apple	Grapes	Watermelon	Plum/ apricot	Almond/ walnut
Banana	**–0.0893*****	0.1407***	0.4134***	0.0678***	0.05246***	0.0968***	0.0876***
Malta		**0.0162*****	0.2768***	0.0596***	0.1105***	0.0381***	0.0559***
Apple			**–0.0859*****	0.0845***	0.0980***	0.0974***	0.1159***
Grapes				**0.0014**	0.0668***	0.0538***	0.0352***
Watermelon					**0.1039*****	0.0492***	0.0583***
Plum/apricot						**0.0150*****	0.0669***
Almond Walnut							–0.1715***

*** represents significance level at 99%, ** significance level at 95% and * significance level at 90%.

Source: author's estimations using HIES (2018–2019).

The cross-price elasticities of compensated demand for malta, apple, grapes, watermelon/ melon, alou-bukhara (plum), apricot (khobani) & guava, and almond, walnut, pistachio, kaju were all positive with respect to the price of bananas, ranging from 0.05246 (for watermelon to 0.4134 (for apple). The compensated cross-price elasticities of demand of malta with respect to apple (0.2768), grapes (0.0596), watermelon (0.1105), plum, apricot & guava (0.0381), and almond, walnut, pistachio, Kaju (0.0559) were positive.

Similarly, the cross-price elasticities of compensated demand for grapes, watermelon, plum, apricot & guava, and almond, walnut, pistachio, kaju were also positive with respect to the price of apple ranging from 0.0845 (for grapes) to 0.1159 (for almond, walnut, pistachio, kaju).

With respect to the price of grapes the compensated demand for watermelon, plum, apricot & guava, and almond, walnut, pistachio, kaju showed positive responses and their range varies from 0.0352 (for almond, walnut, pistachio, Kaju) to 0.0668 (for watermelon). With respect to the price of watermelon/melon, the compensated demand for plum, apricot & guava (0.0492), and almond, walnut, pistachio, and kaju (0.0583) showed positive responses. The cross-price elasticities of compensated demand for almond, walnut, pistachio, and Kaju with respect to the price of plum, apricot & guava (0.0669) was positive which also showed a substitution relationship. Sobekova (2012), Jalil and Khan (2018), Ashagidigbi *et al*. (2019), Obayelu *et al*. (2019), Sadiq *et al.* (2021), Neelima *et al.* (2023) have also reported similar results for their studies.

3.5. Expenditure elasticities

To achieve the desired level of utility, Pakistani households spend their incomes on a variety of fruits. The estimated expenditure elasticities for fruits provide useful information on the level of consumption. Table 5 shows that expenditure elasticities have positive signs (as expected) and are significant at 99% for all the fruits, implying that they are considered necessities. i.e. banana (0.8815), malta (0.8804), apple (0.8560), grapes (0.8677), watermelon (0.8753), plum, apricot & guava (0.8667) and almond, walnut, pistachio, and kaju (0.8557) are reported to be necessities based on their expenditure elasticities. This indicates that if a household's income rises, these fruits will experience a slight increase in demand. The estimated expenditure elasticities are quite similar to the findings of (Lin *et al*., 2009; Sobekova, 2012; Ashagidigbi *et al*., 2019; Obayelu *et al*., 2019; Sadiq *et al*., 2021; Neelima *et al*., 2023).

Table 5. Estimated expenditures elasticities for Pakistan

Fruits	Expenditure elasticities
Banana	0.8748*** (0.0004)
Malta	0.8741*** (0.0005)
Apple	0.8491*** (0.0003)
Grapes	0.8641*** (0.0005)
Water melon	0.8693*** (0.0005)
Plum/apricot	0.8613*** (0.0005)
Almond, walnut, pistachio, kaju	0.8485*** (0.0005)

*** represents significance level at 99%, ** significance level at 95% and * significance level at 90%. Standard errors are given in the parenthesis.

Source: author's estimations using HIES (2018–2019).

Conclusions and recommendations

This papers aim was to examine the food demand patterns of Pakistani households. The analysis reveals that own-price, cross-price, and household food expenditures have a significant effect on the demand for all food groups. Socioeconomic and demographic factors included in the model have an important influence on household food demand.

The estimated expenditure elasticities for all fruits were positive, indicating that they were normal goods and their demand increases as household income increases. The uncompensated own-price demand elasticity of all fruits is less than unity and they are classified as necessities. As per our prior expectation, the majority of the fruits were unaffected by price changes in other fruits shown by the calculated cross-price uncompensated demand elasticities, which confirm the preferences and consumption pattern of the households.

The results of this paper have important policy implications. To increase the minimum daily food requirements of households and encourage appropriate fruit consumption, price stabilization strategies must be developed. Income-earning opportunities must be provided to increase purchasing power for improved quality and quantity of fruits. In the future, similar research studies on particular commodities in various food groups need to be carried out to explore the changes in household preferences for essential food products over time, a panel data analysis thus will be required.

Appendix 1. Data set description

Commodity	Description
lbp	Log of price of banana
lmmkp	Log of price of malta
lap	Log of price of apple
lgp	Log of price of grapes
lwmp	Log of price of watermelon
laagp	Log of price of plum, apricot & guava
lawpkp	Log of price of almond, walnut, pistachio, and kaju
ltfruits	Log of total fruits
lage-class	Log of age class
lhh-size	Log of household size
Marital status	Marital status

Source: Source: own elaboration.

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