HOUSEHOLD DEMAND ANALYSIS: EVIDENCE FROM PAKISTAN USING POOLED DATA

By

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Dedicated To

My Beloved Teachers, Parents and Family

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ARMA	Auto Regressive Moving Average
CPI	Consumer Price Indices
FGLS	Feasible Generalized Least Squares
GLS	Generalized Least Squares
GDP	Gross Domestic Product
HIES	Household Integrated Economic Surveys
KPK	Khyber Pakhtun Khwa
LA/AIDS	Linear Approximation Almost Ideal Demand System
ML	Machine Learning
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PBS	Pakistan Bureau of Statistics
QES	Quadratic Expenditure System
QUAIDS	Quadratic Almost Ideal Demand System
SA	Sensitivity Analysis
SUR	Seemingly Unrelated Regression
TE	Total Expenditure

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ABSTRACT

This study consists of three essays on household demand with the aim to address some key issues related to resource allocation and policy making in public domain. The first essay explores the presence of systematic differences in household demand between rural and urban areas and, especially between the four provinces of Pakistan. The findings of this essay lead to the conclusion that in the light of controversies surrounding the Eighteenth Constitutional Amendment, major portions of goods and services taxes that are not of uniform nature may be redesignated as provincial taxes. The structure of these taxes may be decided by provincial governments keeping in view the prevailing demand patterns and other socioeconomic considerations.

The second essay explores the role of climatic conditions represented by geographic zones, seasonal variations and interaction between climate and seasons in influencing household demand. The study finds systematic differences in household demand and their seasonal patterns across climatic zones. It is proposed that the knowledge of these differences may be included in decision making in public domain to help smooth supply of essential goods, especially to ensure food security.

The third essay focusses on the role of large changes in income in influencing households' preference structure. The study proposes to extend Quadratic AIDS to Quadratic AIDS Splines that allow smooth transition of household demand functions from one range of income to the next one. The study finds significant differences in household demand patterns at extreme ends of income distribution. This result leads to the conclusion that the practice of focusing on the so-called average behavior can be misleading in the context of socioeconomic policies. The information on changes in consumption pattern across income classes, especially at extremely low income levels can be fruitfully utilized for making pricing and taxation policies, especially to ensure food security and provision of essential goods like health to poor households

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND AND RESEARCH ISSUES

Household demand is said to be willingness and ability of households to buy different goods and services in order to fulfil their daily needs (Sheffrin, 2003). Household consumption is the biggest and an important component of Gross Domestic Product in developing as well as developed countries (Onanuga *et al.*, 2015). Goods and services are demanded as these provide satisfaction directly or indirectly and contribute to achieving certain living standards of households. Behavior of households differs in demand related decisions. There is difference in demand for goods and services across individuals, households, income, preferences, cultural traditions and local prices (Andersen and Watson, 2011).

Standard consumer theory focuses on consumer's income and prices as the main factors that can influence how the consumer allocates a given budget to different goods and services. While explaining the role of income and prices in consumers' budget allocation process, although the theory takes preference structure (utility function) of the consumer as given, it does not preclude the role of all such factors that can alter a consumer's choice even for a given income and set of prices.

When the theory is applied to real worlds data, it is unrealistic to take for granted the simplifying assumptions maintained in theory. Depending on the context where household demand system is analyzed, the empirical literature has explored a variety of factors that can influence preference structure (Ray, 1982, Barten, 1968, Deaton and Meulbauer, 1980). Since the unit of analysis even at micro level is family or household rather than individual, a popular practice to represent households' preference structure is to include household demography in demand analysis (Ketkar and Cho, 1982; Barnes and Gillingham, 1984). Some of the other popular variables included in demand analysis are ethnic/cultural identity such as black versus white race; rural versus urban residence and province/state of residence in culturally diverse societies among others (Burney and Khan, 1991, Hamlett *et al*., 2008).

Apart from such factors, external influences on households' choices are also important. Some of these influences are climatic conditions and the landscape that translates into specific cultural footprint. For example, people living in hot and dry deserts, cold mountains and humid coasts have developed their own surviving tools and socioeconomic traditions that result in distinct consumption baskets (Chung, 1998). Contrary to climatic conditions that tend to have permanent effects on consumer behavior, seasonal weather variations also influence demand pattern (Yohannes and Matsuda, 2016). Furthermore, seasonal variations do not necessarily have the same meaning in all types of climates. In some areas winters season is short, while in other areas it is long. Coastal areas around tropics tend to have moderate humid weather throughout the year.

Another factor that matters in household demand behavior is socioeconomic status or class. Households living in abject poverty have a distinct mindset that cannot be explained by usual treatment of income in consumer theory. Here income enters the allocation problem not only in its role in defining the so-called budget constraint but also as a factor that influences household preference structure. On the other extreme, transition from middle class to high income class exposes households to new lifestyles that can alter consumption baskets in fundamental ways.

Given the above background, the present study attempts to focus on three aspects of household demand in Pakistan with the aim to address some key issues related to resource allocation and policy making in public domain. In this respect the study also contributes to methodological side of applied consumer theory. These three aspects along with the related issues are explained in the following section.

1.2. OBJECTIVES OF THE STUDY

The first issue under consideration of this study relates to the possible differences in household demand between rural and urban areas and, especially between the four provinces of Pakistan. This aspect is important in the context of recent developments in the public finance of Pakistan. The Eighteenth Constitutional Amendment has resulted in the transfer of most of the public spending activities to provinces that do not require national harmony such as money printing, central banking and international finance; international affairs and trade; citizenship and immigration; national defense and so on. Some of the activities transferred to provinces are education, health, agriculture, food, social welfare, environment, sports, and culture. This constitutional amendment failed to transfer the matching revenue collection powers to provinces because of which federal government transfers a major portion of its revenues to provinces, which often creates conflicts, especially because the burden of borrowing and then the debt servicing falls almost entirely on federal government.

In this context the first essay of the present study attempts to develop a case for transferring some of the revenue collection powers to provinces employing the same argument that was used in the Eighteenth Amendment. The study explores differences in household demand, especially income and price elasticities across eight regions which are rural and urban areas of the four provinces. If significant differences in household demand between provinces are observed, the study would then argue that major portions of goods and services taxes that are not of uniform nature may be redesignated as provincial taxes. The structure of these taxes may be designed by provincial governments in the light of the specific demand patterns and other socioeconomic considerations prevailing in the respective provinces and independent of any federal government's intervention. However, to avoid the added administrative cost of revenue collection at provincial level, all the collection may be done by the federal government on behalf of provinces.

The second objective of the study is to analyze the influence of climatic conditions prevailing in different parts of the country and month to month seasonal variations on household demand. The country is divided into five climatic zones. The study addresses three specific objectives, which are: whether and how the household demand pattern differs across climatic zones and across months and to what extent seasonal variations in household demand are different across the five climatic zones.

There are three main reasons to represent climate by regions rather than any specific aspect of climate like heating and cooling days. First, any such measure would pick up only one aspect of climate and would ignore many other important aspects such as landscape environment like mountains, deserts and coasts that are responsible for creating the specific climate. Second, if climate is not linked to geography, the aspects like, ruggedness, remoteness and accessibility are ignored. Third, when climate is defined by region, it also covers the socioeconomic and cultural footprint that cannot be properly captured by temperature alone.

The study is important in the context of prevailing markets inefficiencies and monopolistic elements in Pakistan that cause frequent supply-demand imbalances and, hence, price instability. The commonly observed supply shocks are mostly region and season specific and often cause more serious consequences in cold mountain areas and during winter and rainy seasons due to heavy snowfalls, landslides and damage to highways. The knowledge gained through this study can help smooth supply of essential goods, especially to ensure food security.

The third essay focusses on the role of large changes in income in influencing households' preference structure. In this context the study contributes to modeling of household demand by extending Quadratic AIDS (Almost Ideal Demand System) to Quadratic AIDS Splines that allow smooth transition of household demand functions from one range of income to the next one separated by thresholds, which are called knots in the context of spline functions. The study also proposes a grid-search method of determining the number and locations of knots from the data.

This essay provides important information on changes in consumption pattern across income classes, which can be fruitfully utilized for making pricing and taxation policies, especially to ensure food security and provision of essential goods like health to poor households.

1.3. OUTLINE OF METHODOLOGY AND DATA

The study employs the most celebrated demand system, that is AIDS (Almost Ideal Demand System) or its extended form for the analysis. In the absence of any worthwhile panel data, the study relies on nine survey data sets collected over the period 2001 to 2016 pooled together. The pooing of all survey data results in a very large sample that permits combining information on prices from independent sources. Using the household identifying code, the data on each household is tagged to a specific month/year, district and rural versus urban residence. District and rural-urban identification help identifying the rural-urban, province and climatic zone of residence. The month identification is used to tag seasonal dummies and month/year identification is used to place prices against various observations.

To control for changing macroeconomic environment, a set of macroeconomic variables are included as control variables in regression analysis. These are GDP growth rate (G_Y); anticipated per capita GDP (LY_A); unanticipated per capita GDP (LY_U); and anticipated inflations rate (Inf_A) and unanticipated inflations rate (Inf_U).

To make the estimation manageable and keeping in view the limited information on prices, all the 400 plus goods and services are classifies in eight groups: Grains; Milk, Meats & Oil (including other dairy products, poultry, eggs and fish); Other Foods (including fruits, vegetables, herbs, spices, beverages, drinks, spices, sweets, bakery products and ready-made meals). Clothing (including apparel, linen, tapestry, textile and footwear); Housing (including fixture, furniture and other durables); Fuel & Lighting; Transport and Communication; and Other Non-Food (including all those goods and services that are not included in any other category).

1.4. STRUCTURE OF THE THESIS

The thesis comprises three interlinked main chapters. Chapter that follows presents the analysis of household demand for eight rural and urban regions of four provinces of Pakistan. In Chapter 3 the climate effects and seasonal effects on household demand are analyzed by dividing the geographical location of Pakistan in to five climatic zones. Chapter 4 proposes and estimates a system of Quadratic AIDS Splines to analyze the rule of income both as a binding factor in budget constraint and an indicator of changing preferences. Finally, Chapter 5 summarizes the thesis.

CHAPTER 2

COMPARATIVE ANALYSIS OF HOUSEHOLD DEMAND IN DIFFERENT REGIONS OF PAKISTAN

2.1. INTRODUCTION

Passing of the *Eighteenth Constitutional Amendment* by the *Senate* of Pakistan in 2010 was a landmark event that abolished a substantial portion of federal government's powers and transferred some of these to the provinces. Main thrust of the 'devolution' and 'provincial autonomy' was to make provinces responsible for most of public services except the ones that require national uniformity such as national defense; international affairs, citizenship, and immigration; central banking, currency, and foreign exchange. Seventeen ministries that were transferred to provinces included food and agriculture, health, education, social welfare, environment, sports, and culture.[1]

A serious shortcoming of the amendment and the related developments has been the asymmetry in the redistribution of revenues and revenue collecting powers between federation and provinces, because of which the process of devolution is considered incomplete. Although provinces have to spend on the newly assigned responsibilities, yet they are not given sufficient responsibility and autonomy in revenue collection; rather the federal government has taken responsibility of matching the spending needs of provinces in the revenue sharing formulas. Another problem that surfaced is that the federal government is expected to shoulder the entire burden of debt servicing, which after paying provinces' share leaves very little room for the federal government to

[1] See Shah (2012) for a comprehensive descriptive analysis of the amendment.

manage its budget. Although provinces have right and are encouraged to impose taxes on services, their progress is slow because of the cushion provided by provinces' share in federal tax revenues.

The anomaly of increased spending powers/responsibility with no matching revenue collection powers soon created financial pressure on federal government and the voices of reconsidering and possibly reversing the devolution process surfaced.

The present study explores the validity of an argument in favor of devolving the revenue collection powers on the same grounds that was the basis of transferring services provision to provinces. The argument is that all such taxes that are of uniform nature like income tax can be levied by federal government and the potentially non-uniform taxes on goods and services may be levied by provinces at the rates that are determined by revenue needs, welfare considerations and the consumer demand patterns of each province. Although various socioeconomic and political considerations matter in this context, the study focuses on one aspect, that is differences in household demand that provide one solid reason to allow differential tax regimes across provinces. The study does not address whether tax collection administration is to be developed in each province. Rather in case provinces are given autonomy of tax levy, the Canadian model can be used where each province decides its own tax structure, but the federal government makes all collections on behalf of provinces that are then transferred to provinces.

Although quite a few past studies have analyzed differences in consumption patterns across rural and urban regions of Pakistan, only few of them, Malik *et al*. (1987, 988); Ahmad and Malik (1989), have explored the differences across provinces. All these studies employed cross-sectional data and, therefore, confined the analysis to the estimation of Engle equations only. Even with this limited evidence Ahmad and Malik

(1989) concluded the study by proposing transfer of sales and excise taxes to provinces.

Coming now to technical side of the problem, exploration of the possible heterogeneity in household demand across provinces requires separate estimation of demand systems for the provinces, for which extensive data on consumption of goods and their prices are needed. Most of the past studies on household demand in Pakistan have used either pure time-series or pure cross-section data, both of which miss a substantial amount of information. An alternative approach not yet fully exploited for Pakistan is to pool various cross-sectional data sets. A few studies that have adopted this option have either used grouped household data to yield a very small number of observations (Ahmad, *et al*. 2020; Ahmad, *et al*. 2013) or have focused on energy demand rather than full demand system (Aslam and Ahmad, 2018).

Pooling household survey data collected in various independent rounds over time not only provides useful information both in cross-sectional and time dimensions, but also yields sufficient observations for each province to yield acceptable degrees of freedom and allow for reliable parameter estimates of the demand systems.

Apart from making use of year-to-year price variation in pooled data, it is also possible to utilize month-to-month variation as well. Each survey is spread almost across the whole year. From the date when a household was interviewed during each survey and using the recall period lag specified in the questionnaire, it is possible to tag specific month to each observation. The data on prices for various months is then directly placed against household data for the corresponding months.

To address the research question under consideration, it is desirable that the demand system is estimated with minimal extraneous restrictions that accompany with most of the empirical demand systems. Thus, for the sake of flexibility but at the same time adherence to theory and empirical considerations, Almost Ideal Demand System

(AIDS) of Deaton and Muellbauer (1980) is employed for the analysis. The system has the advantage that despite being reasonably flexible, it allows aggregation across consumers and satisfies most of the theoretical properties of well-behaved demand systems.

Although households tend to consume a large variety of goods and services, it is practically not feasible or even desirable to analyze the consumption decision regarding each of them. The common practice is to classify all the goods and services into a manageable number of groups, each containing more-or-less similar goods or services such as grains, clothing, housing, etc. and to analyze household demand with respect to these commodity groups. The goods and services are classified into these eight commodity groups: Grains; Milk, Meats & Oil; Other Foods; Clothing (including other textile items and footwear); Housing (including fixtures and other durable goods); Fuel & Lighting; Transport & Communication; and Other Non-Foods.

The demand systems are estimated for eight regions of Pakistan, that is, rural and urban areas of the four provinces of Pakistan. Nine cross-sectional data sets are pooled over the period 2001 to 2016. To control for changing macroeconomic environment over the sampled period, key macroeconomic variables that are expected to influence households' perceptions about the overall prevailing economic conditions are used as control variables. These include anticipated and unanticipated yearly inflation rates (Inf_A and Inf_U), anticipated and unanticipated output level(LY_A and LY_U) , and growth rate of output (G_Y). On basis of significant differences in household demand systems found across regions of provinces, a separate set of income and price elasticities are estimated for each region.

The rest of the chapter paper is organized as follows: review of literature is given in section 2. Methodology is presented in sections 3. Section 4 deals with data and estimation procedure, while section 5 presents the empirical results. Section 6 concludes the study with some policy implications.

2.2. REVIEW OF LITERATURE

Household demand analysis has received great attention around the world but the literature in case of Pakistan is scarce primarily because of limited data availability. First, there are no worthwhile panel data that can be used for a substantial analysis. Second, time series data are also quite limited and do not provide sufficient information on consistent basis. As a result, most of the literature is confined to cross sectional studies based on survey data. This practice has limited the scope of literature to the role of household level variables such as income and demography of households with no or very limited analysis of full demand functions in which prices play critical role.

Table 2.1 gives some idea of what is available in the literature for Pakistan. The table shows that despite limitation of data the literature has improved over time in terms of the specification of demand system, choice of explanatory variables as determinants of demand, estimation procedures and efficient use of the limited data. Most of the earlier studies have relied on cross-section survey data. Since in household surveys no substantial information is available on price variation that can only be observed over time, the studies tended to confine the analysis to estimation of Engle equations and income elasticities and focused more on the role of household characteristics, especially the rural versus urban residence and demographic composition of households. A few studies also extended the analysis to consider the role of rural versus urban residence and education level of household heads. The literature in 1980s and 1990s was mostly confined to Linear Expenditure System. All the studies that have estimated price elasticities in this part of the literature have not even used any information on prices and have derived price elasticities on the basis of estimated linear Engle equations. This

Table 2.1: Summary of Literature on Households' Demand for Pakistan

Study	Data Type	Focus of Analysis
Ali (1981)	Cross section	• Engle Equations system • Income and Price elasticities • Regional differences in consumption pattern
Ali (1985)	Cross section	• Engle Equations system • Income and Price elasticities • Regional differences in consumption pattern
Ahmad and Ludlow (1987)	Cross section	• Engle Equations system • Income and Price elasticities • Regional differences in consumption pattern
Malik *et al*. (1987)	Cross section	• Engle Equations system • Regional differences in consumption pattern
Ahmad *et al*. (1988)	Cross section	• Engle Equations system • Income and Price elasticities • Regional differences in consumption pattern
Malik *et al*. (1988)	Cross section	• Engle Equations system • Regional differences and over time changes in consumption pattern
Ahmad and Malik (1989)	Cross section	• Engle Equations system • Regional differences in consumption pattern
Burney and Akhtar (1990)	Cross section	• Engle Equations system • Income and price elasticities of demand for fuel items.
Burney and Khan (1991)	Cross section	• Engle Equations system • Engle equations estimated with focus of economies of scale and role of demographic composition of households
Burki (1997)	Time series	• Full demand system • Estimation of income and price elasticities of demand for food categories • Analysis of changing consumption pattern over time
Arshad and Ahmad (2006)	Cross section	• Engle Equations system • Estimation of flexible quadratic spline functions with three knots chosen through search algorithm • Estimation of income elasticities for rural and urban samples at different locations of income distribution

Table 2.1: Summary of Literature on Households' Demand for Pakistan

Study	Data Type	Focus of Analysis
Shamim and Ahmad (2007)	Cross section	• Engle Equations system • Estimation of flexible quadratic spline functions with six knots • Estimation of Engle Curves for rural and urban samples • Analysis of the role of demographic composition of households
Khan and Ahmed (2009)	Time series	• Demand functions for energy products • Income and price elasticities of demand for energy products at macro level
Jamil and Ahmad (2010)	Time series	• Demand function for electricity • Short and long run responses in sector-wise electricity demand to price and income changes
Jamil and Ahmad (2011)	Time series	• Demand function for electricity • Short and long run sector-wise income and price elasticities of electricity demand
Ahmad *et al.* (2013)	Grouped cross-sectional data pooled over time	• Full demand system • Income and price elasticities • Welfare effects of proposed tax reforms estimated
Ahmad *et al.* (2020)	Grouped cross-sectional data pooled over time	• Full demand system • Welfare implications of energy price changes
Sher and Ahmad (2021)	Micro-level survey data pooled over time	• Full demand system • Estimation of income and price elasticities for rural and urban areas

is done by imposing the arbitrary condition that the utility function underlying the estimated linear Engle equations is of Stone-Geary type.

As far as household demand analysis for Pakistan is concerned, Burki's (1997) study is perhaps the first one to estimate complete demand system using time series data on actual prices. Income and price elasticities of demand for only food categories were estimated.

Later, Jamil and Ahmad (2010, 2011) analyzed electricity demand for Pakistan also using time-series data. Income and price elasticities for electricity demand both at aggregate and disaggregate level for Pakistan were calculated. Demand functions for selected goods rather than complete demand systems were estimated.

Contrary to earlier studies where commodities specific demand functions were estimated, only recently three studies (Ahmad *et al*. 2013; Ahmad *et al*. 2020; and Sher and Ahmad, 2021) have estimated complete demand systems by pooling data from independent household surveys conducted over several years for rural and urban regions of Pakistan (aggregate level).

To conclude, the empirical literature on consumer demand in Pakistan is quite limited in its scope partly because it is constrained by data limitations. Only a few studies have attempted to estimate the complete demand system using genuine price variation over time. However, the first two of these studies employ grouped data in which households in a survey are categorized into 12 income groups. This grouping causes substantial loss of information on cross sectional variation in data. Furthermore, all the three studies mentioned above rely on limited price variation across years, ignoring the variation across months because in grouped data it is not possible to identify the months in which various households are approached in the surveys.

It is in this context that present study extends the literature on household demand for consumer goods to further disaggregate levels: rural and urban regions of four provinces of Pakistan, using pooled data and following complete demand system approach. Estimates of own price, cross price and income elasticities have important policy implications.

2.3. METHODOLOGY

Although quite a few functional forms of household demand functions are available in the literature, we choose AIDS of Deaton and Meulbauer (1980), which has served as a breakthrough in demand system. Alston and Chalfant (1993) commented that, in a relatively short time since the introduction of AIDS, economists had adopted it to the extent that it appeared to be the most popular of all demand systems. The system can be derived starting with the specification of expenditure function or more easily using the associated indirect utility function, which is given by:

$$U = \frac{\log M - \left(\alpha_0 - \sum_k \alpha_k \log P_k - \frac{1}{2}\sum_k \sum_j \gamma_{kj} \log P_k \log P_j\right)}{\beta_0 \prod_k (P_k)^{\beta_k}} \tag{1}$$

Here U, *M* and *P* denote utility, total expenditure, and the price vector, respectively.

It is now straightforward to apply Roy's identity to obtain the following uncompensated demand functions for goods *i = 1, ..., n* in expenditure shares form.

$$S_i = \alpha_i + \sum_j \gamma_{ij} \log P_j + \beta_i log \frac{M}{P^*} \tag{2}$$

where *M/P** is the real expenditure and *P** is the price index, defined as:

$$log(P^*) = \alpha_0 + \sum_k \alpha_k \log(P_k) + \frac{1}{2}\sum_k \sum_j \gamma_{kj} \log(P_k) \log(P_j) \tag{3}$$

Imposing the standard 'homogeneity' and 'adding-up' properties on the demand system leads to the following restrictions on parameters of the system.

$$\gamma_{ij} = \gamma_{ji}, \quad \sum_i \alpha_i = 1, \quad \sum_i \beta_i = 0, \quad \sum_i \gamma_{ij} = 0 \tag{4}$$

Further, to allow for the possible seasonal effects and the influence of macroeconomic environment on household demand, equation (2) is extended by including month dummies and the five macroeconomic variables that are likely to influence household perceptions and confidence and hence their demand decisions. These variables are anticipated and unanticipated annual inflation rate (Inf_A and Inf_U), anticipated and unanticipated components of GDP (LY_A and LY_U) and annual GDP growth rate (G_Y). The anticipated components are derived using the best fitted ARMA models applied to log first differences of CPI and real GDP, while the unanticipated components are obtained from residuals of these estimated models. The extended model is:

$$S_i = \alpha_i + \sum_j \gamma_{ij} \log(P_j) + \beta_i log\left(\frac{M}{P^*}\right) + \sum_{m=1}^{11} \theta_i^m \, D^m + \sum_{k=1}^{5} \lambda_i^k \, X^k + \mu_i \qquad (5)$$

In this equation D^m are dummy variables for the 11 months other than March starting with April and ending with February. Furthermore X^k denote the macroeconomic variables mentioned earlier. Finally, μ_i is the random error term. Based on theoretical properties of demand system the following additional restrictions are imposed on parameters of equation (5).

$$\sum_i \theta_i^m = \sum_i \lambda_i^k = 0 \quad for\ all\ m = 1, \ldots, 11\ and\ k = 1, \ldots 5 \qquad (6)$$

It can be verified that despite being highly flexible, AIDS satisfies the standard theoretical properties of demand system such as adding-up, homogeneity and Slutsky symmetry. The system is nonlinear in parameters. For given relative prices and real income *M/P** all the budget shares remain constant. The effects of changes in prices on demand are traced mainly through the parameters γ_{ij} while the effects of changes in real income works mainly through the parameter β_i. Further note that β_i is positive for relative luxuries and negative for relative necessities.

Due to non-linearity of demand functions, the system is often difficult to estimate and may lead to unreliable parameter estimates when the sample size is not sufficiently large. Even when the sample size is large as in our case, estimation inefficiency becomes as issue when some of the variables have small number of independent observations. This is the case with our price variables because for each point in time dimension the same set of prices are faced by all the sampled households. To handle these data deficiencies, we follow Deaton and Muellbauer (1980) and adopt linear approximation to AIDS by approximating the price index P^* to some known price index that can be calculated beforehand independent of the demand system. Specifically, they recommend the use of Stone (1953) price index given by:

$$log(P^*) = \alpha_0 + \sum_k s_k \log(P_k) \quad (7)$$

The advantage of this index is that it does not involve parameters of the demand system and can be estimated separately before the estimation of demand system AIDS. Once P^* is given the share equations of AIDS become linear in parameters and can be estimated easily. The AIDS that utilizes Stone price index is called Linear Approximation AIDS or LA/AIDS.

All own and cross price elasticities can be derived by taking log on both sides of the share equation (5) for good i and differentiating with respect to $\log(P_j)$. While applying differentiation, the goods' shares used in Stone price index given by equation (7) are treated endogenously and are subject to the same differentiation. The result of this differentiation is as follows wherein δ_{kj} is Kronecker delta; equal to 1 when i = j and zero when i ≠ j.

$$\eta_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{s_i} - \frac{\beta_i s_j}{s_i} - \frac{\beta_i}{s_i}\left[\sum_k s_k \ln P_k \left(\eta_{kj} + \delta_{kj}\right)\right] \quad (8)$$

Since price elasticities appear on both sides of the equation, all such equations are solved simultaneously. This can be easily done by writing the above equation for all $n \times n$ elasticities in matrix form as follows.

$$E = A - (BC)(E + I) \quad (9)$$

E is the n × n matrix of price elasticities η_{ij}.

A is the $n \times n$ matrix of elements $a_{ij} = -\delta_{ij} + \left(\frac{\gamma_{ij}}{s_i}\right) - \beta_i \left(\frac{s_j}{s_i}\right)$.

B is the $n \times 1$ vector of elements $b_i = (\beta_i / s_i)$ in n x 1 vector B.

C is the $1 \times n$ vector of elements $c_j = s_j \ln P_j$ in 1 x n vector C.

Now it is possible to find reduced form solution for the matrix of elasticities *E*:

$$E = [I + BC]^{-1}[A + I] - I \tag{10}$$

For income elasticities the share equation (8) for good i is differentiated after taking log on both sides to yield:

$$\eta_{iM} = 1 + \frac{\beta_i}{s_i} - \frac{\beta_i}{s_i}\left[\sum_k s_k \ln P_k \,(\eta_{kM} - 1)\right] \tag{11}$$

Or, in matrix form:

$$N = i + B - BC\lfloor N - i\rfloor \tag{12}$$

Therefore,

$$N = (I + BC)^{-1}B + i \tag{13}$$

N is the $n \times 1$ vector of income elasticities η_{iM}.

i is the $n \times 1$ matrix of ones.

2.4. DATA AND ESTIMATION

For empirical analysis nine cross-section data sets are pooled to yield a reasonably large sample for efficient estimation of the regions-wise demand systems even for the (population-wise) small regions like rural and urban Balochistan and urban Khyber Pakhtunkhwa.[2] Pooling is also needed to obtain price variation in data. These data are extracted from *HIES* (*Household Integrated Economic Survey*) carried out by Pakistan Bureau of Statistics (PBS) for the nine survey years: 2001-02, 2004- 05, 2005-06, 2007-08, 2008-09, 2010-11, 2011-12, 2013-14 and 2015-16.

Even though households use a large number of goods and services, it is neither feasible, nor advisable to estimate demand function at disaggregate level. Thus, the goods and services are classified into in eight broad commodity groups namely: 1)

[2] Region-wise sample size varies from the minimum of 5489 for urban Balochistan to 31535 for rural Punjab.

Grains (rice, wheat, lentils, peas and flours); 2) Milk, Meats & Oils (milk, milk products, meat, poultry, fish and edible oils, that is the main sources of protein, fats and calcium); 3) Other Foods (including vegetables, fruits, herbs, spices, sauces, bakery products, confectioneries, drinks, prepared meals); 4) Housing, Fixture & Furniture (houses, fixtures and other durables); 5) Clothing (all types of wears and textile products); 6) Fuel and Lighting; 7) Transport & Communication; and 8) Other Non-Food (consisting of all those goods and services that are not included in any of the other seven commodity group).

Although the surveys are conducted throughout the year, data on daily consumption items like foods and fuels are reported on fortnightly or monthly basis, while data on some goods like durables are reported on annual basis. Since the present study uses monthly data, all the consumption expenditure data are converted to monthly frequency. Thus, all the fortnightly expenditures are multiplied by 26 and then divided by 12, while annual expenditures are simply divided by 12.

Following the convention in empirical literature, especially for Pakistan, household income is proxies by total expenditure despite the availability of data on income. The reason is that households are often suspected not to accurately report their incomes intentionally or unintentionally and there are conceptual issues with how income data are reported. For example, proceed from sale of assets which is a measure of dissaving is reported as income. In rural areas income is also underreported because wages are partially paid in kind and some work activities are reported as unpaid work. Total expenditure is assumed to track the underlying income and is commonly used in literature to represent income.[3] Total expenditure is expressed in per adult equivalent

[3] See, for, example, Ahmad *et al*. (2013), Ahmad *et al*. (2020), Arshad and Ahmad (2006), Burney and Khan (1991), Malik *et al*. (1987), Malik *et al*. (1988), Huang *et al.* (1992), Karunakaran and Ahmad (1996); Ahmad and Karunakaran (1997) and Shamim and Ahmad (2007).

terms using OECD adult equivalence scales, where value of 1 is assigned to the first household adult member; 0.7 to each additional adult member and of 0.5 to each child.[4]

For prices of various commodity groups, the study uses data on the corresponding consumer price indices (CPIs). For some commodity groups the CPIs are directly taken from *Statistical Bulletin* or website of the Federal Bureau of Statistics. Where direct data on CPI are not available, the index is calculated as Laspeyres price index using the data on goods and services included in the groups and applying expenditure weights for the base year taken from the household survey data. The price index of the 'Miscellaneous' category is derived by using the statistical property of CPI that the overall CPI can be expressed as weighted average of commodity-group CPIs, where the weights are expenditure shares in the base year. All price indices are converted to the base year 2001-02.

To benefit from the maximum available information on prices, all price data are taken at monthly frequency. The household expenditure surveys are conducted throughout the year and from the date when a household was interviewed during each survey, the month can be identified. Using this information and the recall period lag specified in the questionnaire, a specific month is tagged to each observation. The monthly price data are then directly placed against household expenditure data for the corresponding months.

For macroeconomic indicators data on GDP and overall CPI are needed. While the data on CPI are taken from the website of the Federal Bureau of Statistics, no monthly data are available from any source. However, using the quarterly GDP data from the website of the State Bank of Pakistan, monthly data are constructed by

[4] We do not need to express expenditure on any individual expenditure category in per adult equivalent terms because in the econometric analysis expenditures on all categories are used in expenditure share forms which are independent of such scaling.

imposing linear logarithmic trend, continuity and consistency in aggregation of the interpolated monthly data to the observed quarterly data. Anticipated components of the variables are derived using the best fitted ARMA models applied to log first differences of CPI and real GDP, while the unanticipated components are obtained as residuals from these models.

The AIDS specified in equation (5) is a system of equations in which there are quite a few common parameters across various equations. Because of this reason and the possibility of contemporaneous correlation between errors of various share equation, all equations of the model are estimated together as one system referred to as Seemingly Unrelated Regression (SUR) model. The estimation technique followed is iterative two-step search procedure for Feasible Generalized Least Squares (FGLS) method. The systems approach permits the imposition of demand theory restrictions as given in equations (4) and (6) and provides a more-efficient parameter estimates than single OLS estimation of each equation (Ahmadi-Esfahani, 1998).

Since due to 'adding up' property of the demand system expenditure shares sum to one, a demand system composed of all the eight expenditure share equations would be singular. Therefore, one of the equations is dropped in direct estimation of the system. Parameter estimates of the omitted equation along with their standard errors are retrieved by applying the restrictions in equation (4) and (6) and the implied restrictions on the variance-covariance matrix of errors. [5] The system is estimated separately for each of the rural and urban regions of the four provinces of Pakistan; that is, rural and urban Balochistan, rural and urban Khyber Pakhtunkhwa, rural and urban Punjab, and rural and urban Sindh.

[5] Parameter estimates of the system are invariant with respect to the equation dropped in the direct estimation.

Once the demand systems are estimated, it is easy to compute all the price and income elasticities. However, since these elasticities are non-linear functions of the estimated parameters, their standard errors cannot be computed directly from the regression results. To overcome this limitation, the study employs bootstrapping procedure.

2.5. TESTS FOR REGIONAL DIFFERENCES IN DEMAND SYSTEMS

2.5.1. PRELIMINARIES

Before analyzing the nature of households' demands it is necessary to decide as to what level of region-wise classification of data is suitable for the estimation of AIDS. Most of the past studies consider it worthwhile to classify the data into rural and urban areas of Pakistan (See for example, Ali, 1981; Ahmad and Malik, 1989; Burney and Khan, 1991; Bouis, 1992; Burki, 1997; Aziz and Malik, 2010; Ahmad *et al*., 2020; Ahmad *et al*., 2012; Urooj *et al.*, 2013; Jalil and Khan, 2018; Aslam and Ahmad, 2018; Sher and Ahmad, 2021). A few studies also classify the data into the four provinces or even in eight regions comprising rural and urban areas of the four provinces (See for example, Ahmad and Ludlow, 1987; Muhammad Malik and Azam Syed, 2012; Shabnam *et al*., 2021; Ahmad et al., 2015; Hina *et al*., 2022). In this study, we consider all the possibilities and follow two approaches to make a choice between the following four alternative classifications:

A. All Pakistan with no further classification
B. Rural and urban households
C. Four provinces of Pakistan: Punjab, Sindh, Khyber Pakhtunkhwa and Balochistan

D. Rural and urban households of the four provinces: rural Punjab, urban Punjab. rural Sindh, urban Sindh, rural Khyber Pakhtunkhwa, urban Khyber Pakhtunkhwa, rural Balochistan and urban Balochistan

The first approach used for choosing between the four classification options is based on conventional statistical tests of hypotheses for the differences between sets of coefficients. The second approach is based on machine learning (hereafter ML) models. The first approach and its results are presented in sub-section 2.5.2, while the second approach and its results are presented in sub-section 2.5.3.

2.5.2. CHOICE OF REGIONAL CLASSIFICATION BASED ON CONVENTIONAL HYPOTHESIS TESTS

Table 2.2 presents the outcome of testing various null hypotheses to explore the

Table 2.2: Tests of Differences in Demand System Across Regions (All F-statistics are significant at 1% level)

Null Hypothesis	F statistic
There is no difference in parameters of demand system between rural and urban Balochistan	78.61
There is no difference in parameters of demand system between rural and urban Khyber Pakhtunkhwa	276.05
There is no difference in parameters of demand system between rural and urban Punjab	204.66
There is no difference in parameters of demand system between rural and urban Sindh	245.67
There is no difference in parameters of demand system between rural and urban areas within any province (differences across provinces are allowed)	194.03
There is no difference in parameters of demand system across the four provinces within the category of rural households	190.07
There is no difference in parameters of demand system across the four provinces within the category of urban households	40.23
There is no difference in parameters of demand system across the four provinces within rural or within urban households (differences between rural and urban areas are allowed)	112.84
There is no difference in parameters of demand system across the eight regions (rural and urban areas of the four provinces)	66.02

Note: Author's own calculations.

regional differences in demand systems. The first four rows show that household demand functions differ significantly in each province considered one at a time. The fifth row shows the result of joint null hypothesis that the demand system remains the same between rural and urban areas of all provinces, while allowing the system to be different across provinces. This joint hypothesis also stands rejected. It follows, therefore, that household consumption pattern differs significantly between rural and urban areas, not only in Pakistan in general but also within each of the four provinces. The next three rows (6, 7 and 8) test the null hypotheses that parameters of the demand systems are the same across provinces within the categories of rural or urban households considered one by one or jointly. These hypotheses are also rejected, indicating that significant differences in consumption patterns exist across provinces. The last row of the table tests the null hypothesis that parameters of the demand systems are the same across all the eight regions and this hypothesis is also rejected.

The above results signify the need for estimating a separate demand system for the eight regions of Pakistan, that is, rural and urban areas of each of the four provinces.

2.5.3. CHOICE OF REGIONAL CLASSIFICATION BASED ON MACHINE LEARNING

To make a choice between alternative classifications of data, cross-validation approach is used in which the out-of-sample predictive power of the estimated models under each of the four classifications of data is evaluated. We adopt the cross-validation approach proposed in Zhao *et al*. (2022), suitably modified for the purpose at hand. So, the data are split randomly between two mutually exclusive subsets called the training and validation sets. The split ratio is often set at 80:20 (that is 80% for training set and 20% for validation set). If the data are stratified as in our case, more-or-less the same split ration should be applied to all the strata (see Kohavi, 2001).

The models under consideration are estimated on the training set and the estimated models are used to make predictions over the validation set. This exercise is repeated k folds many, where k is usually set at 10 or 20 of even 100. Using the k-fold predictions the predictive accuracy of each model is evaluated and the model with minimum prediction error is selected. In the present context the following steps are carried out.

Step 1: Sort the entire data of 127441 households by eight regions comprising rural and urban regions of the four provinces.

Step 2: In each region split the data randomly into training set and validation set using a split-ratio of 80: 20 for each region.

Step 3: Estimate AIDS models under each of the four classifications options A, B, C and D using the respective training sets.

Step 4: Use the estimated AIDS models to make predictions over the respective validation sets under the classification options A, B, C and D.

Step 5: Compute means absolute forecast error and mean square forecast error for each of the four classifications.

Step 6: Create 100-fold independent sets of predictions for each classification option by repeating steps 1 to 5 above 100 times.

Step 7: Find simple means of the 100-fold forecast error measures computed in step 5.

Step 8: Chose the classification option that yields the lowest value of the mean forecast error measures.

The results of cross-validation analysis under ML forecast performance algorithm are shown in Table 2.3. Since only seven of the eight demand functions are independent due to adding-up restrictions, the cross-validation results are shown for the first seven commodity groups and the overall demand system. The table shows that the estimated demand system with data classified into eight regions comprising rural and urban areas of the four provinces outperforms all the other classification. According to both the forecast error criteria the disaggregated analysis is observed to perform better in cross validation for the entire demand system as well as for each of the seven commodity groups.

The results further show that according to mean square error criterion the province-wise disaggregate analysis is the second-best performer, while by the mean absolute

Table 2.3: The results of Machine Learning Cross Validation Analysis

Commodity Group Categories	Data Classification Options			
	All Pakistan	Rural and urban Pakistan	The Four provinces of Pakistan	Rural and urban areas of the four provinces
Mean Absolute Error				
Grains	0.037879	0.035288	0.036667	**0.033449**
Milk, meats & Oil	0.058249	0.056815	0.058340	**0.056166**
Other foods	0.045005	0.044473	0.040583	**0.038415**
Clothing	0.020531	0.020141	0.019421	**0.019333**
Housing	0.065289	0.056790	0.078198	**0.055351**
Fuel & lighting	0.037977	0.037439	0.034062	**0.031341**
Transport & commun	0.038032	0.038016	0.040462	**0.037275**
Complete demand system	0.043280	0.041280	0.043962	**0.038761**
Mean Square Error				
Grains	0.002569	0.002275	0.003045	**0.002058**
Milk, meats & Oil	0.005788	0.005491	0.006721	**0.005348**
Other foods	0.003886	0.003819	0.003384	**0.003095**
Clothing	0.000759	0.000721	0.000682	**0.000676**
Housing	0.007647	0.006329	0.142218	**0.006063**
Fuel & lighting	0.002614	0.002550	0.003101	**0.001933**
Transport & commun	0.003252	0.003253	0.003423	**0.003189**
Complete demand system	0.003788	0.003491	0.023225	**0.003195**

Note: Author’s own calculations.

error criterion rural-urban disaggregate analysis performs slightly better than the province-wise disaggregate analysis. Finally, as expected, aggregate Pakistan level analysis appears the worst performer.

The above results on cross-validation performance along with the results of conventional hypothesis testing presented in the sub-section 2.5.2 indicate that the estimates of demand system based on disaggregate analysis for the rural and urban areas of each province are relatively more reliable for understanding household demand system in Pakistan and to using this knowledge in income, pricing and taxation policies.

2.6. FINAL RESULTS AND DISCUSSION

2.6.1. ESTIMATES OF AIDS

Parameter estimates of the eight demand systems are presented in Tables A1 to A8 in the appendix. Each of these tables shows estimates of 80 parameters related to the main AIDS, out of which 42 parameters are independent, another 21 parameters appear twice because of symmetry restrictions while the remaining 17 parameters are obtained from the adding-up restrictions. Beside these, another 40 parameters represent demand responses to changes in macroeconomic conditions and out of these 35 are independent and 5 are driven by adding-up restrictions.

Table 2.4: Percentage of Significant Parameters in Estimated AIDS

Region	Micro variables	Macro variables	All variables
Urban Balochistan	57.50	65.00	60.00
Urban Khyber Pakhtunkhwa	58.75	62.50	60.00
Urban Punjab	58.75	67.50	61.67
Urban Sindh	63.75	82.50	70.00
Rural Balochistan	57.50	80.00	65.00
Rural Khyber Pakhtunkhwa	67.50	82.50	72.50
Rural Punjab	71.25	80.00	74.17
Rural Sindh	70.00	85.00	75.00
All regions	63.13	75.63	67.29

Note: Author’s own calculations.

Direct interpretation of the estimated parameters of AIDS is not straightforward. Given that we are going to estimate all the income and price elasticities along with their standards errors, it is not worthwhile to try to interpret all the parameter estimates presented in the tables. Nevertheless, it may be noted that the regression results are reasonably credible because a large proportion of parameters are significantly different from zero. Percentage of significant parameters for above mentioned estimated AIDS models reported in Table 2.4 shows that about 63% of the parameters associated with microeconomic variables (goods prices and household income) are significantly different from zero, while almost 76% of the parameters associated with macroeconomic variables are significant. We can also notice that a fairly large number of parameters are significant in each of the eight regions.

2.6.2. INCOME AND PRICE ELASTICITIES

The results of income and price elasticities are presented in Tables: 2.5 to 2.12. Own price elasticities are given on diagonal while cross price elasticities lie off-diagonal in these tables. All income elasticities appear in last columns of the tables. The standard errors and, hence, t-statistics of various elasticities are computed following bootstrapping technique. Hence, all the elasticities are re-estimated based on repeated resamples (with replacement) drawn from the original data. The standard errors are then computed using the sets of elasticities generated through various bootstrap samples. Initial experiments show that at 200 samples the standard errors become quite stable. However, to be more careful the number of samples is set equal to 250.

The results show that all income elasticities are positive and significantly different from zero in each of the eight regions. That is, none of the commodity groups is considered as 'inferior' in any region. This is an expected result in the present analysis wherein goods and services are aggregated into a small number of groups. As far as classification of goods between relative necessities and relative luxuries is concerned, most of the income elasticities are similar across the eight regions.

Specifically, income elasticities for Grains, Other Foods, Clothing and Fuel & lighting are less than one in all the regions, while those for Housing, Transport & communication and other non-foods are greater than one. Only in case of Milk, meats & oil income elasticity varies around one across various regions, but the range of variation is small. However, the magnitudes of income elasticities are somewhat different across the eight regions. For example, income elasticity of Grains varies from the lowest value of 0.59 in rural Punjab to the highest value of 0.92 in rural Khyber Pakhtunkhwa. Similarly, income elasticity of Fuel & lighting varies from 0.64 in rural Khyber Pakhtunkhwa to 0.94 in rural Sindh and 0.95 in urban Sindh. For all the other commodity groups the variation in income elasticity across regions is relatively less.

Coming now to own-price elasticities, the tables show that all the elasticity parameters are negative as expected and about 92% (that is, 59 of the 64) elasticities are significantly different from zero. The demand for Grains; Milk, meats & oil; Other foods and Clothing are relatively price inelastic in all the eight regions except that in urban Balochistan where the demand for clothing is highly price elastic (elasticity equals to -1.85). On the other hand, the demand for Housing; Fuel & lighting and Other non-foods are price elastic with two exceptions. First, contrary to its pattern in other regions, Housing demand in rural Sindh appears highly price inelastic. Second, unlike the other regions, demand for Fuel & lighting in rural Khyber Pakhtunkhwa is slightly price inelastic. Finally, the demand for Transport & communication shows mixed pattern. It is price inelastic in urban Balochistan, rural Khyber Pakhtunkhwa and rural Sindh and price elastic in the other five regions.

Apart from the classification of goods between price elastic and price inelastic

Table 2.5: Own Price, Cross Price and Income Elasticities for Urban Baluchistan

Commodity group	Grains	Milk, meats & Oil	Other foods	Clothing	Housing	Fuel & lighting	Transport & commun.	Other non-food	Income Elasticity
Grains	-0.161 (-2.18*)	0.121 (-0.55)	0.24 (2.26*)	-0.789 (-7.01*)	-0.815 (-5.09*)	0.016 (3.77*)	0.36 (5.93*)	0.315 (-1.53)	0.724 (116.8*)
Milk, meats & Oil	0.015 (-0.07)	-0.24 (-4.05*)	-0.729 (-7.95*)	0.766 (6.14*)	0.024 (-0.68)	0.01 (2.08*)	-0.167 (-5.66*)	-0.682 (-0.57)	1.002 (160.6*)
Other foods	0.151 (2.20*)	-0.835 (-7.85*)	-0.212 (-4.21*)	0.453 (2.92*)	0.348 (-1.25)	0.013 (1.91**)	-0.773 (-1.15)	-0.106 (2.06*)	0.962 (158.9*)
Clothing	-1.427 (-7.16*)	2.393 (6.21*)	1.243 (2.98*)	-1.85 (-0.78)	-6.18 (-7.43*)	-0.011 (-0.05)	2.111 (4.63*)	2.826 (-0.03)	0.898 (113.0*)
Housing	-0.583 (-5.68*)	-0.029 (-0.40)	0.33 (-1.37)	-2.281 (-7.36*)	-1.143 (-4.39*)	0.009 (-1.18)	0.321 (2.71*)	2.208 (4.97*)	1.162 (124.9*)
Fuel & lighting	0.01 (2.56*)	0.066 (3.68*)	0.041 (2.50*)	-0.043 (-1.46)	0.016 (2.20*)	-1.05 (-119.4*)	0.073 (5.66*)	0.001 (-3.21*)	0.89 (97.73*)
Transport & commun.	0.535 (5.40*)	-0.591 (-5.84*)	-2.137 (-1.28)	2.156 (4.58*)	1.044 (3.00*)	0.035 (2.07*)	-0.156 (-2.00*)	-2.098 (-4.56*)	1.203 (77.64*)
Other non-food	0.121 (-2.04*)	-0.863 (-0.42)	-0.148 (1.97*)	1.12 (-0.02)	2.428 (5.05*)	-0.034 (-5.68*)	-0.807 (-4.57*)	-2.919 (-3.67*)	1.098 (151.7*)

Note: Each row shows elasticities of the commodity group indicated in the row. The t-values (in parentheses) significance at 5% and 10% levels are indicated by * and ** respectively.

Table 2.6: Own Price, Cross Price and Income Elasticities for Urban Khyber Pakhtunkhwa

Commodity group	Grains	Milk, meats & Oil	Other foods	Clothing	Housing	Fuel & lighting	Transport & commun.	Other non-food	Income Elasticity
Grains	-0.282 (-2.68*)	0.021 (-0.20)	-0.299 (-2.49*)	-0.563 (-9.24*)	0.026 (-0.22)	0.001 (-0.15)	-0.221 (-1.77**)	0.649 (5.45*)	0.684 (155.6*)
Milk, meats & Oil	-0.024 (-0.37)	-0.304 (-2.47*)	-0.539 (-4.63*)	-0.116 (-1.76**)	-0.073 (-0.80)	0.034 (5.11*)	0.264 (2.33*)	-0.158 (-1.25)	0.921 (236.5*)
Other foods	-0.21 (-2.51*)	-0.591 (-4.56*)	-0.81 (-4.53*)	-0.29 (-3.01*)	0.258 (2.06*)	-0.011 (-1.36)	-0.163 (-1.14)	0.863 (5.85*)	0.956 (210.5*)
Clothing	-1.174 (-9.33*)	-0.357 (-1.65**)	-0.856 (-3.01*)	-0.568 (-2.70*)	1.078 (4.26*)	0.031 (3.38*)	0.336 (-1.15)	0.61 (2.82*)	0.905 (185.3*)
Housing	-0.063 (-0.68)	-0.166 (-1.43)	0.275 (1.96**)	0.398 (4.16*)	-1.468 (-9.64*)	-0.008 (-0.72)	0.322 (2.43*)	-0.528 (-3.44*)	1.226 (162.7*)
Fuel & lighting	-0.014 (-1.41)	0.093 (6.37*)	-0.026 (-1.72**)	0.015 (2.44*)	0.05 (2.66*)	-1.056 (-96.27*)	-0.015 (-1.10)	0.108 (5.29*)	0.853 (106.2*)
Transport & commun.	-0.543 (-2.21*)	0.744 (2.11*)	-0.474 (-1.18)	0.313 (-1.13)	0.819 (2.47*)	-0.065 (-3.31*)	-1.043 (-1.77**)	-1.025 (-2.77*)	1.261 (56.5*)
Other non-food	0.344 (4.50*)	-0.22 (-1.70**)	0.773 (5.68*)	0.18 (2.67*)	-0.414 (-3.27*)	0.019 (2.12*)	-0.322 (-2.62*)	-1.525 (-9.03*)	1.156 (113.2*)

Note: Each row shows elasticities of the commodity group indicated in the row. The t-values (in parentheses) significance at 5% and 10% levels are indicated by * and ** respectively.

Table 2.7: Own Price, Cross Price and Income Elasticities for Urban Punjab

Commodity group	Grains	Milk, meats & Oil	Other foods	Clothing	Housing	Fuel & lighting	Transport & commun.	Other non-food	Income Elasticity
Grains	-0.496 (-5.45*)	-0.186 (-5.03*)	-0.274 (4.19*)	-0.249 (-5.82*)	0.022 (-0.52)	0.015 (2.95*)	-0.067 (0.68)	0.666 (1.79**)	0.589 (196.4*)
Milk, meats & Oil	-0.116 (-6.2*)	-0.514 (-8.25*)	0.009 (-4.88*)	0.065 (5.20*)	-0.208 (-3.49*)	0.025 (7.68*)	-0.082 (-2.54*)	-0.095 (0.42)	0.918 (307.9*)
Other foods	-0.145 (4.51*)	0.037 (-4.69*)	-0.342 (-7.54*)	-0.213 (0.26)	-0.714 (-2.29*)	0.012 (2.77*)	-1.006 (-6.29*)	1.431 (6.01*)	0.944 (263.0*)
Clothing	-0.37 (-6.05*)	0.209 (5.21*)	-0.472 (0.28)	-0.949 (-1.58)	-0.035 (-1.52)	0.012 (3.29*)	0.373 (-0.90)	0.35 (1.39)	0.887 (240.9*)
Housing	-0.051 (-1.61)	-0.264 (-4.14*)	-0.493 (-2.47*)	-0.028 (-1.59)	-1.639 (-5.61*)	0.005 (0.94)	1.089 (8.05*)	0.173 (-0.11)	1.197 (300.0*)
Fuel & lighting	-0.008 (-1.33)	0.065 (7.89*)	-0.006 (1.98*)	0.007 (0.44)	0.08 (6.02*)	-1.079 (-182.5*)	0.047 (4.86*)	0.043 (2.35*)	0.857 (181*)
Transport & commun.	-0.235 (-0.45)	-0.346 (-3.16*)	-2.1 (-6.49*)	0.336 (-1.00)	3.261 (8.08*)	0.001 (-0.50)	-1.114 (-2.94*)	-1.124 (-3.60*)	1.307 (160.3*)
Other non-food	0.235 (0.94)	-0.147 (-0.13)	1.011 (5.71*)	0.098 (1.30)	0.217 (-0.03)	-0.015 (-3.18*)	-0.363 (-3.45*)	-2.162 (-7.28*)	1.122 (296.4*)

Note: Each row shows elasticities of the commodity group indicated in the row. The t-values (in parentheses) significance at 5% and 10% levels are indicated by * and ** respectively.

Table 2.8: Own Price, Cross Price and Income Elasticities for Urban Sindh

Commodity group	Grains	Milk, meats & Oil	Other foods	Clothing	Housing	Fuel & lighting	Transport & commun.	Other non-food	Income Elasticity
Grains	-0.264 (-2.17*)	0.623 (5.97*)	0.612 (6.08*)	-0.237 (-2.92*)	-0.742 (-4.45*)	0.014 (2.60*)	0.466 (4.20*)	-1.103 (-6.42*)	0.644 (13.0*)
Milk, meats & Oil	0.304 (6.23*)	-0.308 (-4.47*)	-0.295 (-3.89*)	0.336 (4.80*)	-0.515 (-5.90*)	0.019 (4.80*)	-0.439 (-6.30*)	0.014 (0.16)	0.887 (165.7*)
Other foods	0.387 (6.23*)	-0.398 (-3.95*)	-0.8 (-4.89*)	0.078 (0.80)	0.609 (4.27*)	0.013 (2.58*)	-1.06 (-9.23*)	0.226 (1.37)	0.946 (144.7*)
Clothing	-0.394 (-2.57*)	1.375 (4.86*)	0.262 (0.89)	-0.529 (-1.06)	-2.034 (-3.69*)	0.022 (4.08*)	-1.167 (-3.35*)	1.584 (3.18*)	0.885 (35.5*)
Housing	-0.449 (-5.87*)	-0.575 (-6.58*)	0.424 (4.01*)	-0.505 (-3.62*)	-1.406 (-8.16*)	-0.007 (-1.24)	1.093 (8.20*)	0.197 (1.16)	1.22 (73.72*)
Fuel & lighting	-0.001 (-0.14)	0.046 (3.84*)	0.029 (2.56*)	0.006 (1.51)	0.027 (1.59)	-1.079 (-114.4*)	0.026 (2.20*)	0.002 (0.15)	0.945 (140.7*)
Transport & commun.	0.523 (3.72*)	-1.267 (-6.67*)	-2.21 (-9.46*)	-0.799 (-3.37*)	3.015 (8.29*)	0.004 (0.42)	-1.093 (-3.33*)	0.638 (1.81**)	1.182 (71.08*)
Other non-food	-0.672 (-7.02*)	-0.029 (-0.29)	0.164 (1.18)	0.442 (3.15*)	0.245 (1.26)	-0.01 (-1.88**)	0.256 (1.73**)	-1.504 (-5.99*)	1.103 (256.9*)

Note: Each row shows elasticities of the commodity group indicated in the row. The t-values (in parentheses) significance at 5% and 10% levels are indicated by * and ** respectively.

Table 2.9: Own Price, Cross Price and Income Elasticities for Rural Baluchistan

Commodity group	Grains	Milk, meats & Oil	Other foods	Clothing	Housing	Fuel & lighting	Transport & commun.	Other non-food	Income Elasticity
Grains	-0.367 (-4.68*)	-0.855 (-12.7*)	0.162 (2.70*)	-0.092 (-1.77**)	0.036 (-0.86)	0.073 (6.91*)	0.342 (5.99*)	-0.041 (-0.81)	0.755 (172.7*)
Milk, meats & Oil	-0.639 (-13.5*)	-0.406 (-6.28*)	-0.734 (-18.6*)	0.164 (4.23*)	0.247 (4.27*)	0.042 (3.54*)	-0.21 (-4.60*)	0.504 (8.43*)	1.031 (199.3*)
Other foods	0.094 (-1.63)	-0.856 (-18.4*)	-0.841 (-18.6*)	-0.142 (-3.63*)	0.013 (-0.53)	-0.008 (-0.94)	0.573 (12.1*)	0.167 (2.62*)	0.999 (226.6*)
Clothing	-0.257 (-2.08*)	0.568 (4.33*)	-0.396 (-3.52*)	-0.555 (-1.56)	-0.305 (-1.08)	0.068 (4.84*)	0.198 (-1.30)	-0.254 (-1.77**)	0.937 (165.8*)
Housing	-0.018 (-0.2)	0.522 (4.26*)	-0.012 (-0.18)	-0.205 (-1.15)	-1.007 (-4.68*)	-0.044 (-1.86**)	-0.511 (-4.04*)	0.103 (-0.75)	1.164 (112.0*)
Fuel & lighting	0.136 (7.00*)	0.127 (3.94*)	0.007 (-0.38)	0.059 (5.34*)	-0.03 (-0.97)	-1.158 (-68.6*)	-0.0001 (-0.07)	-0.019 (-0.77)	0.883 (119.9*)
Transport & commun.	0.735 (5.23*)	-0.734 (-4.62*)	1.652 (11.8*)	0.178 (-1.13)	-0.828 (-3.98*)	-0.036 (-1.48)	-1.349 (-5.75*)	-0.859 (-4.28*)	1.229 (100.3*)
Other non-food	-0.115 (-1.76**)	0.751 (8.39*)	0.189 (2.32*)	-0.123 (-1.97*)	0.083 (-0.85)	-0.029 (-1.94**)	-0.36 (-4.19*)	-1.501 (-12.6*)	1.099 (161.8*)

Note: Each row shows elasticities of the commodity group indicated in the row. The t-values (in parentheses) significance at 5% and 10% levels are indicated by * and ** respectively.

Table 2.10: Own Price, Cross Price and Income Elasticities for Rural Khyber Pakhtunkhwa

Commodity group	Grains	Milk, meats & Oil	Other foods	Clothing	Housing	Fuel & lighting	Transport & commun.	Other non-food	Income Elasticity
Grains	-0.675 (-13.1*)	-0.788 (-12.9*)	0.373 (6.17*)	-0.358 (-1.61)	0.269 (4.26*)	0.052 (6.30*)	0.243 (5.51*)	-0.029 (-5.77*)	0.918 (231.9*)
Milk, meats & Oil	-0.661 (-13.2*)	-0.544 (-7.12*)	-0.043 (-1.34)	-0.076 (-7.23*)	0.745 (15.5*)	0.026 (3.11*)	-0.139 (-3.13*)	-0.299 (-5.20*)	0.991 (262.3*)
Other foods	0.456 (6.47*)	-0.05 (-1.19)	-0.495 (-7.77*)	-0.283 (7.31*)	-1.113 (-9.71*)	-0.07 (-8.88*)	-0.167 (-2.62*)	0.801 (5.91*)	0.925 (275.5*)
Clothing	-0.982 (1.72**)	-0.246 (-7.17*)	-0.663 (7.28*)	-0.612 (-2.62*)	2.159 (-2.27*)	0.031 (4.03*)	0.022 (-3.25*)	-0.657 (4.92*)	0.951 (205.0*)
Housing	0.428 (3.57*)	1.693 (15.3*)	-1.844 (-9.91*)	1.499 (-2.32*)	-1.259 (-3.92*)	-0.015 (-1.28)	-0.917 (-2.38*)	-0.813 (2.46*)	1.214 (149.9*)
Fuel & lighting	0.17 (10.5*)	0.113 (5.24*)	-0.108 (-6.65*)	0.049 (4.10*)	0.092 (1.69**)	-0.896 (-55.9*)	0.012 (1.77**)	-0.047 (-2.60*)	0.636 (116.2*)
Transport & com	0.768 (5.04*)	-0.604 (-3.33*)	-0.496 (-2.81*)	0.009 (-3.32*)	-1.659 (-2.40*)	-0.021 (-0.05)	-0.715 (-3.52*)	1.504 (6.82*)	1.203 (111.7*)
Other non-food	-0.088 (-7.01*)	-0.378 (-5.61*)	0.632 (5.23*)	-0.251 (4.64*)	-0.433 (2.38*)	-0.076 (-6.76*)	0.428 (6.68*)	-1.037 (-16.7*)	1.191 (243.8*)

Note: Each row shows elasticities of the commodity group indicated in the row. The t-values (in parentheses) significance at 5% and 10% levels are indicated by * and ** respectively.

Table 2.11: Own Price, Cross Price and Income Elasticities for Rural Punjab

Commodity group	Grains	Milk, meats & Oil	Other foods	Clothing	Housing	Fuel & lighting	Transport & commun.	Other non-food	Income Elasticity
Grains	-0.349 (-8.54*)	-0.247 (-3.85*)	-0.074 (-2.62*)	0.162 (4.95*)	0.173 (2.49*)	0.082 (8.80*)	0.034 (-0.83)	-0.444 (-6.01*)	0.683 (278.4*)
Milk, meats & Oil	-0.153 (-4.47*)	-0.364 (-5.58*)	0.396 (14.3*)	-0.211 (-5.22*)	-1.17 (-20.17*)	0.031 (3.09*)	0.082 (1.90**)	0.364 (4.54*)	1.024 (361.5*)
Other foods	-0.110 (-4.89*)	0.605 (14.5*)	-0.843 (-26.5*)	-0.383 (-13.08*)	0.229 (3.69*)	0.031 (3.51*)	0.094 (2.70*)	-0.602 (-8.81*)	0.981 (344.4*)
Clothing	0.207 (3.71*)	-0.685 (-5.06*)	-0.837 (-12.7*)	-0.571 (-2.96*)	2.577 (8.54*)	0.01 (-0.77)	-0.273 (-2.64*)	-1.319 (-4.37*)	0.898 (264.2*)
Housing	0.137 (1.82**)	-2.538 (-20.5*)	0.293 (3.31*)	1.63 (8.56*)	-1.386 (-3.31*)	0.021 (-1.20)	-0.849 (-6.80*)	1.505 (3.61*)	1.177 (220.8*)
Fuel & lighting	0.113 (8.76*)	0.088 (3.46*)	0.074 (4.91*)	0.028 (2.68*)	0.052 (2.28*)	-1.173 (-78.87*)	-0.0035 (-0.19)	-0.041 (-1.53)	0.87 (227.9*)
Transport & commun.	0.041 (-0.48)	0.310 (1.84**)	0.200 (2.20*)	-0.369 (-3.04*)	-1.575 (-6.8*)	-0.018 (-0.61)	-1.546 (-8.07*)	1.69 (6.35*)	1.252 (152.5*)
Other non-food	-0.389 (-8.34*)	0.443 (4.47*)	-0.511 (-9.02*)	-0.513 (-4.64*)	0.857 (3.52*)	-0.046 (-3.72*)	0.544 (6.52*)	-1.517 (-5.81*)	1.125 (336.5*)

Note: Each row shows elasticities of the commodity group indicated in the row. The t-values (in parentheses) significance at 5% and 10% levels are indicated by * and ** respectively.

Table 2.12: Own Price, Cross Price and Income Elasticities for Rural Sindh

Commodity group	Grains	Milk, meats & Oil	Other foods	Clothing	Housing	Fuel & lighting	Transport & commun.	Other non-food	Income Elasticity
Grains	-0.453 (-5.19*)	-0.081 (-2.36*)	-0.322 (-2.61*)	0.143 (-0.06)	0.101 (2.43*)	0.059 (4.48*)	0.262 (3.56*)	-0.457 (-3.21*)	0.759 (27.92*)
Milk, meats & Oil	-0.081 (-3.61*)	-0.796 (-12.43*)	-0.12 (-0.96)	-0.011 (3.54*)	-0.202 (-3.55*)	-0.01 (-1.30)	-0.225 (-4.52*)	0.423 (-0.07)	1.023 (246.3*)
Other foods	-0.256 (-3.65*)	-0.153 (-0.80)	-0.762 (-8.82*)	-0.277 (1.74**)	-0.504 (-2.64*)	0.023 (3.41*)	-0.127 (6.47*)	1.093 (-0.26)	0.966 (311.5*)
Clothing	0.364 (-0.37)	-0.032 (4.36*)	-0.851 (1.92**)	-0.671 (-2.48*)	-0.005 (-5.69*)	0.034 (-1.01)	-0.49 (-7.65*)	0.721 (2.90*)	0.932 (193.2*)
Housing	0.032 (2.59*)	-0.514 (-3.48*)	-0.964 (-2.97*)	-0.022 (-3.95*)	-0.153 (-3.84*)	-0.041 (-3.69*)	0.783 (3.38*)	-0.318 (3.24*)	1.188 (27.75*)
Fuel & lighting	0.125 (5.95*)	-0.025 (-0.95)	0.055 (3.94*)	0.03 (-0.57)	-0.031 (-4.23*)	-1.129 (-71.9*)	0.0005 (-1.40)	0.037 (6.52*)	0.94 (141.5*)
Transport & commun.	0.495 (2.98*)	-0.871 (-5.97*)	-0.374 (6.46*)	-0.495 (-7.92*)	1.202 (4.26*)	-0.024 (-2.33*)	-0.449 (-11.1*)	-0.725 (-2.97*)	1.231 (138.9*)
Other non-food	-0.469 (-4.61*)	0.55 (-0.02)	1.099 (-0.39)	0.231 (2.59*)	-0.164 (3.34*)	0.004 (5.37*)	-0.247 (-2.45*)	-2.089 (-4.59*)	1.082 (188.6*)

Note: Each row shows elasticities of the commodity group indicated in the row. The t-values (in parentheses) significance at 5% and 10% levels are indicated by * and ** respectively.

categories, substantial variation in own-price elasticities is observed across regions, especially in non-food categories Clothing; Housing; Transport & Communication and Other non-food categories. It is further observed that the range of variation in own-price elasticities across regions is much greater than the range of variation in income elasticities.

Next, tables 2.5 to 2.12 show that unlike income and own price elasticities, quite a few cross-price elasticities (109 out of 448 or about 24%) are not significantly different from zero. About half (49%) of the cross-price elasticities are negative and the remaining half (about 51%) are positive.

As compared to income and own-price elasticities, the pattern of cross-price elasticities appears more diverse across regions. For example, each of the 56 cross-price elasticities is negative in at least one region with just one exception and positive in at least one region with no exception. In other words, each pair of goods is classified as complements in some regions (with one exception) and substitutes in some other regions (with no exception).

To sum up the above results, it is observed that income elasticities do not vary much across regions for food as well as non-food categories. On the other hand, own-price elasticities do not show such identical pattern. While for food categories own-price elasticities appear quite similar across regions, for non-food categories the difference in the elasticities across regions is quite substantial. The divergence in cross-price elasticities across regions is even more pronounced. The overall picture that emerges is that households' responses to price variations are diverse across regions at least in quantitative terms, even though the evidence on qualitative differences is not much strong.

2.6.3. SENSITIVITY OF ELASTICITY ESTIMATES TO COMMODITY-WISE AGGREGATION

It is understood that parameter estimates of a demand system, particularly the income and price elasticities are sensitive to formation of commodity groups as well as the level of aggregation. Despite this understanding, it is quite common to treat consumption basket as a set of broad categories of groups rather than the set of all the individual goods and services. In the HIES data there are about 450 goods and services on which expenditure data are provided. But most of the studies for Pakistan aggregate these goods and services into a small number of groups keeping in view that the data on prices at this level of disaggregation are scarcely available. However, the main reason for aggregation is that even if all the data are available, the number of parameters in any flexible parametric demand system would increase rapidly as the number of goods is increased. Table 2.13 indicates that even if we do not consider any other variables in the demand system besides income and prices, the number of parameters

Table 2.13: Relationship Between Number of Goods and the Number of Parameters in AIDS

Number of goods	Intercepts	Income coefficients	Price coefficients	All parameters
2	1	1	1	5
4	3	3	6	16
6	5	5	15	31
8	7	7	28	50
10	9	9	45	73
20	19	19	190	248
30	29	29	435	523
40	39	39	780	898
50	49	49	1225	1373
100	99	99	4950	5248
200	199	199	19900	20498
300	299	299	44850	45748
400	399	399	79800	80998

Note: Author's own calculations.

increases to an unmanageable level as we increase the number of goods beyond even a moderate number. This not only results in a great loss in degrees of freedom but can also make estimation impossible for certain subsets of data. The above observations indicate that it is not necessarily desirable to seek higher level of disaggregation. What is needed is to ensure that the qualitative nature of results remains consistent if the commodity groups are disaggregated. However, even this type of sensitivity analysis cannot be undertaken at large scale given the limitations of data and the need for preserving degrees of freedom. Therefore, what follows is that we split each of the eight commodity groups, taken one at a time, into two parts consisting of a specific good and all the other goods in that category. This yields a system of nine, rather than eight commodity groups in each case. This splitting is done keeping in view the availability of data on prices. Furthermore, the analysis is performed at the rural and urban levels with no further disaggregation to provincial levels.

The second column of Table 2.14 indicates the number of sub-groups considered within each of the eight broad commodity groups used in the estimation of AIDS. Given the data availability and other considerations discussed above, the total number of sub-groups considered here is 62. It may be noted here that reliable price data are generally available or can be extracted from the reliable information for the main consumption items in household budget. Therefore, the selected 62 cover a large percentage of total expenditure on more than 400 goods considered in the surveys. The table shows that the demand systems estimated with these sub-groupings cover about 78 percent and 77 percent of the total expenditures in the rural and urban samples, respectively.

All the 62 demand systems are estimated for the rural and urban areas. Since the purpose of this exercise is to evaluate sensitivity of our results to commodity-wise disaggregation, it is not desirable to present and discuss the entire set of results in detail, which can take lose to 100 pages. What we present here is the summary of our findings on the sensitivity of results only.

Table 2.14 provides the essential information on the sensitivity of our results. We observe that the results for income elasticities are reasonably robust. In the rural sample the sign of income elasticities of the 61 out of the 62 sub-categories remains the same as the sign of income elasticities of the respective broad categories, which is positive throughout both for the rural and urban areas. In the urban sample the sign consistency for income elasticities hold for 60 of the 62 sub-categories.

As far the classification of goods in terms of high (greater than one) and low (less than one) income elasticities is concerned, we do not find this level of consistency. The nature of goods with respect to income elasticity of the sub-categories remains consistent with the pattern of income elasticities for the broader categories in case of 50 and 52 sub-categories in rural and urban sample respectively. In other words, the classification is reversed for 12 and 10 sub-groups in the rural and urban samples. In rural sample this reversal is observed mostly for food categories, while in the urban sample the reversal is evenly divided between food and non-food sub-categories. It is interesting to note that in the urban sample the reversal occurs mostly in the heterogeneous broad categories of ‘other foods’ (three reversals) and ‘other non-foods’ (four reversals).

Coming to own price elasticities, we observe quite a large number of cases where the sign of own price elasticity is reversed (to positive). Specifically, the own price elasticities for nine and seven sub-categories are positive in the rural and urban samples respectively, which are inconsistent with the negative signs of the own price elasticities of the respective broad categories.

To conclude this analysis, we concede that aggregation bias has affected our estimates of own price elasticities. However, the analysis presented here does not by any means provide an alternative set of results that can be relied upon; it is sufficient to point out the presence of aggregation bias only. For a proper disaggregate analysis we have to estimate a complete demand system comprising all the sub-groups taken together rather than following the piecemeal approach as carried out above. But, for

Table 2.14: Sensitivity of Demand Elasticities to Sub-Categorization of Goods

Commodity group	Number of sub-categories	Nature of income elasticities of the broad and sub categories		Nature of price elasticities of the broad and sub categories	
		Same sign	Same classification (elastic/inelastic)	Same sign	Same classification (elastic/inelastic)
Rural Sample					
Grains	8	8	6	8	8
Milk, meats & Oil	9	8	4	9	1
Other foods	18	18	15	15	3
Clothing	5	5	4	3	5
Housing	6	6	6	4	2
Fuel & lighting	4	4	4	3	0
Transport & commun	3	3	3	3	1
Other non-food	9	9	8	8	5
Sum	62	61	50	53	25
Urban Sample					
Grains	8	8	8	8	5
Milk, meats & Oil	9	9	7	7	7
Other foods	18	18	15	16	14
Clothing	5	3	4	2	3
Housing	6	6	6	6	6
Fuel & lighting	4	4	4	4	4
Transport & commun	3	3	3	3	1
Other non-food	9	9	5	9	9
Sum	62	60	52	55	49

Note: Author's own calculations.

such an analysis for 62 sub-groups the given micro data set even after pooling nine surveys seems insufficient. Probably estimation of demand system with a moderate level disaggregation like into 10 to 15 groups may be practically useful.

Following paragraphs present a link and comparisons of statistical estimates of present study with those of earlier studies on household demand for consumer goods in Pakistan. In one the pioneer studies on household demand for Pakistan, Burki (1997) through estimation of complete demand system conclude that chicken and gram are substitutes for lower-income households in Pakistan. Aziz and Malik (2010) estimate expenditure elasticities for nine food groups in Pakistan using survey data for 2004-05 for rural and urban regions of Pakistan and find that vegetables and meat expenditures increase for fruits, fish, and milk products for urban household. It also finds higher expenditure elasticities for fruits and cereals for urban households while the same are higher for meat, vegetables, pulses, edible oil and fats for rural households. The entire food group is found to be necessities. Some other studies on demand for consumer goods for Pakistan also found individual food items or entire food group to be necessities (see for example, Ali (1981, 1985); Khan and Ahmed (2009); Safdar *et al.* (2012); Siddique *et al*. (2019); Mustafa *et al.* (2022)).

Some studies have analyzed demand for individual consumer goods (individual item or individual commodity group) for Pakistan rather than complete demand system. Using time series data for Pakistan, Jamil and Ahmad (2011) found that electricity demand is elastic in the long run to both income and price at aggregate level. At sectoral level, long-run income and price elasticity estimates follow this pattern except in agricultural sector, where electricity demand is found to be elastic to output but inelastic to electricity price.

Later Ahmad *et al.* (2013) estimate AIDS model using pooled data and conclude that all expenditure elasticities are positive and in the range of 0.619 to 1.458 for all the six commodity groups. The expenditure elasticities are less than one for food & beverages, textile & footwear and fuel & lighting implying that these group of commodities are relative necessities while expenditure elasticities are positive for transport & communication, rent & housing and miscellaneous, confirming that the former group of commodities corresponds to relative necessities, while the latter one to relative luxuries. All the own price elasticities are negative (between -0.171 to -0.681) for all the six composite groups of commodities: Food, beverages and tobacco; Textile, apparel and footwear; Transport and communication; Rent and housing; Fuel and lighting; and Miscellaneous, implying that demand for all items lying in these composite groups is less elastic.

In another study Hayat *et al.* (2016) estimate demand elasticities for selected food commodity groups in Pakistan based on LA/AIDS model. The empirical results reveal that food grains, pulses, ghee, sugar and vegetables are necessities (own price elasticities lie in range of -0.79 to -0.87), while milk and meat are luxuries (own price elasticities is -1.01). Pulses and vegetables, ghee and meat, milk and sugar are identified as gross complements on the basis of uncompensated cross-price elasticities (values of cross price elasticities are negative in these cases). The uncompensated cross-price elasticities of food grains indicate the substitutive relationship between different food items, such as pulses, meat and vegetables as the values of cross price elasticities are positive. Values of income elasticities for all food items lie below 1 implying relative necessities except those for milk and meat that are found to be relative luxuries.

In most recent study, Sher and Ahmad (2021) estimated various elasticities of demand following complete demand systems approach by pooling data from independent household surveys conducted over several years. The results show that household demand responses to income changes are similar between rural and urban households, while the response to price changes differ considerably. Specifically, all income expenditure elasticities are positive in urban Pakistan (in the range of 0.626 to 1.262) and in rural Pakistan (in the range of 0.762 and 1.234) and all the own price elasticities are negative with reasonable magnitudes in urban Pakistan (in the range of -0.50 to -1.249) and in rural Pakistan (in the range of -0.673 and -1.44) for all the eight groups of commodities: Grains; Milk, Meats & Oil; Other Foods; Clothing (including other textile items and footwear); Housing (including fixtures and other durable goods); Fuel & Lighting; Transport & Communication; and Other Non-Foods..

The following lines present an overview and comparison of the results of studies on household demand for countries other than Pakistan. Ahmed and Shams (1994) based on estimation of AIDS model found that rural households in Bangladesh, in general, are highly responsive to changes in income and higher price foods have higher income elasticities. Income elasticities and own price elasticities for food items lie in the range of -1.94 to 1.05 and -0.17 to -1.94, respectively. Interestingly, wheat is found to be an inferior good in rural Bangladesh that is normal good in Pakistan. Estimates of cross-price elasticities show strong substitution effects. Based on household survey data for rural and urban India, Abdulai and Sharma (1999) conclude that for commodity groups (milk and milk products; cereals and pulses; edible oils; meat, fish, and eggs; vegetables and fruits; other foods) demand is elastic only for milk and milk products in both rural and urban areas of India.

Davis *et al.* (2010) estimate price and expenditure elasticities for the 12 dairy products and margarine selected products for USA. Results show that the magnitudes of 10 of the 13 own-price elasticities have absolute values greater than 1; substitute relationships are found among most dairy categories and expenditure elasticities are 1 or greater for 7 of the 13 products. Zheng and Henneberry (2011) estimate price and income elasticities for ten major food groups across low-, medium-, and high-income classes, using the 2004 China urban household survey data for Jiangsu province. Results indicate that for the majority of the studied food categories, the demand for the low-income group is found to be more income and own-price elastic; while the demand for the high-income group is found to be less income and own-price elastic.

Nimanthika and Edirisinghe (2014) in a study for Sri Lank estimate price and expenditure elasticities using LA/AIDS. All milk products except milk powder are highly responsive to their own prices and fresh milk, milk powder and infant milk powder are identified as necessities whereas, the rest show luxurious behavior, with the income. Contrary to other items analyzed, milk powder is both price and income inelastic. In a study for India, Kumar and Sinha (2016) estimate income and own price elasticities for selected food and non-food items for rural and urban households. Commodity groups: food and clothing are found to be necessities (own price elasticities range is: -0.24 to -0.83) and normal goods while commodity groups: fuel and lighting and other items are found to be luxuries (own price elasticities range is: -1.42 to -2.57) for Indian households.

In a similar study for Bangladesh, Jahan (2018) found that household demand for food items is affected by commodity prices, household income and other socio-economic factors. Talukder and Chile (2013) also have similar findings in case of Bangladesh.

The conclusion that emerges from comparison of findings of present study with those of other than Pakistan is that nature and magnitudes of values of elasticities different between different countries. Due the fact that income levels and tastes differ from country to country, the results of present study cannot be generalized to regions and countries outside Pakistan. Different income levels and own prices of items imply different level of affordability and prices of other goods mean possibility of substitution. To sum up, there is mix evidence on estimates of own price elasticities, cross elasticities and income elasticities in different regions within as well as outside Pakistan.

2.7. CONCLUDING REMARKS AND POLICY IMPLICATIONS

This study estimates household demand system for eight regions of Pakistan namely rural and urban areas of the four provinces. The specific demand system selected for estimation is the Almost Ideal Demand System because of its flexibility and consistency with consumer theory. To benefit from the information available at household level as well as the information available over time, the study pools *Household Integrated Economic Survey* (*HIES*) data collected by Federal Bureau of Statistics for nine different years from 2001-02 to 2015-16. Since it is possible to trace month of data collection for each sampled household, the study has been able to utilize price variation across years as well as across months available from the website and *Statistical Bulletin* or website of the Federal Bureau of Statistics.

Eight systems of demand functions are estimated, one for each region. Formal tests provide sufficient statistical evidence against pooling the demand systems across provinces within rural and/or within urban categories or across rural-urban divide within each province as well as within all provinces. At the next stage, income and price elasticities are estimated for each of the eight regions and their standard errors are computed using bootstrapping.

Based on the results of cross-validation analysis under ML forecast performance algorithm, the disaggregated analysis is observed to perform better in cross validation for the entire demand system as well as for each of the seven commodity groups under forecast error criteria, followed by the province-wise disaggregate analysis based on mean square error criterion. Similarly, by the mean absolute error criterion rural-urban disaggregate analysis performs slightly better than the province-wise disaggregate analysis. Finally, as expected, aggregate Pakistan level analysis appears the worst performer.

Based on sensitivity analysis of results, the estimates of demand system based on disaggregate analysis for the rural and urban areas of each province are relatively more reliable for understanding household demand system in Pakistan. The results for income elasticities are reasonably robust. In the rural sample the sign of income elasticities of the 61 out of the 62 sub-categories remains the same as the sign of income elasticities of the respective broad categories, which is positive throughout both for the rural and urban areas. In the urban sample the sign consistency for income elasticities hold for 60 of the 62 sub-categories.

On the other hand, based on sensitivity of results of own price elasticities, we observe quite a large number of cases where the sign of own price elasticity is reversed (to positive). Specifically, the own price elasticities for nine and seven sub-categories are positive in the rural and urban samples respectively, which are inconsistent with the negative signs of the own price elasticities of the respective broad categories. Hence, it is concluded that there exists aggregation bias and this has affected our estimates of own price elasticities.

The study finds substantial evidence of variations in price elasticities across the eight regions, but it did not observe much variation in income elasticities. Variations in the price elasticities appear more pronounced for non-food categories of goods and services. This finding of the present study has important policy suggestion This evidence provides at least one justification for change in public policy for differential treatment of goods and services taxes in various regions. Since there is neither any administrative or political division between rural and urban areas, nor there is any justification of such a division, especially because of close intermingling of rural and urban areas; it is not possible to device separate taxation policy for rural versus urban areas.

On the other hand, formal administrative and political setups at provincial levels already exist. Furthermore, following the *Eighteenth Constitutional Amendment* in 2010 as such the spending powers of federal government that do not require national unity have been transferred to provinces. Similar argument may also be applied on revenue side in the light of statistical evidence provided in the present study that shows substantial variation in households' consumption patterns between provinces. Such a move will address the shortcoming of *Eighteenth Constitutional Amendment* related to asymmetry in the redistribution of revenues and revenue collecting powers between federation and provinces. Although provinces are assigned new spending tasks, they are not pushed for setting the matching revenue collection tasks.

In the light of above observations, the study proposes that major portions of goods and services taxes that are not of uniform nature may be redesignated as provincial taxes. The structures of these taxes may be designed entirely by provincial governments keeping in view the specific preferences and other socioeconomic considerations prevailing in the respective provinces and independent of any federal government's intervention. However, to avoid the added administrative cost of revenue collection at provincial level, all the collection may be done by the federal government on behalf of provinces.

APPENDIX 2

Table A1: Parameter Estimates of AIDS for Urban Baluchistan

Commodity group	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	γ_{i8}	Inf_A	Inf_U	LY_A	LY_U	G_Y	R^2
Grains	0.169	-0.037*	-0.024*	-0.006	0.042*	-0.023*	-0.020*	-0.002*	-0.013	0.046	0.001*	0.001	0.000	0.008	-0.044	0.33
Milk, meat & oil	1.942*	-0.016*	0.012	-0.043*	-0.023*	0.089*	0.004	0.003*	-0.018*	-0.024	0.000	0.001	-0.121*	0.409*	-0.051*	0.05
Other Foods	1.664*	-0.007*	-0.029	-0.097*	-0.020*	0.004	0.088*	0.001	-0.135*	0.188	0.007*	0.006*	-0.096*	-0.227*	0.164*	0.17
Housing	-0.913*	-0.007*	0.003	-0.004	-0.024*	0.012	-0.029	0.000	0.022	0.020	-0.003*	-0.002	0.075*	0.009	-0.007	0.11
Clothing	-2.499*	0.037*	-0.004	-0.111*	-0.006	-0.043*	-0.097*	0.004*	0.211*	0.046	-0.006*	-0.001	0.187*	-0.375*	0.220*	0.12
Fuel & lighting	0.873*	-0.012*	0.000	0.004*	-0.002*	0.003*	0.001	-0.008*	0.002*	0.000	0.002*	-0.001*	-0.055*	0.209*	-0.115*	0.13
Transport & Com	-1.146*	0.019*	0.022	0.211*	-0.013	-0.018*	-0.135*	0.002*	-0.004	-0.065	0.005*	0.006*	0.071*	-0.107*	0.042	0.08
Other Non-Food	-0.090	0.023 *	0.020	0.046	0.046	-0.024	0.188 *	0.000	-0.065 *	-0.211 *	-0.006 *	-0.010 *	-0.061	0.074	-0.209	0.28

Note: The parameters significant at 5% level are indicated by *.

Table A2: Parameter Estimates of AIDS for Urban Khyber Pakhtunkhwa

Commodity group	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	γ_{i8}	Inf_A	Inf_U	LY_A	LY_U	G_Y	R^2
Grains	1.147*	-0.037*	-0.067*	-0.005	0.080*	-0.006	-0.036*	-0.003*	-0.030*	0.067	0.006*	-0.002*	-0.070*	0.516*	-0.412*	0.46
Milk, meat & oil	0.549	-0.015*	-0.021	-0.017	-0.006	0.125*	-0.100*	0.005*	0.047*	-0.033	-0.005*	0.003*	-0.024	0.233*	0.123*	0.09
Other Foods	-0.969	-0.007*	-0.048*	0.041*	-0.036*	-0.100*	0.031	-0.002*	-0.028	0.142	0.006*	0.006*	0.090*	0.148*	-0.105*	0.05
Housing	-2.235*	-0.005*	0.024	0.059*	-0.067*	-0.021	-0.048*	0.001	0.018	0.034	-0.001	0.004*	0.168*	-0.131*	0.088	0.10
Clothing	-0.161	0.034*	0.059*	-0.063*	-0.005	-0.017	0.041*	0.002	0.051*	-0.068	0.000	0.003*	0.010	-0.872*	0.545*	0.14
Fuel & lighting	1.725*	-0.013*	0.001	0.002	-0.003*	0.005*	-0.002*	-0.006*	-0.003*	0.006	0.007*	0.001	-0.118*	0.068	-0.118*	0.12
Transport & Com	-0.289	0.015*	0.018	0.051*	-0.030*	0.047*	-0.028	-0.003*	-0.001	-0.054	0.000	-0.002	0.020	0.041	-0.066	0.10
Other Non-Food	0.233	0.028 *	0.034 *	-0.068 *	0.067 *	-0.033	0.142 *	0.006	-0.054 *	-0.094*	-0.013 *	-0.013 *	-0.076	-0.003	-0.055	0.39

Note: The parameters significant at 5% level are indicated by *.

Table A3: Parameter Estimates of AIDS for Urban Punjab

Commodity group	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	γ_{i8}	Inf_A	Inf_U	LY_A	LY_U	G_Y	R^2
Grains	0.169	-0.037*	-0.024*	-0.006	0.042*	-0.023*	-0.020*	-0.002*	-0.013	0.046	0.001*	0.001	0.000	0.008	-0.044	0.45
Milk, meat & oil	1.942*	-0.016*	0.012	-0.043*	-0.023*	0.089*	0.004	0.003*	-0.018*	-0.024	0.000	0.001	-0.121*	0.409*	-0.051*	0.08
Other Foods	1.664*	-0.007*	-0.029	-0.097*	-0.020*	0.004	0.088*	0.001	-0.135*	0.188	0.007*	0.006*	-0.096*	-0.227*	0.164*	0.06
Housing	-0.913*	-0.007*	0.003	-0.004	-0.024*	0.012	-0.029	0.000	0.022	0.020	-0.003*	-0.002	0.075*	0.009	-0.007	0.10
Clothing	-2.499*	0.037*	-0.004	-0.111*	-0.006	-0.043*	-0.097*	0.004*	0.211*	0.046	-0.006*	-0.001	0.187*	-0.375*	0.220*	0.13
Fuel & lighting	0.873*	-0.012*	0.000	0.004*	-0.002*	0.003*	0.001	-0.008*	0.002*	0.000	0.002*	-0.001*	-0.055*	0.209*	-0.115*	0.11
Transport & Com	-1.146*	0.019*	0.022	0.211*	-0.013	-0.018*	-0.135*	0.002*	-0.004	-0.065	0.005*	0.006*	0.071*	-0.107*	0.042	0.09
Other Non-Food	-0.090	0.023 *	0.020	0.046	0.046 *	-0.024	0.188 *	0.000	-0.065 *	-0.211 *	-0.006 *	-0.010 *	-0.061	0.074	-0.209 *	0.39

Note: The parameters significant at 5% level are indicated by *.

Table A4: Parameter Estimates of AIDS for Urban Sindh

Commodity group	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	γ_{i8}	Inf_A	Inf_U	LY_A	LY_U	G_Y	R^2
Grains	2.434*	-0.035*	-0.021	-0.077*	0.064*	0.054*	0.055*	-0.001	0.041*	-0.115	-0.003*	-0.007*	-0.166*	0.353*	-0.267*	0.43
Milk, meat & oil	1.466*	-0.022*	0.067*	-0.102*	0.054*	0.129*	-0.060*	0.002*	-0.088*	-0.002	0.000	-0.001	-0.090*	0.025	0.288*	0.15
Other Foods	0.819*	-0.008*	0.012	0.089*	0.055*	-0.060*	0.028	0.001	-0.157*	0.032	0.006*	0.005*	-0.052*	-0.181*	0.176*	0.04
Housing	0.927*	-0.006*	0.024	-0.101*	-0.021	0.067*	0.012	0.001	-0.059*	0.077	0.001	-0.004*	-0.053*	0.098*	0.015	0.14
Clothing	-2.942*	0.043*	-0.101*	-0.074*	-0.077*	-0.102*	0.089*	0.001*	0.218*	0.046	-0.011*	0.005*	0.229*	-0.390*	0.089*	0.22
Fuel & lighting	0.772*	-0.004*	0.001	0.001*	-0.001	0.002*	0.001	-0.006*	0.001	0.001	0.003*	-0.003*	-0.051*	0.215*	-0.219*	0.08
Transport & Com	-1.591*	0.013*	-0.059*	0.218*	0.041*	-0.088*	-0.157*	0.001	-0.005	0.049	0.007*	0.011*	0.105*	-0.265*	0.175*	0.07
Other Non-Food	-1.885 *	0.019 *	0.077	0.046	-0.115 *	-0.002	0.032	0.001	0.049	-0.088	-0.003	-0.006 *	0.078 *	0.145	-0.257 *	0.41

Note: The parameters significant at 5% level are indicated by *.

Table A5: Parameter Estimates of AIDS for Rural Baluchistan

Commodity group	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	γ_{i8}	Inf_A	Inf_U	LY_A	LY_U	G_Y	R^2
Grains	-0.787*	-0.038*	-0.017	0.003	0.088*	-0.135*	0.017*	0.008*	0.049*	-0.013	0.001	0.004*	0.062*	-0.499*	0.301*	0.28
Milk, meat & oil	-2.816*	0.007*	0.036*	0.053*	-0.135*	0.127*	-0.156*	0.010*	-0.044*	0.109	0.004*	0.003*	0.223*	-0.510*	0.504*	0.03
Other Foods	-0.725*	0.000	-0.026*	0.002	0.017*	-0.156*	0.029*	-0.001	0.104*	0.031	0.006*	0.012*	0.057*	-0.425*	0.485*	0.21
Housing	-0.073	-0.004*	0.028	-0.019	-0.017	0.036*	-0.026*	0.004*	0.012	-0.018	-0.002	0.001	0.010	-0.101*	0.046	0.08
Clothing	2.543*	0.017*	-0.019	0.001	0.003	0.053*	0.002	-0.003	-0.050*	0.013	-0.001	-0.006*	-0.172*	0.694*	-0.735*	0.10
Fuel & lighting	-0.523*	-0.009*	0.004*	-0.003	0.008*	0.010*	-0.001	-0.013*	-0.001	-0.004	-0.003*	-0.002*	0.047*	0.238*	-0.020	0.10
Transport & Com	2.232*	0.014*	0.012	-0.050*	0.049*	-0.044*	0.104*	-0.001	-0.020	-0.050	0.001	-0.002*	-0.160*	0.210*	-0.343*	0.06
Other Non-Food	0.149	0.013 *	-0.018	0.013	-0.013	0.109 *	0.031 *	-0.004	-0.050 *	-0.068	-0.006 *	-0.010 *	-0.067 *	0.393 *	-0.238 *	0.18

Note: The parameters significant at 5% level are indicated by *.

Table A6: Parameter Estimates of AIDS for Rural Khyber Pakhtunkhwa

Commodity group	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	γ_{i8}	Inf_A	Inf_U	LY_A	LY_U	G_Y	R^2
Grains	0.073	-0.014*	-0.063*	0.043*	0.052*	-0.138*	0.064*	0.007*	0.041*	-0.006	-0.002*	0.004*	0.004	-0.410*	0.200*	0.15
Milk, meat & oil	-0.743*	-0.002*	-0.016	0.154*	-0.138*	0.095*	-0.009	0.005*	-0.029*	-0.062	-0.002*	0.002*	0.073*	-0.206*	0.231*	0.02
Other Foods	1.848*	-0.011*	-0.042*	-0.164*	0.064*	-0.009	0.073*	-0.011*	-0.025*	0.114	0.002*	-0.006*	-0.117*	0.234*	-0.189*	0.07
Housing	-1.305*	-0.003*	0.024	0.136*	-0.063*	-0.016	-0.042*	0.002	0.001	-0.042	0.000	0.003*	0.096*	-0.130*	0.026	0.04
Clothing	3.407*	0.019*	0.136*	-0.019	0.043*	0.154*	-0.164*	0.001	-0.082*	-0.069	0.008*	0.001	-0.253*	0.529*	-0.273*	0.17
Fuel & lighting	-0.190*	-0.034*	0.002	0.001	0.007*	0.005*	-0.011*	0.006*	0.000	-0.010	0.000	0.003*	0.026*	-0.446*	0.369*	0.26
Transport & Com	-0.907*	0.010*	0.001	-0.082*	0.041*	-0.029*	-0.025*	0.000	0.015	0.079	0.000	0.000	0.069*	0.222*	-0.182*	0.08
Other Non-Food	-2.183 *	0.035 *	-0.042	-0.069 *	-0.006	-0.062 *	0.114 *	-0.010 *	0.079 *	-0.004	-0.006 *	-0.007 *	0.102 *	0.207 *	-0.182 *	0.03

Note: The parameters significant at 5% level are indicated by *.

Table A7: Parameter Estimates of AIDS for Rural Punjab

Commodity group	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	γ_{i8}	Inf_A	Inf_U	LY_A	LY_U	G_Y	R^2
Grains	0.173	-0.040*	0.012	0.019*	0.071*	-0.033*	-0.017*	0.007*	0.006	-0.065	-0.002*	0.003*	-0.007	-0.293*	0.236*	0.36
Milk, meat & oil	1.415*	0.005*	-0.046*	-0.262*	-0.033*	0.143*	0.090*	0.007*	0.018*	0.083	-0.006*	-0.006*	-0.069*	0.021	0.192*	0.02
Other Foods	1.080*	-0.003*	-0.058*	0.034*	-0.017*	0.090*	0.023*	0.004*	0.014*	-0.090	-0.002*	-0.001*	-0.069*	-0.228*	0.210*	0.08
Housing	-0.950*	-0.007*	0.027	0.172*	0.012	-0.046*	-0.058*	0.000	-0.018	-0.089	-0.001	0.003*	0.064*	-0.135*	0.022	0.11
Clothing	1.677*	0.018*	0.172*	-0.039	0.019*	-0.262*	0.034*	0.004*	-0.089*	0.161	0.015*	0.008*	-0.121*	0.351*	-0.312*	0.11
Fuel & lighting	-0.040	-0.011*	0.000	0.004*	0.007*	0.007*	0.004*	-0.016*	0.000	-0.006	0.002*	0.000	0.010*	-0.018	0.078*	0.06
Transport & Com	0.306*	0.014*	-0.018	-0.089*	0.006	0.018*	0.014*	0.000	-0.032*	0.101	0.002*	-0.001*	-0.013	0.218*	-0.094*	0.06
Other Non-Food	-3.661 *	0.024 *	-0.089 *	0.161 *	-0.065 *	0.083 *	-0.090 *	-0.006	0.101 *	-0.095	-0.008 *	-0.006 *	0.205 *	0.084	-0.332 *	0.36

Note: The parameters significant at 5% level are indicated by *.

Table A8: Parameter Estimates of AIDS for Rural Sindh

Commodity group	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	γ_{i8}	Inf_A	Inf_U	LY_A	LY_U	G_Y	R^2
Grains	1.244*	-0.037*	0.020*	0.009	0.071*	-0.017*	-0.047*	0.007*	0.034*	-0.077	-0.007*	0.002*	-0.080*	0.116*	-0.050*	0.30
Milk, meat & oil	-1.024*	0.005*	-0.002	-0.045*	-0.017*	0.047*	-0.028*	-0.002	-0.050*	0.097	0.000	0.002*	0.096*	-0.159*	0.078*	0.09
Other Foods	-0.86*	-0.006*	-0.049*	-0.089*	-0.047*	-0.028*	0.042*	0.004*	-0.023*	0.190	0.002*	0.003*	0.089*	-0.112*	0.136*	0.10
Housing	0.504*	-0.004*	0.019	-0.001	0.020*	-0.002	-0.049*	0.002	-0.029*	0.040	0.001*	-0.002*	-0.031*	0.081*	-0.034	0.16
Clothing	-0.572*	0.017*	-0.001	0.081*	0.009	-0.045*	-0.089*	-0.003*	0.074*	-0.026	0.002*	0.004*	0.037*	-0.008	0.100*	0.06
Fuel & lighting	0.112	-0.004*	0.002	-0.003*	0.007*	-0.002	0.004*	-0.008*	-0.001	0.001	0.001*	0.000	-0.003	-0.043*	0.022	0.02
Transport & Com	-0.601*	0.014*	-0.029*	0.074*	0.034*	-0.050*	-0.023*	-0.001	0.035*	-0.040	0.005*	0.003*	0.035*	-0.108*	0.064*	0.09
Other Non-Food	1.197 *	0.015 *	0.040	-0.026	-0.077 *	0.097 *	0.190 *	0.001	-0.040 *	-0.185 *	-0.004 *	-0.012 *	-0.143 *	0.233 *	-0.316 *	0.43

Note: The parameters significant at 5% level are indicated by *.

CHAPTER 3

THE ROLE OF CLIMATIC AND WEATHER CONDITIONS IN INFLUENCING DEMAND FOR HOUSEHOLD CONSUMPTION GOODS IN PAKISTAN

3.1. INTRODUCTION

Households' expenditure on consumer goods stands out as a significant portion of national income and aggregate demand. The share of household consumption expenditures in GDP is about 79% implying that Pakistanis households are consumption-oriented households (*Pakistan Economic Survey* 2018-19). Almost every area of economic theory requires understanding and know-how of household consumer behavior and mostly economic policy formulation is based on empirical evidence of consumer behavior (Barten, 1968). The analysis of consumer behavior is applicable to a wide range of economic problems.

At individual level, however, household's behavior regarding demand for goods and services varies with respect to various factors. Among these, relative prices, income levels of the households and climatic conditions are the most influential factors of demand (see, for example, Karbasi and Sayyadi, 2016; Hoyos and Artabe, 2017, Li, 2019).

Both climate and weather are important factors affecting household demand. Climate refers to atmospheric conditions of a region that prevail over a long period of time and reflects the average weather conditions across months and across several years. Weather, on the other hand, represents atmospheric conditions of a geographical region prevailing during a short span of time, such as a month and can change quickly. It means that while climate varies across climatic zones, weather can vary not only across climatic zones but also across months and over the years within a given climatic zone.

When we try to relate household demand to atmospheric conditions, we must be able to distinguish between three types of such conditions between observation points. These are a) the differences in climatic conditions for households living in different climatic zones; b) differences in climatic conditions for households whose data are observed in different periods spanning several decades during which climatic conditions might have changed; and c) differences in weather conditions for households whose data are observed in different calendar months of the same year or years between which no significant climatic changes have occurred. The differences in household demand related to the above three types of atmospheric conditions may be referred to as climate effects, climatic change effects and seasonal effects, respectively.

This above distinction is important because of the following reasons. Climate is a long-term phenomenon and its effect on household demand will be of permanent nature, such as on the types of housing units, cooling and warming systems and the associated fuel consumption, types of clothing and footwear, food types, etc. Climate change effects, on the other hand, are expected to be small and gradual because before making long-run decisions the households observing climate change tend to wait till it is confirmed that the climate change is not a temporary fluctuation observed between years and in the medium run and because households also tend to adopt to the changing conditions. Finally, the seasonal effects are temporary across months but mostly permanent across years. These effects are normally endogenized within consumption decisions because seasonal atmospheric variations are well anticipated. Nevertheless, seasonal changes in weather do affect consumption pattern of households.

Given this background, the present study analyzes the effects of atmospheric conditions on household demand in Pakistan using micro data collected through nine independent household expenditure surveys conducted by Federal Bureau of Statistics. These data cover all climatic zones of Pakistan and are spread over past 15 years. Since time span of the study is not long enough to expect substantial implications of climatic change for household consumption pattern, the study is confined to estimating the climate and seasonal effects.

Geographic area of Pakistan is classified in five climatic zones or regions, each having its own specific and more-or-less homogeneous atmospheric conditions. Using the information in household identifiers it is possible to find out the climatic zone of residence and the survey month for each household. Further, using the recall period used in questionnaire, it is possible to identify the month in which expenditures on various goods and services are incurred. Based on this information and using monthly prices, the study estimates two demand systems one each for the sets of households living in rural and urban areas of Pakistan. Climatic zone and seasonal effects are quantified by including climatic zone dummies and month dummies included directly as well as in interactive form in the demand equations. Statistical tests are applied to determine whether household consumption patterns are uniform or different across climatic zones and/or across months. If significant differences are found as expected, the study would analyze the way consumption of various categories of goods and services varies across climatic zones and across months.

The study is important for Pakistan, where markets are not efficient due to the presence of monopolistic elements and one cannot always rely on market mechanism to avoid frequent supply-demand imbalances and, hence, to ensure price stability. Recent history shows that supply shocks in Pakistan are the most common reason for inflation and such shocks are often created by rent-seeker intermediaries that cause sudden spikes in the prices of commodities like grains, sugar and petroleum products.

Although such price shocks are mostly seasonal and often specific to some regions, they cause significant welfare losses to poor households, who are most vulnerable because of the dominance of food, especially basic food items, in their consumption baskets. In this context, it is utmost important to be able to quantify demand conditions across climatic regions and across months so that informed policies are in place to counter the consequences of non-competitive acts in the markets of essential goods.

Although quite a few studies have explored differences in consumption patterns across rural and urban divide and across provinces of Pakistan,[6] research on the role of climate and seasons is confined to selected goods rather than the whole demand system. For example, the climate related studies of Jamil and Ahmad (2010, 2011) and Aslam and Ahmad (2018) have focused on demand for energy. The present study is expected to fill this gap and lead more work on the lines pursued here.

Section 3.2 of the paper provides a brief review of literature, followed by methodology and data in section 3.3. The results are presented is section 3.4 and the paper is concluded in section 3.5.

3.2. LITERATURE REVIEW

Household demand analysis has been the focus of planners in particular, and researchers in general. Many researchers have analyzed household demand both theoretically as well as empirically. Literature on household demand analysis has improved over time in different dimensions. Among others, weather conditions are also an important factor affecting household demand for goods and services as different weather conditions like temperature, rains, humidity, etc. influence households' consumption decisions. Also, different months have different weather conditions in different zones. Some zones have more severe weather conditions while the others have

[6] See Ahmad and Malik (1989), Malik *et al*. (1988) and Ahmad and Sher (2021).

less severe or moderate weathers.

As shown in Table 1, several studies have investigated the climatic and month effect on household demand for consumer goods in different countries and regions. Different variables have been used in literature to investigate the effect of seasonality and weather variations on household demand for consumer goods with use of temperature dummies and/or zone dummies common in them.

Studies of Camara (2004), Murray *et al.* (2010), Kaminski *et al.* (2016). Ardeshiri and Swait (2018), Li *et al*. (2018) and Zhang *et al.* (2019) use temperature as an explanatory variable in regression models to analyze the effect of weather on household demand for a commodity or commodity group. On the other hand, some studies divide the whole country into different climatic zones (a climatic zone comprises of all those areas that have similar climatic conditions approximately) and investigate the demand by the households across different climatic zones and months (see for example, Petrick *et al*., 2010; Fell *et al*., 2014; Randazzo *et al.*, 2020; and Andruszkiewicz, 2020).

There is only little research carried out for Pakistan that focuses on investigation of the effect of weather conditions on household demand. A study by Mahmood *et al*. (2016) tests the effect of climate changes on electricity demand for Pakistan using monthly data on temperatures. In a recent study, Aslam and Ahmad (2018) apply APC model augmented with control variables for households' expenditure on three energy types: electricity, gas, and firewood. The whole country is divided in five climatic zones. Effect of climate on household demand for three energy types are investigated using climatic zones dummy variables. The study finds that the electricity expenditure is higher in the zones with relatively higher temperatures, gas expenditures are higher in the cold zone where gas connections ae also provided, whereas firewood expenditure are highest in the high-altitude cold zone in Himalaya, Hindukush and surrounding areas where no gas connections are provided, and cylinder gas gets frozen. The results of this study reveal that the household energy consumption varies across zones because of their different climatic characteristics.

Table 3.1: Review of Selected Recent Studies on Effect of Seasonality on Household Demand

Study	Country	Data Type	Model	Main Findings/conclusion
Fidan and Ahmad (2002)	Turkey	Cross Section (2001)	Almost Ideal Demand System (AIDS)	• Seasonal fluctuations in consumption of meat varies across meat types. • Consumption of red meat (cattle, sheep and goat) increases during spring and the household budget share of these varieties increases too. • Consumption and the budget share of fish products increase during winter. • Chicken and beef, and chicken meat and other fish varieties are complements, while the other meat varieties are substitutes.
De Cian *et al.* (2007)	Italy	Panel Data (1978-2000)	Household Demand Model	• Demand for electricity is influenced by temperature increases in summer and spring while the effects of temperature increase on gas and coal are similar between hot and cold countries. • Gas demand is strongly influenced by the heating effect with a reduction of demand for energy in the warm seasons while the heating effect also influences the demand for oil products, although to a smaller extent. • The demand for coal instead decreases with temperature increments in summer and winter but it increases in mid-seasons.
De Cian *et al.* . (2013)	31 OECD and non-OECD countries	Panel Data (1978-2000)	Dynamic Model of Household Demand	• Cold countries, such as Canada and Norway, experience reductions in all components of energy demand. • In mild countries, like Italy, higher demand for electricity during summer is compensated by a lower demand for gas and oil products in winter and spring. • In warm countries, such as Mexico, the cooling effect leads to increases in energy demand not only in the summer, but also in the spring.
Fell *et al.* (2014)	USA	Time Series (2004-2006)	Double Log Electricity Demand Model	• Price elasticity estimates vary across the four census regions—the South at –1.02 is the most price-elastic region and the Northeast at –0.82 is the least. • In general, these price elasticity estimates are considerably larger in magnitude than those found in other studies using household-level data that assume that consumers respond to marginal prices.

Jakušenoks and Laizāns (2016)	Latvia household	Cross section (2012)	Descriptive Analysis	• Annual electric energy consumption data splitting by seasons showed significant difference in household electric energy consumption. • Sunshine duration data explains 67% of household electric energy consumption variations.
Karbasi and Sayyadi (2016)	Iran	Province Wise Panel (2001-2010)	Dynamic Panel Data Model	• Rainfall, increased temperature, among others reduce allocated food expenditure of rural households. • Correlation is found between climate, income and consumption at the village level.
Yohannes and Matsuda (2016)	Japan	City Wise Panel (2000-2012)	LA/QUAIDS	• Demand for green tea, black tea, and tea beverage are own-price elastic while coffee and coffee beverage are own-price inelastic. • Green tea and black tea are luxuries, while tea beverage, coffee and coffee beverage are necessities. • Temperature has a positive effect on demand for tea and coffee beverage and has a negative effect on green and black teas and coffee all the year.
Hoyos and Artabe (2017)	Spain	Cross Section (2012)	Semi-Logarithmic Model	• Demand for water is elastic in the Northern region (−1.32), where the availability of water is higher due to their oceanic climate. • Demand for water is more inelastic in Central and Southern regions, due to their Mediterranean drier climate. • Eastern and Canarian regions are found to be, in line with the Spanish average, price inelastic (−0.41 and −0.39, respectively). • Climatic conditions (temperature and precipitation level) are also found to have a significant impact on water demand.
Li (2019)	Yangtze River Delta, China	Daily Cross Section (2017-18)	Log-Linear Model	• For warm days (>25 °C, a 1 °C increase in daily temperatures leads to a 14.5% increase in electricity consumption. • As income increases, households' weather sensitivity remains the same for hotter days in the summer but increases during the winter. • annual electricity consumption increases by 9.2% per +1 °C in annual global mean surface temperature (GMST). • In comparison, annual peak electricity use increases by as much as 36.1% per +1 °C in annual GMST.

Ardeshiri *et al.* (2019)	USA	Cross Section (2018)	Utility Function	• US consumers vary in their preferences for beef products by season. • US consumers on average purchase diced and roast products more often in winter "slow cooking season", than in summer; whereas New York strip and flank steak are more popular in the summer "grilling season.
Berkouwer (2019)	South Africa	Panel Data 2010-2013	Log-Linear Model	• For every 1℃ increase in temperature, electricity consumption decreases by 4.1% among temperatures below the heating threshold but increases by 12.2% among temperatures above the cooling threshold. • Holding all else constant, a 3.25◦C increase in temperatures would reduce electricity consumption by 1,093.4 kWh (6.2%) per year per household.
Botzen *et al.* (2021)	Mexico	Panel Data (2002-2016)	Electricity and gas consumption functions	• Non-linear relationship between energy consumption and temperature is found. • Electricity consumption increases with temperature, and this effect is stronger in warm states. • Liquefied petroleum gas consumption declines with temperature, and this effect is slightly stronger in cold states.

3.3. METHODOLOGY AND DATA

3.3.1. METHODOLOGY

The study uses Almost Ideal Demand System (AIDS) of Deaton and Meulbauer (1980), which is quite flexible as well as mostly consistent with consumer theory. The system is based on an expenditure function of the form given below, where M, U, P denote total expenditure, utility and the price vector, respectively.

$$log[M(P,U)] = (1-U)\log[a(P)] + U\log[b(P)] \quad (1)$$

where

$$log[a(P)] = \alpha_0 + \sum_k \alpha_k log(P_k) + \tfrac{1}{2}\sum_k\sum_j \gamma_{kj}\, log(P_k)\, log(P_j) \quad (2)$$

$$\log[b(P) = \log[a(P)] + \beta_0 \prod_k (P_k)^{\beta_k} \quad (3)$$

Substituting Eq. (2) and Eq. (3) into Eq. (1), yields:

$$log[M(P,U)] = \alpha_0 + \sum_k \alpha_k \log(P_k) + \tfrac{1}{2}\sum_k\sum_j \gamma_{kj}\log(P_k)\log(P_j)$$

$$+U\beta_0 \prod_k (P_k)^{\beta_k} \quad (4)$$

Applying Shepherd' Lemma on the above expenditure equation would yield compensated demand functions that show expenditure shares as functions of prices and utility. To obtain uncompensated demand functions the above expenditure function is inverted to obtain indirect utility function, which is then substituted into the compensated demand functions. This would result in the following uncompensated demand functions, again in the form of expenditure share equations.

$$S_i = \alpha_i + \sum_j \gamma_{ij}\log(P_j) + \beta_i log\left(\frac{M}{P^*}\right) \quad (5)$$

where $P*$ is the price index:

$$log(P^*) = \alpha_0 + \sum_k \alpha_k \log(P_k) + \tfrac{1}{2}\sum_k \sum_j \gamma_{kj} \log(P_k) \log(P_j) \qquad (6)$$

The above system of demand functions is non-linear in parameters because the price index used in the share equations itself depends on parameters of the demand system. As suggested in Deaton and Muellbauer (1980), this non-linearity can be avoided if the price index in (6) is replaced by Stone price index given below, which does not involve parameters of the demand system and can, therefore, be estimated beforehand, independent of the demand system.

$$log(P^*) = \alpha_0 + \sum_k s_k \log(P_k) \qquad (7)$$

We now bring-in climate and seasonal factors in demand analysis. Most studies of the role of climate for energy consumption use some indicator of climate based on temperature such as the number of heating and cooling days (See, for example Aslam. and Ahmad, (2018) and Jamil and Ahmad, 2010, 2011). However, climate does not just mean temperature; it also includes temperature volatility, humidity, winds, and a lot more like cultural footprint of climate. For example, hot and dry weather in desert areas of lower Punjab and upper Sindh or the extreme cold in high mountains range have had long-lasting effects on way of life of the people, that would affect their consumption basket as well.

In the light of above observations, we represent climate by climatic zones rather than any one aspect of atmospheric conditions. Following Salma and Rehman (2012), the study classifies the geographical area of Pakistan into five climatic zones or regions. These are: Zone A, Zone B, Zone C, Zone D and Zone E, as shown in Figure A3.1 of the Appendix, along with their latitudinal extent, where each climatic zone has specific temperature, humidity, rainfall distribution, etc. as described below.

Zone A comprises the districts/areas having very cold climate and high mountains. This zone is situated in the north of Pakistan. The major districts/areas in this region are: Chitral, Gilgit, Muzaffarabad, Said-u-Sharif, Skardu, Astor, Dir, Chilas Parachinar and Kakul. These are mostly hill stations located between 34 N to 38 N in the Himalaya, Hindukush and Koh-e-Sufaid mountain ranges.

Zone B comprises those districts/areas that have mild cold climate and sub mountains, located between 31N to 34 N. The major districts/areas in this region are Sialkot, D. I. Khan, Islamabad, Peshawar, Cherat and Lahore.

Zone C has cold climate in winters and hot in summers. Most of the area surrounds mountainous stations with high elevations from mean sea level and cover an area between 27 N to 32N and 64 E to 70 E. The major districts / areas in this region included in this zone are Quetta, Zhob, Kalat and Khuzdar.

Zone D consists of the hottest and dry areas of the country where highest maximum temperatures are recorded in stations of Sibbi and Jacobabad. The area is almost plain with some area included in Thar Desert. The major districts/areas included in this region are: Sibbi, Jacobabad, Bahawalpur, Khanpur, Multan and Rohri.

Zone E is a big zone having many stations and coastal cities, near to Arabian Sea. The coastal part comprises a portion of this region and climate above coastal parts in Balochistan as well as in Sindh province is mostly arid to hyper arid. The major districts areas in this region included in this zone are Hyderabad, Karachi, Nawabshah and Jewani.

The sampled households are classified according to the climatic zone where they reside. More details are provided in the following section on data. Then four climatic zone dummy variables are generated representing Zones B, C, D and E taking zone A as the base category. These four dummies are directly included in the share equations (5) as additional variables.

For seasonal effects households are classified according to the month for which data are reported. Again, the details are provided in the data section that follows. Taking the month of January as base, 11 month-dummy variables are created representing the months February to December. These dummies are also included in the share equations (5).

The climatic zone and month dummies are also included in interactive form to allow for the possibility that seasonal effects are not the same for all the climatic zones. For example, in Zone A winter is long and summer is short, while in Zone E, the opposite is true. Besides, in Zone E, there is not much variation in temperature across months.

Finally, the study also uses data on five macroeconomic variables as control variables that may affect household demand for consumer goods. These are anticipated and unanticipated inflation rates (Inf_A and Inf_U), anticipated and unanticipated components of GDP (LY_A and LY_U) and the year-to-year growth rate of GDP (G_Y). Anticipated and unanticipated components of inflation rate and GDP are derived from ARMA models fitted to log first differences of CPI and real GDP.

Based on the above discussion, the share equations of AIDS given in equation (5) are augmented as follows, where M^m, Z^z and X^k denote month dummies, climate zone dummies and macroeconomic variables.

$$S_i = \alpha_i + \sum_j \gamma_{ij} \log(P_j) + \beta_i log\left(\frac{M}{P^*}\right) + \sum_{m=1}^{11} \delta_i^m M^m + \sum_{z=B}^{E} \theta_i^z Z^z$$

$$+ \sum_{m=1}^{11} \sum_{z=B}^{E} \lambda_i^{mz} M^m Z^z + \sum_{k=1}^{5} \phi_i^k X^k + \mu_i \qquad (8)$$

Based on theoretical properties of demand system ('homogeneity' and 'adding-up') the following restrictions are imposed on parameters of the system.

$$\gamma_{ij} = \gamma_{ji}, \quad \sum_i \alpha_i = 1, \quad \sum_i \beta_i = 0, \quad \sum_i \gamma_{ij} = 0,$$

$$\sum_i \delta_i^m = 0, \quad \sum_i \theta_i^z = 0, \quad \sum_i \lambda_i^{mz} = 0, \quad \sum_i \phi_i^k = 0 \qquad (9)$$

Once the system of demand functions is estimated, standard Wald tests are applied to determine whether the climatic-zone effects and seasonal (month) effects are significantly different from zero. If the differences are statistically, we can analyze and interpret these differences appropriately.

3.3.2. DATA

The study uses micro data on household consumption expenditures. Monthly expenditure data on different commodity groups (defined below) are extracted from *Household Integrated Economic Survey* conducted by Pakistan Bureau of Statistics for the years: 2001-02, 2004- 05, 2005-06, 2007-08, 2008-09, 2010-11, 2011-12, 2013-14 and 2015-16. The data reported on fortnightly and yearly frequencies are also converted to monthly frequency. As large number of goods and services are used by households and given the fact that each one of them cannot be evaluated, so, we the goods and services are divided in 8 different commodity groups and household demand is analyzed with respect to any of the commodity groups. Eight commodity groups are as follows: 1) Grains (rice, wheat, lentils, peas and flours); 2) Milk, Meat & Oil (sources of protein, fats and calcium); 3) Other foods (including vegetables, fruits, herbs, spices, sauces, bakery products, confectioneries, drinks, cooked/readymade food); 4) Clothing, Apparel, Textile and Footwear (all types of wears, linen and tapestry); 5) Housing (including fixture, furniture and other durables); 6) Fuel & Lighting; 7) Transport and Communication; and 8) Other Non-Food. The last category (Other Non-Food) comprises goods and services that are not part of any of the other seven categories.

Following the practice and convention in empirical literature, total household expenditures are used as proxy for household income. The reasons for doing this include the possibility that incomes are not accurately reported by households intentionally or unintentionally and some conceptual issues involved in reporting of income data.[7] All the expenditures are expressed in per adult equivalent terms using OECD adult equivalence scales, where value of 1 is assigned to the first household adult member; 0.7 to each additional adult member and of 0.5 to each child.

As far as data on prices is concerned, commodity groups specific consumer price indices (CPIs) are utilized. The prices indices are available from *Pakistan Economic Survey* in most cases directly. For those not directly provided, are calculated using the prices of individual items or price indices of sub-categories using data available in the same source. The study also uses month and climatic zone dummy variables. Monthly dummy variables are used to capture the effects of seasonal variations in weather on household demand for consumer goods using the month of January as base month. Climatic zone dummy variables are used to capture the climate effects on household demand for consumer goods using climatic zone A as the base category.

Household survey data does not directly identify the climatic zone where households reside. Therefore, first, the districts that belong to each climatic zone are identified and then using district code as identifier provided in HIES survey questionnaires and mentioned in micro data containing files for each household, all the sampled households are classified into the five climatic zones.

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[7] See, for, example, Ahmad *et al*. (2013), Ahmad *et al*. (2020), Arshad and Ahmad (2006), Burney and Khan (1991), Malik *et al*. (1987) and Malik *et al*. (1988) and Shamim and Ahmad (2007).

3.4. ESTIMATION AND RESULTS

Regression results for AIDS estimated for the rural and urban regions of Pakistan are presented in Tables A3.1 and A3.2 of appendix. Parameters of the system can be classified into five categories, which are related to the main AIDS, macroeconomic variables, month dummies, climate-zone dummies and interaction of month and climate-zone dummies. Direct interpretation of the parameter estimates of demand system involving prices and income is quite complicated. Although the estimated parameters associated with other variables are interpretable, this exercise does not appear fruitful when the number of parameters is too large as in our case. Since the objective of this study is on explore how sensitive is household demand to the changes in weather conditions associated with seasonal and climatic-zone factors, we will confine our analysis specifically on these aspects. However, before this analysis a brief description of statistical significance of parameters of the estimated demand system is presented below.

Table 3.1 shows that while in the rural sample quite a few estimated parameters in each category are statistically significant, in urban sample the percentage of significant parameters is lower, especially those related to month dummies and interaction of month dummies with climate-zone variables. Compared to urban households, demand functions for rural households appear to be more sensitive to seasonal changes in weather represented by month dummies as well as to climatic conditions as indicated by climatic zone dummied.

However, to determine whether the joint effect of month dummies or the joint effect of climate-zone dummies on the entire demand system is statistically significant, we apply Wald tests on four joint null hypotheses, considered one at a time. The results of these tests are reported in Table 3.2. These results show that all the null hypotheses

Table 3.1 Percentage of Significant Parameters in the Estimated AIDS

Category	Number of parameters	Percentage of Significant parameters	
		Urban Pakistan	Rural Pakistan
Main AIDS	80	75.00	70.00
Macroeconomic variables	40	87.50	92.50
Month dummies	88	38.64	64.77
Climate-zone dummies	32	59.38	71.88
Months zone interactions	352	31.53	52.56
Total	592	43.75	60.47

Note: Author's own calculations.

Table 3.2 F Statistics for Tests of Null Hypotheses
(All F-statistics are significant at 1% level)

Null Hypothesis	Urban Sample	Rural Sample
Month and climatic zone effects are zero	27.52	79.72
Month effects are zero	11.58	14.77
Climatic zone effects are zero	25.40	89.54
Month zone interaction effects are zero	5.73	9.64

Note: Author's own calculations.

stand rejected. We conclude, therefore, that household demand varies systematically across months due to seasonal variations in weather conditions and across climatic zones due to different consumption needs of households living in different climatic conditions. We also conclude that month related seasonal effects and climate-zone effects are not mutually independent. In other words, seasonal pattern and its relationship with household demand varies systematically across different climatic zones.

To analyze the seasonal and climatic zone effects, we classify the entire data in 60 groups pertaining to 12 months and five climatic zones and then using the estimated demand system, we estimate mean expenditure shares on each of the eight commodity groups, converted to percentage form, in different months and different climatic zones. While estimating these expenditure shares for each of the 60 groups in urban or rural sample, all the variables other than month dummies and climatic-zone dummies are set equal to the mean values of the entire urban or rural sample respectively. This is done to ensure that the month and climatic-zone effects are not mixed up with varying prices and especially income across months and across climatic zones.

The results are presented in graphic in Figures 3.1 to 3.16, which show the patterns and trends in the means expenditure shares of the eight commodity groups across urban and rural regions of the five climate zones. These figures show substantial variation in the expenditure shares of various commodity groups across months a well as between climatic zones and between urban and rural areas.

Figures 3.1 and 3.2 show that both in urban and rural areas the percentage expenditure share of the commodity group Grains (rice, wheat, lentils, peas and flours) is the relatively higher during winter and spring months of February to March and the months of May and June. Two factors account for this seasonal pattern. First, the greater need of carbohydrates during cold season accounts for greater demand of grains in winter. Second, expenditure on grains goes up sharply, especially in rural areas immediately after harvesting of wheat in April and May and rice in November December when many households purchase stapple grains for the whole year due to their lower price in the following one or two months.

If we compare the consumption pattern across various climatic zoned, an interesting picture emerges. While in urban areas of Zone A the expenditure share of grains consumption is highest among all the zones, in rural areas of the same zone the expenditure share is the lowest. Zone A comprises the coldest and most remote areas of Pakistan that has by far the highest number of locations for tourists and adventurists.

The base camps of some of the greatest mountains of the world including the ones having 8000 meters plus peaks [K2, Nanga Parbat, Gasherbrum I (K5), Broad Peak and Gasherbrum II (K4)] are all located in Zone A. Tourism is a significant source of income in this region. Many adult male household members spend their days (and often nights as well) in urban areas to make earnings through the provision of tourism related services although they are counted as resident members of rural households. This explains the huge difference in the expenditure share of grains in the urban and rural areas of Zone A.

The second coldest zone is Zone C where the expenditure share of grains is also quite high. But unlike zone A, the high consumption of grains is equally prevalent in urban and rural areas. Since in this area there is no major tourist activity, we do not observe much contrast between urban and rural areas as seen in Zone A. In Zone E, which comprises the moderately hot but humid areas, grains consumption is obviously on lower side. The consumption pattern in the remaining two zones does not show any substantial pattern.

As seen in Figures 3.3 and 3.4, the second food consumption group, Milk, Meat & Oil shows mixed seasonal pattern except that the expenditure share of this group seems systematically on higher side during the late winter/spring months of February and March. The variation is consumption between climatic zones appears substantial. The expenditure share is on higher side in Zones A and Zone E. But unlike the expenditure on grains there is no substantial difference in consumption of Milk, Meat & Oil between urban and rural areas of Zone A. A plausible reason is that for this relatively more values food category male household members on average tend to fetch their due share even though they are often out to cities for earning from tourism related activities.

Coming now to Other Foods that incudes fruits, vegetables, herbs, spices,

Figure 3.1: Monthly HH Expenditure Share for Grains in Urban Zones

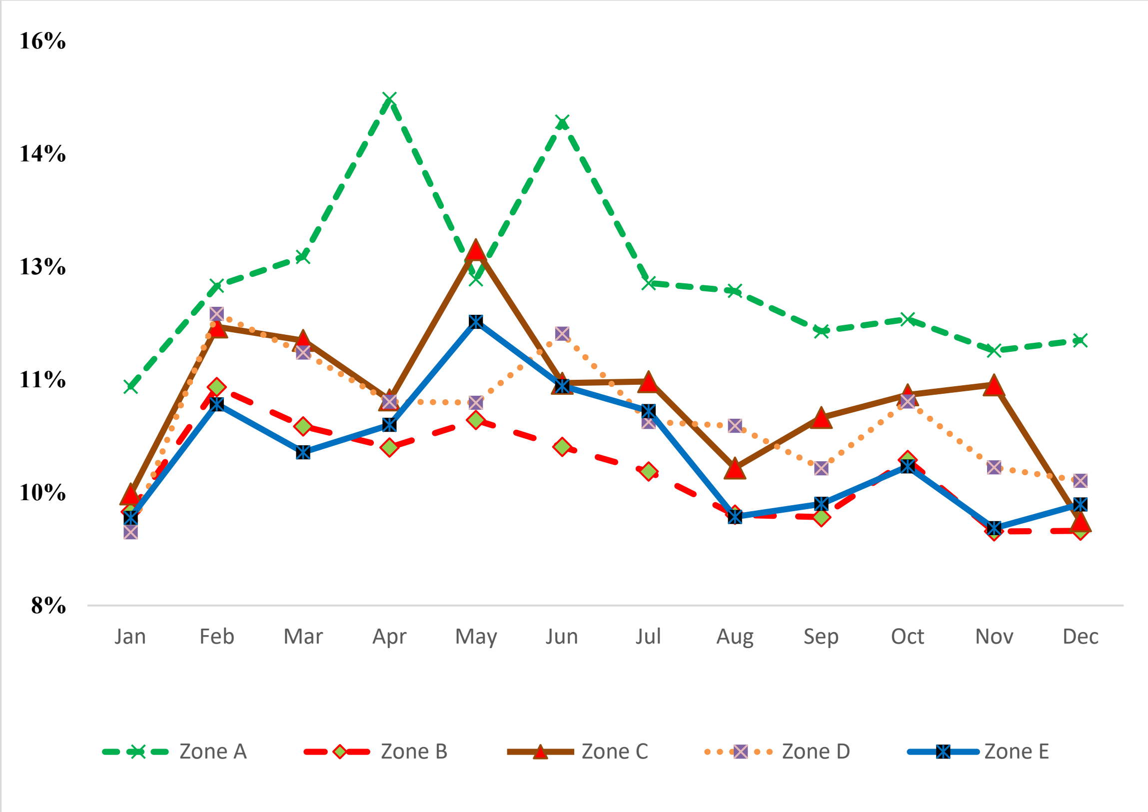


Figure 3.2: Monthly HH Expenditure Share for Grains in Rural Zones

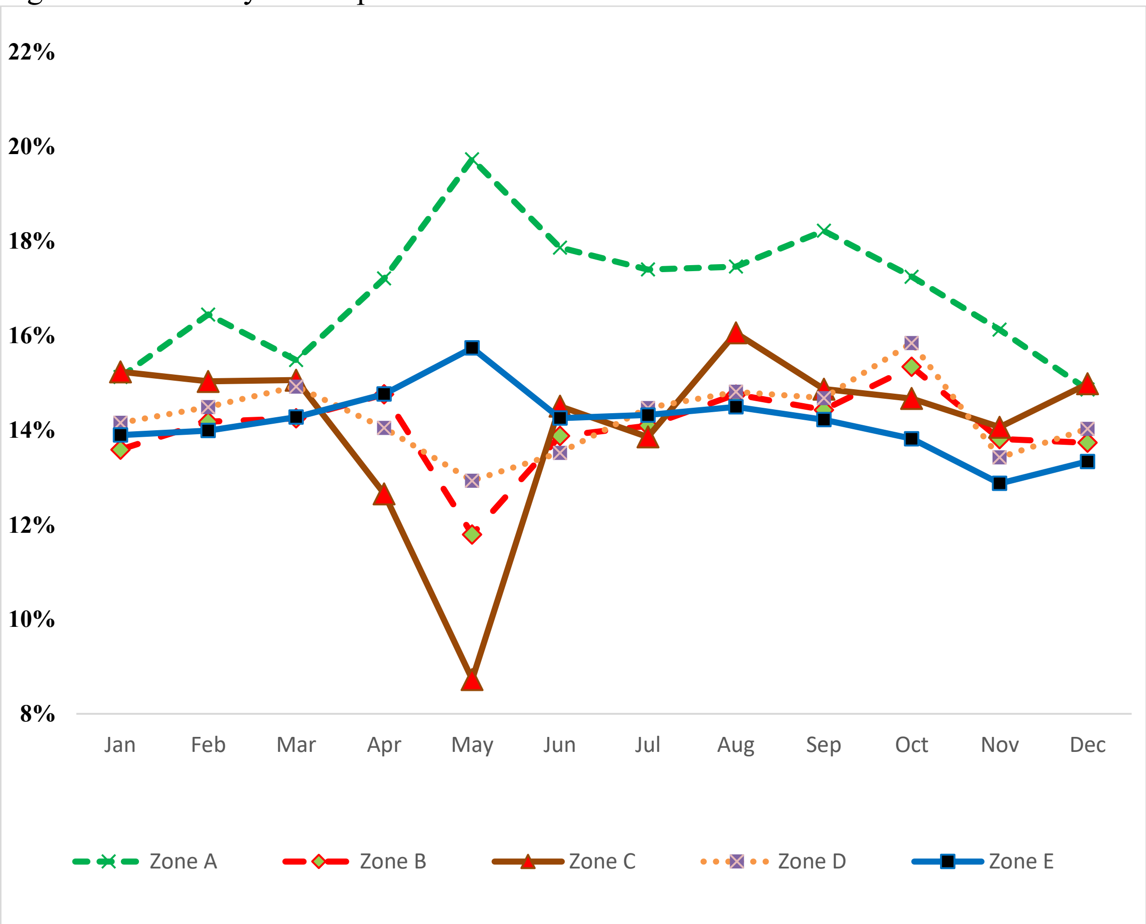


Figure 3.3: Monthly HH Expenditure Share for Milk, Meat and Oil in Urban Zones

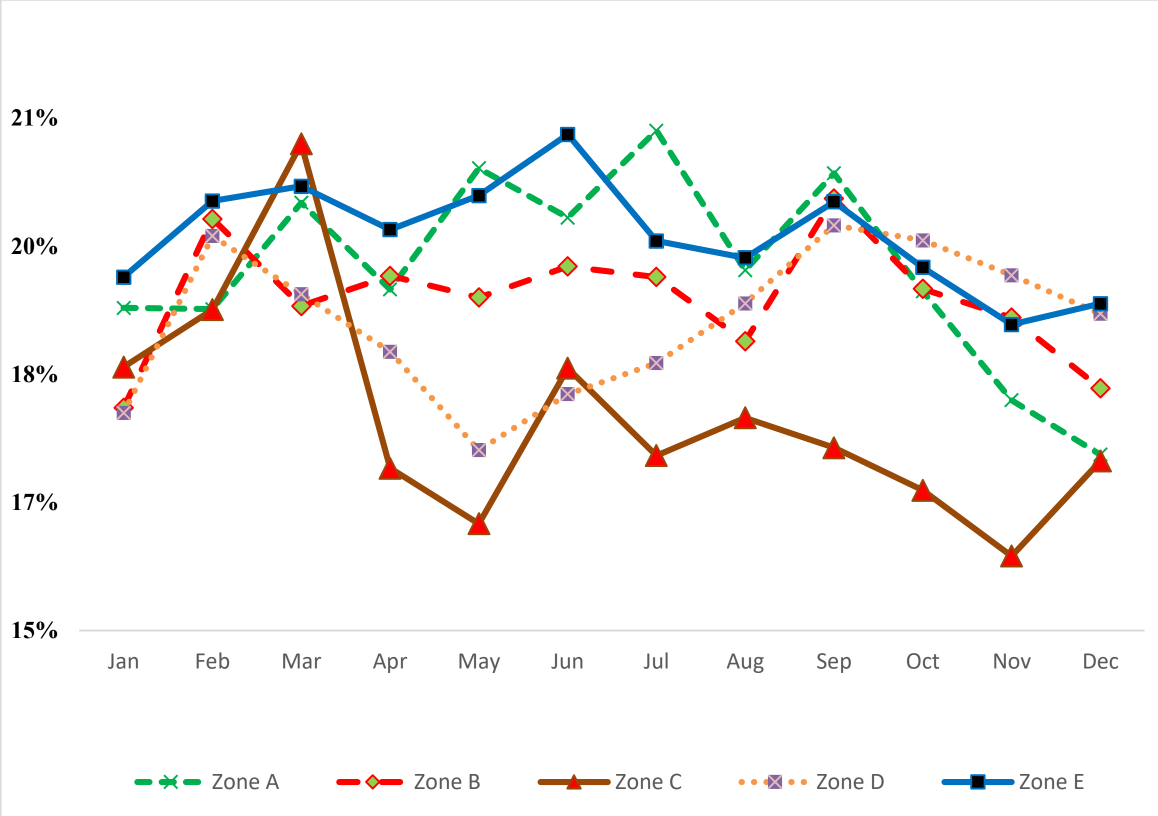
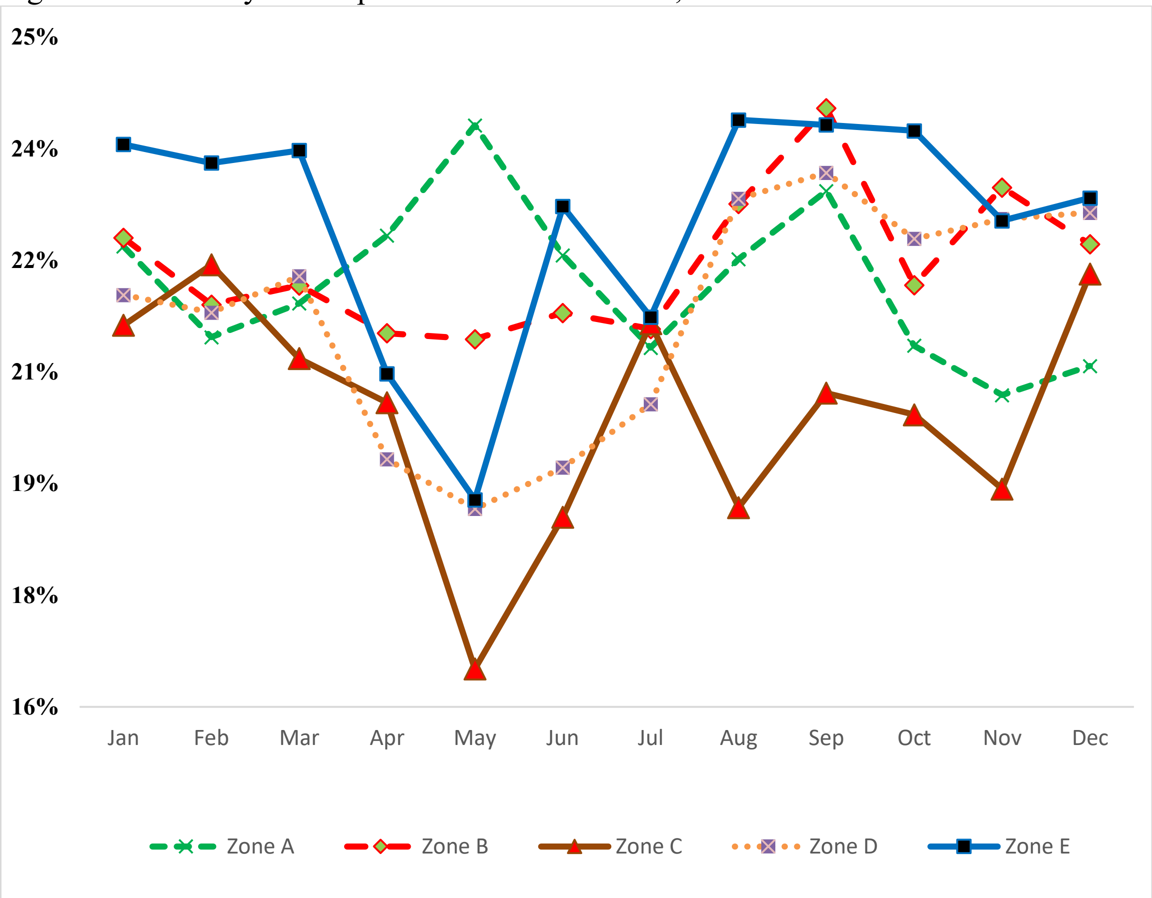


Figure 3.4: Monthly HH Expenditure Share for Milk, Meat and Oil in Rural Zones



beverages/drinks, sauces, bakery products, confectioneries and cooked/readymade food, we observe from Figures 3.5 and 3.6 that the expenditure share on this category has systematic seasonal pattern. In most areas, the expenditure share of Other Foods is relatively higher in the summer months. There are various factors that can explain this pattern. First, during summer not only there is abundant availability of vegetables and fruits, but also people tend to consume such light food items in larger quantities. Second, consumption of beverages and drinks is also maximum during these months. Third, due to hot weather in most areas, many families that can afford tend to avoid cooking at home and prefer to either dine out or order for ready-made food.

Zone-wise pattern of the expenditure share of Other Foods is somewhat similar to the patter of expenditure share of grains. While the expenditure share of other foods is highest in the urban areas of Zone A, it is lowest in the rural areas of the same zone. A possible reason, as explained earlier is the reduced consumption by male members in rural areas because of their engagement in tourism related earning activities in cities. Urban households spend more on Other Foods because Zone A provides the most suitable climatic conditions for many popular fruits like apples, pears, peach, apricot, plums. In some areas like Gilgit and Chitral apples and pears are consumed almost like staple food.

Among the remaining four climatic zones, the average expenditure share of Other Foods is lowest in Zone E that comprises most of the coastal area, which is moderately hot but highly humid. Most areas of this zone do not have potential for vegetables and fruits growth and popular foods in this area include meats, poultry and fish.

The first non-food category is clothing, and its consumption profile is presented in Figures 3.7 and 3.8. The seasonal pattern of expenditure share of clothing is somewhat different between urban and rural areas. In urban areas clothing expenditure is higher during autumn and early winter months (November, December and January), which obviously means increased spending on winter clothes, which are relatively expensive. In rural areas this peak expenditure occurs in just one month, November, indicating that rural households do their shopping for winter clothing well in time because most of them cannot afford frequent visits to cities for this shopping. Clothing expenditure is also higher in the winter season because it is a popular season for weddings and other such festive activities.

The climatic-zone effect on clothing seems weak. Figures 3.7 and 3.8 do not show much variation in the expenditure share of clothing between the five zones except for Zone E, where the expenditure is on lower side, especially in urban areas. This zone includes Karachi, by far the largest city of Pakistan, Hyderabad and all other coastal areas where winter is mild and almost throughout the year there is hardly a need for expensive warm clothing. The most popular clothes are made of locally manufactured cotton, which are cheap but suitable for the prevailing climatic conditions.

The next non-food category is Housing, including fixtures, furniture and other durables. Figures 3.9 and 3.10 show the trends. Before further discussion, it may be noted that it is unlikely that households would change their housing due to seasonal considerations. Therefore, whatever variation is observed across months, it would most likely relate to fixtures, furniture and other durables. The figures indicate considerable seasonal variation in the average expenditure share of Housing in the urban sample, which shows that the expenditure tends to be higher during the months of August, September and October, some of which can be related to wear and tear of dwellings, fixtures, furniture and appliances at the end of summer and Monsoon rains. In rural areas, on the other hand, the average expenditure shares of Housing remain mostly

Figure 3.5: Monthly HH Expenditure Share for Other Foods in Urban Zones

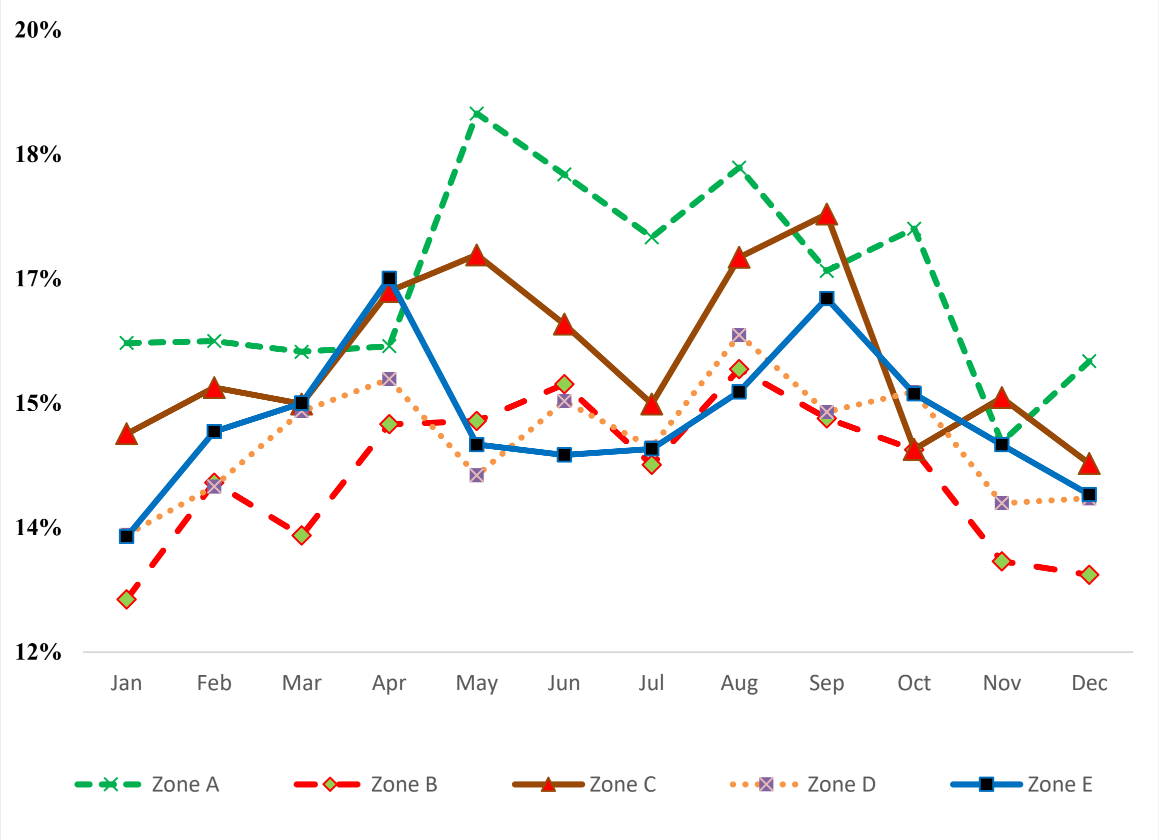


Figure 3.6: Monthly HH Expenditure Share for Other Foods in Rural Zones

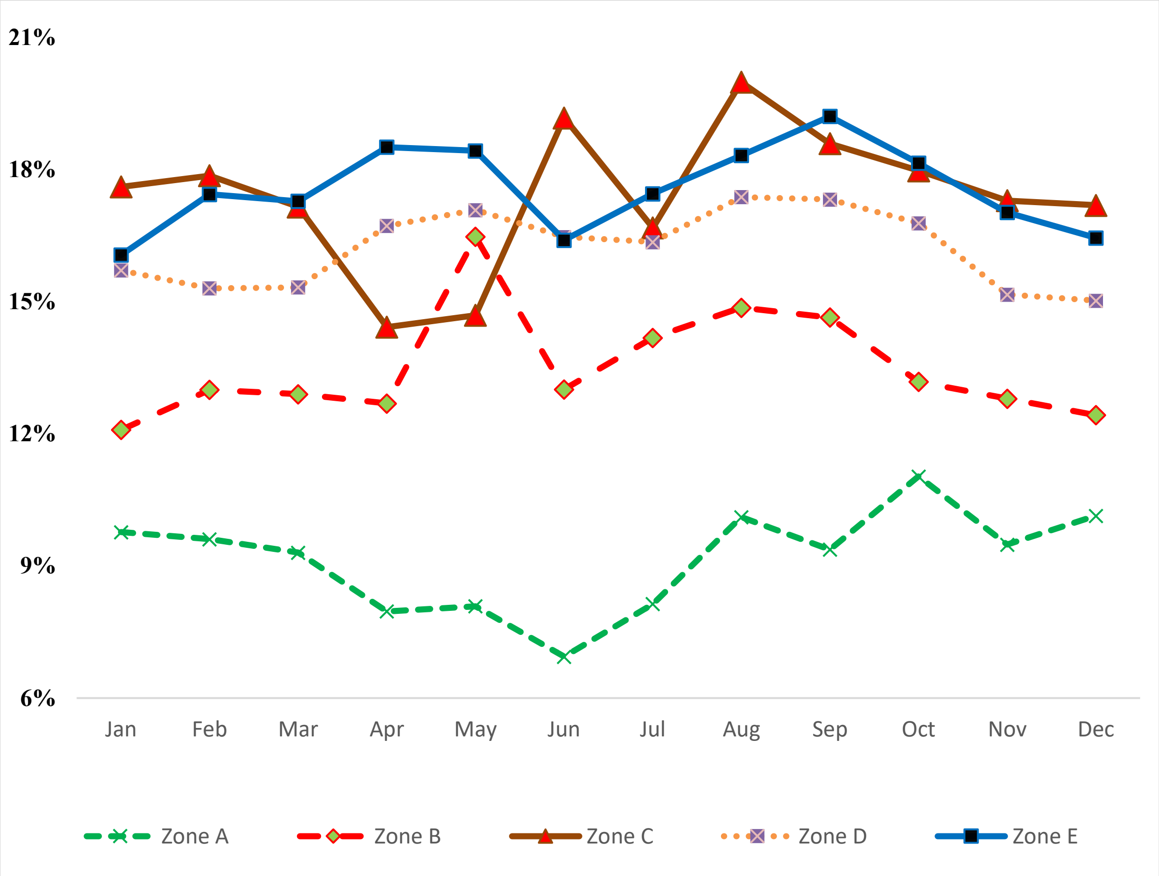


Figure 3.7: Monthly HH Expenditure Share for Clothing in Urban Zones

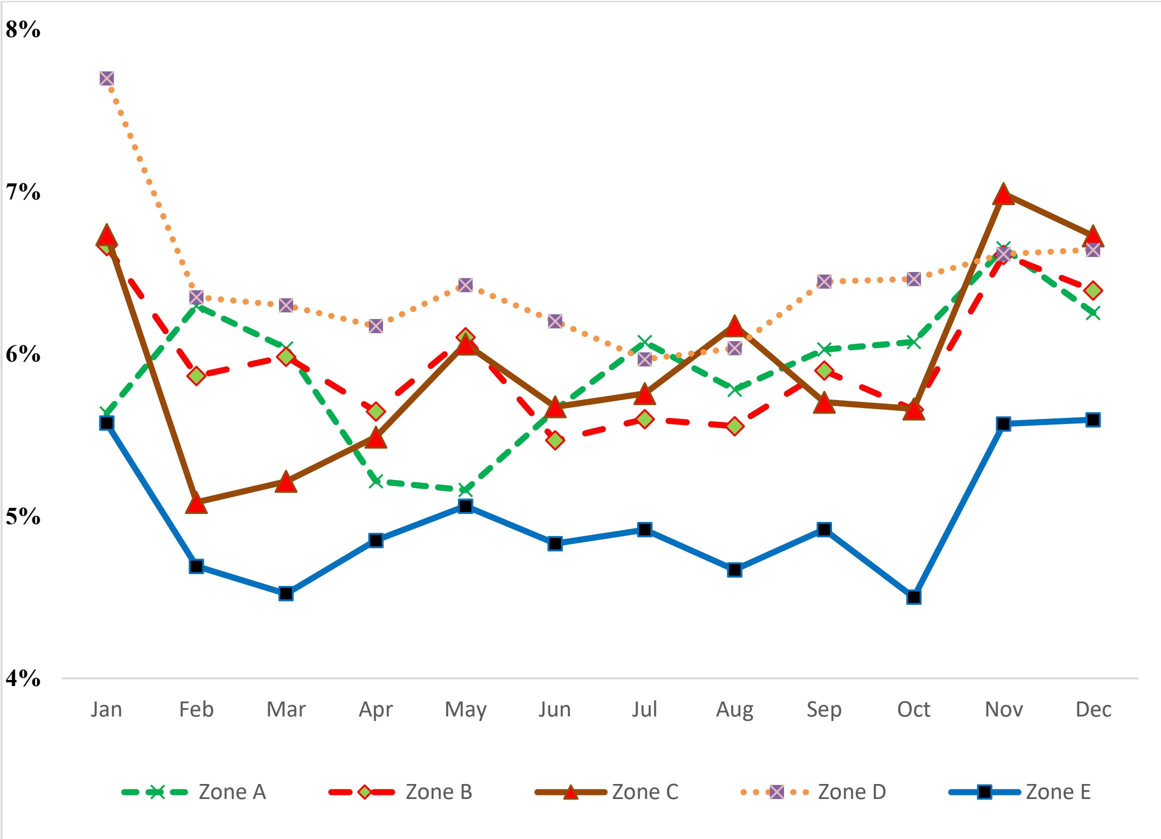
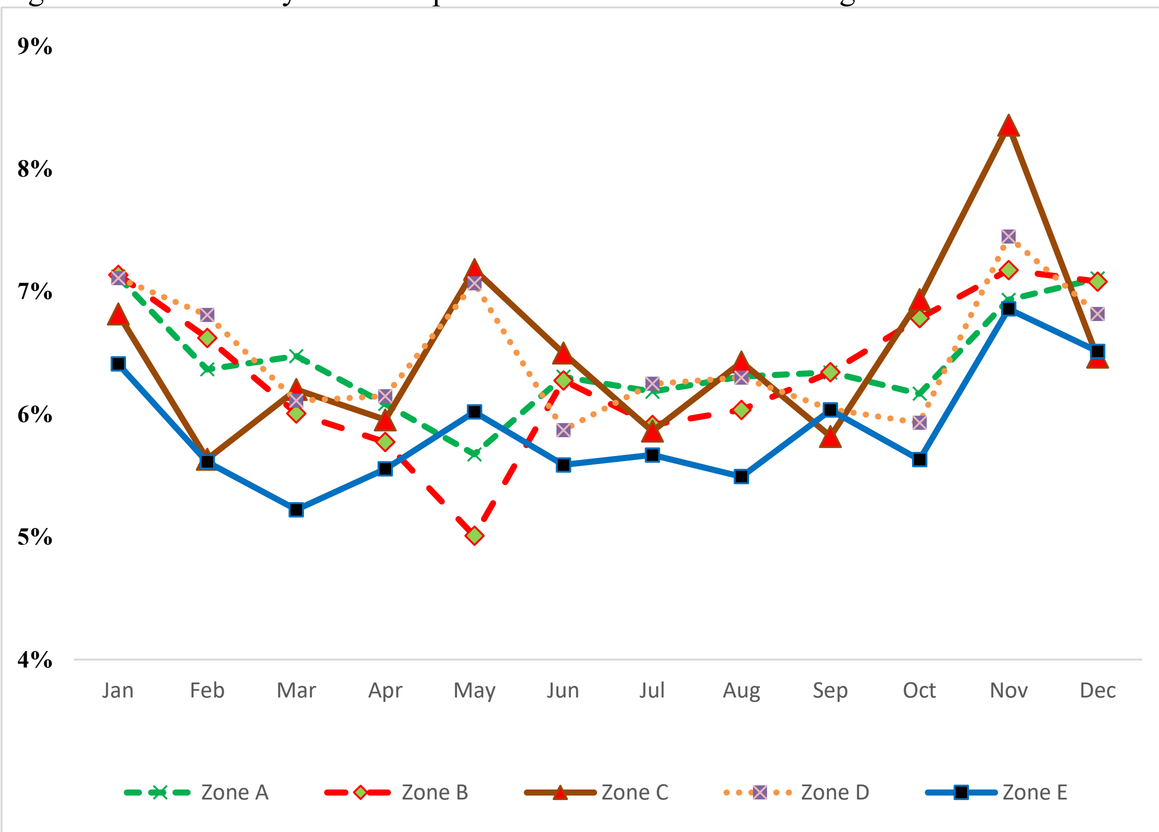


Figure 3.8: Monthly HH Expenditure Share for Clothing in Rural Zones



stable across months, except an unexpected spike in Zone A and dip in Zone C during the month of May, for which no plausible reasoning can be offered.

The commodity group Fuel and Lighting includes all types of fuels and electric power used in a house. It excludes the fuel used in motor vehicles, which are covered under the group Transport and Communication. Figures 3.11 and 3.12 show the pattern of the average expenditure share of Fuel & Lighting. In urban areas of the zones B and D we can see a clear association of fuel consumption with weather conditions. The expenditure is higher during summer month as the use of air conditioners, coolers and fans goes up. On the other hand, there is no such increase in fuel consumption in winter. The main source of heating in urban areas of these zones is natural gas, which has been subsidized during the period of analysis.

Zone A is cold almost throughout the year. Therefore, there is no spike in the expenditure share of fuel during summer, but the fuel expenditure share is somewhat higher during winter months November to February. Zone E does not show much seasonal variation because this zone comprises mostly coastal areas and the temperature does not change much throughout the year. Except for some small cities like Hyderabad and Nawabshah, the temperatures remain moderate. This explains lack of variation in the share of fuel consumption. Almost identical pattern is observed in Zone C.

In rural areas, while seasonal variation in the expenditure share of Fuel and Lighting is minimal, the variations across climatic zones are substantial. A plausible reason for the lack of increase in fuel and lighting expenditure during summer months is that in rural areas it is quite uncommon to use air conditioners, the most expensive device for cooling. Similarly, in Zones B, D and E, the winter is short and rural households tend to use warmer clothes rather than electric heaters in the absence of gas connections in most rural areas.

Figure 3.9: Monthly HH Expenditure Share for Housing in Urban Zones

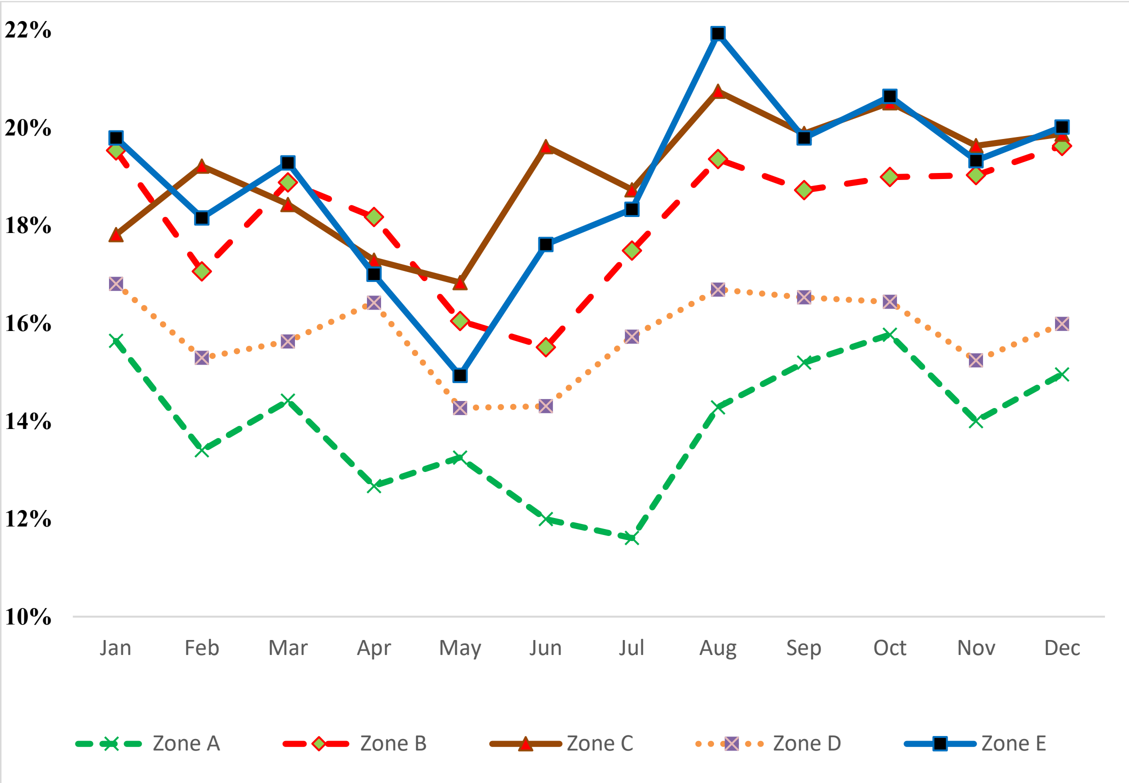


Figure 3.10: Monthly HH Expenditure Share for Housing in Rural Zones

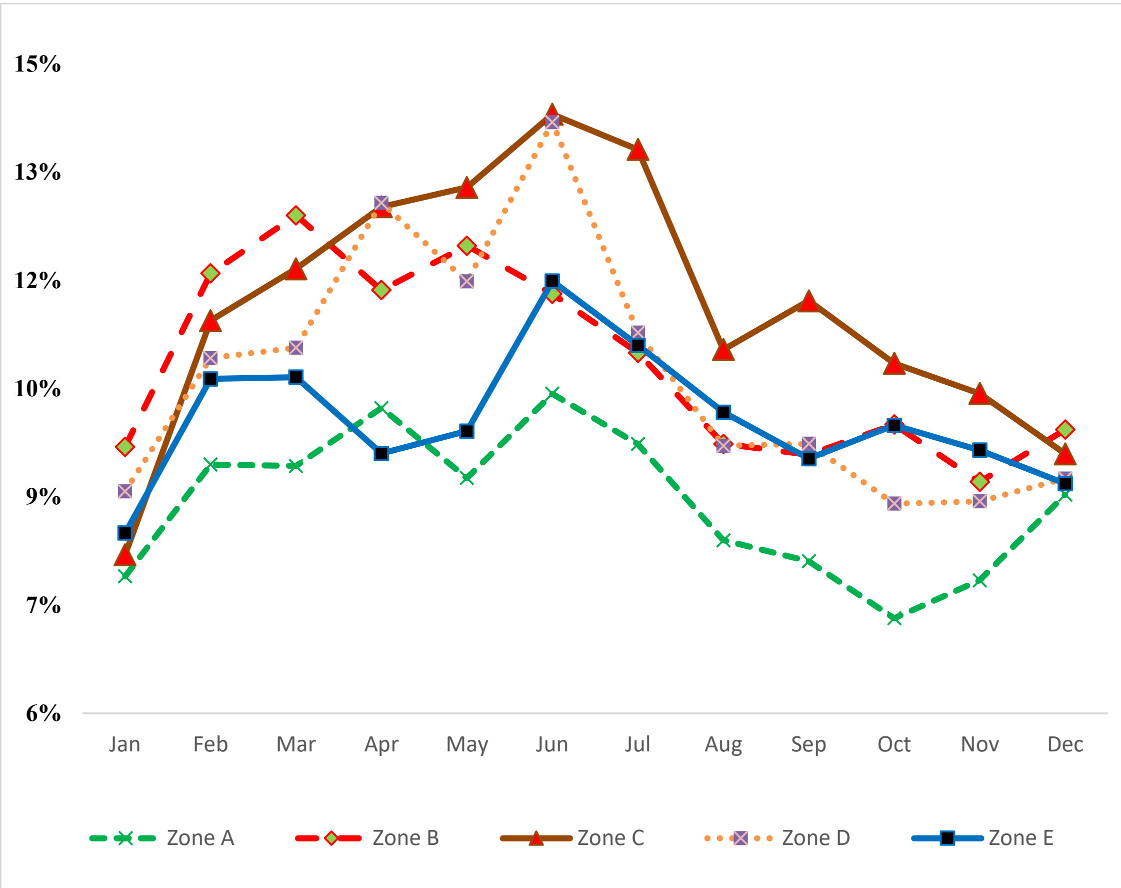


Figure 3.11: Monthly HH Expenditure Share for Fuel and Lighting in Urban Zones

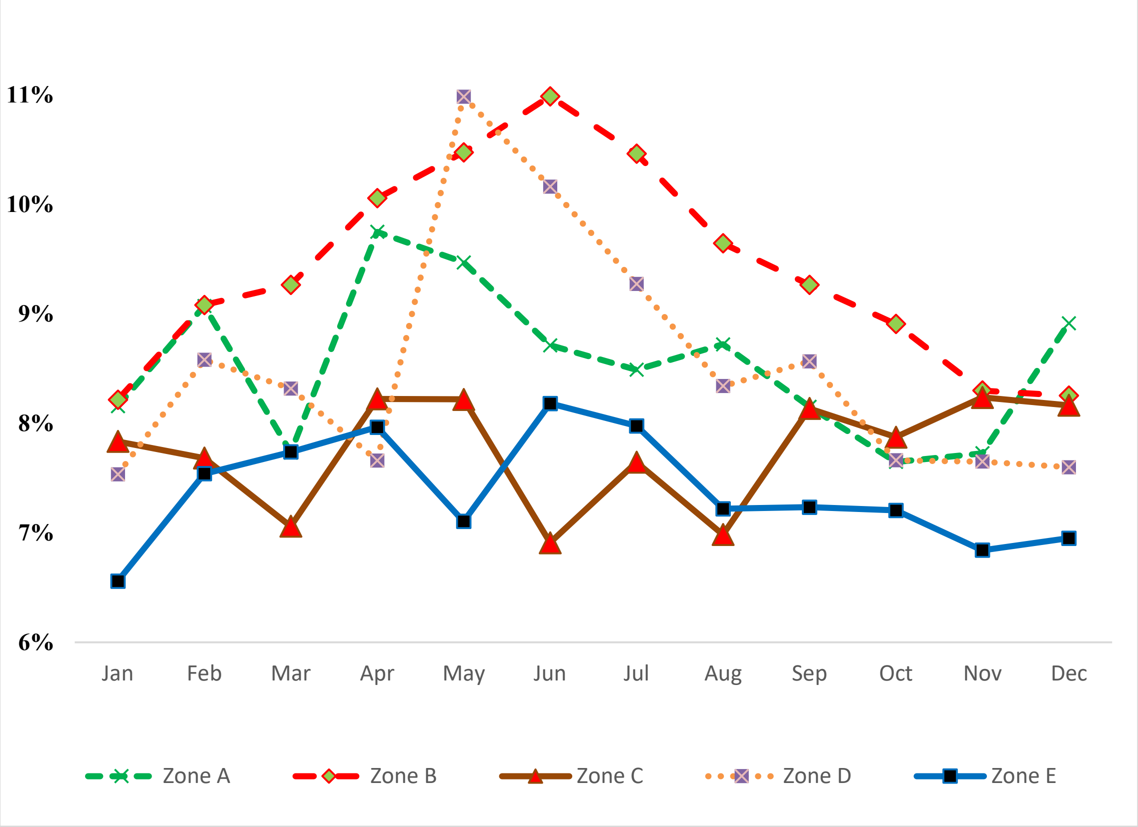
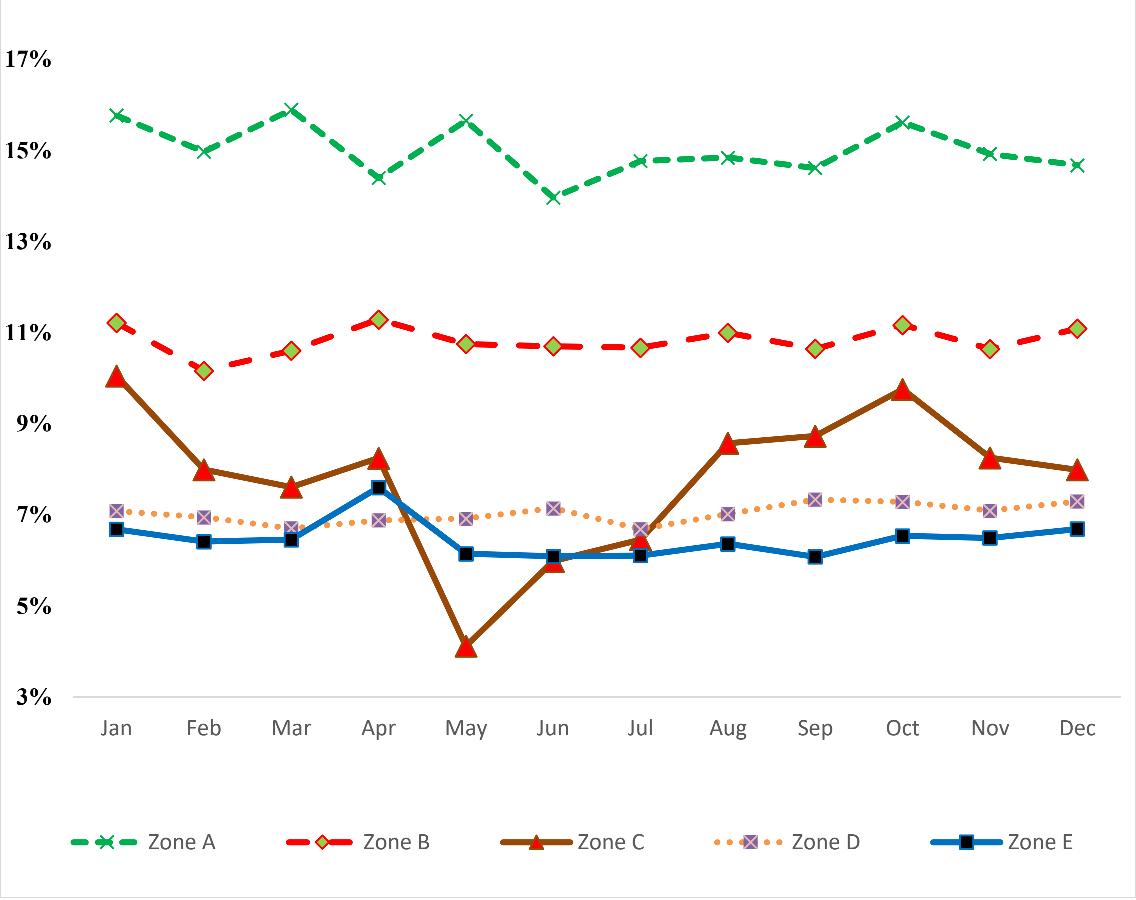


Figure 3.12: Monthly HH Expenditure Share for Fuel and Lighting in Rural Zones



The zone-wise comparison shows that the highest expenditure share of Fuel and Lighting is observed in the coldest zone, that is Zone A, where summer is very short and mild, and heating, especially hot water, remains in demand throughout the year. The main source of heating is firewood, which is more expensive than natural gas in terms of price of a comparable energy unit. This is followed by Zone B, which is also cold to a less degree and follows more-or-less the same pattern as Zone A. In the remaining three zones, the expenditure share of Fuel and Lighting is lower and almost identical.

In the next category of goods and services, that is Transport & Communications, the transport expenditure consists of expenditure on all types of public and private transport services including fuel consumption and maintenance of self-owned vehicles. Also note that transport expenditure is the main expenditure in this category. Communication is included in the category because information on the relevant prices is available only in the form of a consumer price index for the combined category Transport & Communications. In any case Figures 3.13 and 3.14 show the trend. In urban areas travel activities are not uniformly distributed, therefore there is substantial seasonal and climatic zone wise variation in the expenditure share of Transport & Communications.

The highest expenditure share is observed in Zone E, which includes Karachi, by far the largest metropolitan city and the business hub of Pakistan. More than half of the sampled households reside is Karachi, which is spread over a large area. In the absence of a respectable public transport service network of buses and trains, transportation cost of households is quite high. Another region in this zone comprises the wide-spread coastal areas of Balochistan where again the transportation costs are expected to be high. Zone E is followed by Zone C where the share of Transport &

Communications is also on higher side because of very low population density and, therefore, the need for travelling long distances for reaching jobs and carrying on other out of home activities like shopping, schooling, visiting hospitals, etc. On the other extreme, the lowest expenditure share of Transport & Communications is observed in Zone A where because of highly rugged and hilly surface, transport activities are quite limited.

We can see that in rural areas the expenditure share of this category is quite low and there is hardly any seasonal or climatic-zone wise variation in the average expenditure, indicating that travel activities in rural areas are limited and evenly spread throughout the year and throughout the various climatic zones.

The last category of goods and services is Other Non-Food, which includes all the non-food expenditures that are not covered in any other head. This includes expenditure on the services like education, health, entertainment and personal care services; and some of the goods like cleaning/laundry soaps, etc., personal care items (like make-up items, shampoo, shaving gel), jewelry; and above all, the activities associated with weddings and other such festivals. Figures 3.15 and 3.16 show substantial seasonal variation in the average expenditure share of this category. In particular, the expenditure share is on higher side during the months of moderate weather when most of the wedding and festival activities take place. Not only there is increased expenditure on such activities, but also household members, especially ladies spend large amounts of money on personal appearances. The figures show that both in the urban and rural areas the largest expenditure share of Other Non-Foods is observed in Zone D and the lowest expenditure share is reported in Zone C. This completes the presentation of our results, and we can now conclude this study.

Figure 3.13: Monthly HH Expenditure Share for Transport & Commun. in Urban Zones

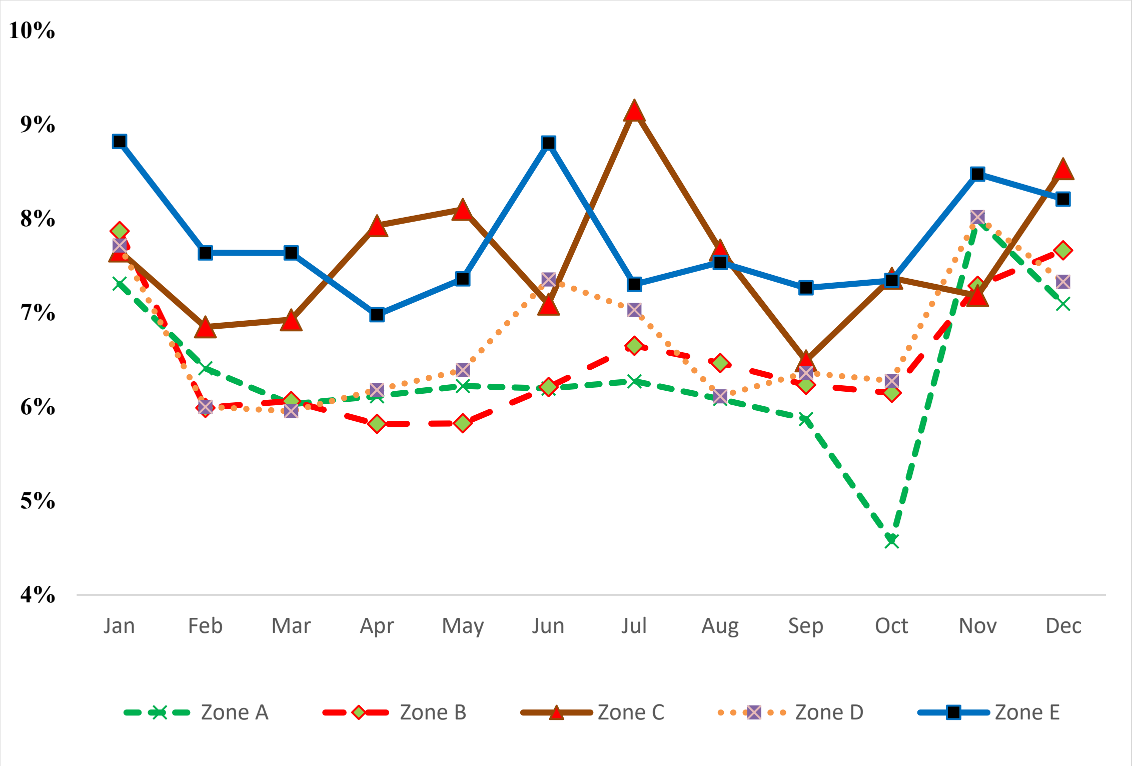


Figure 3.14: Monthly HH Expenditure Share for Transport & Commun. in Rural Zones

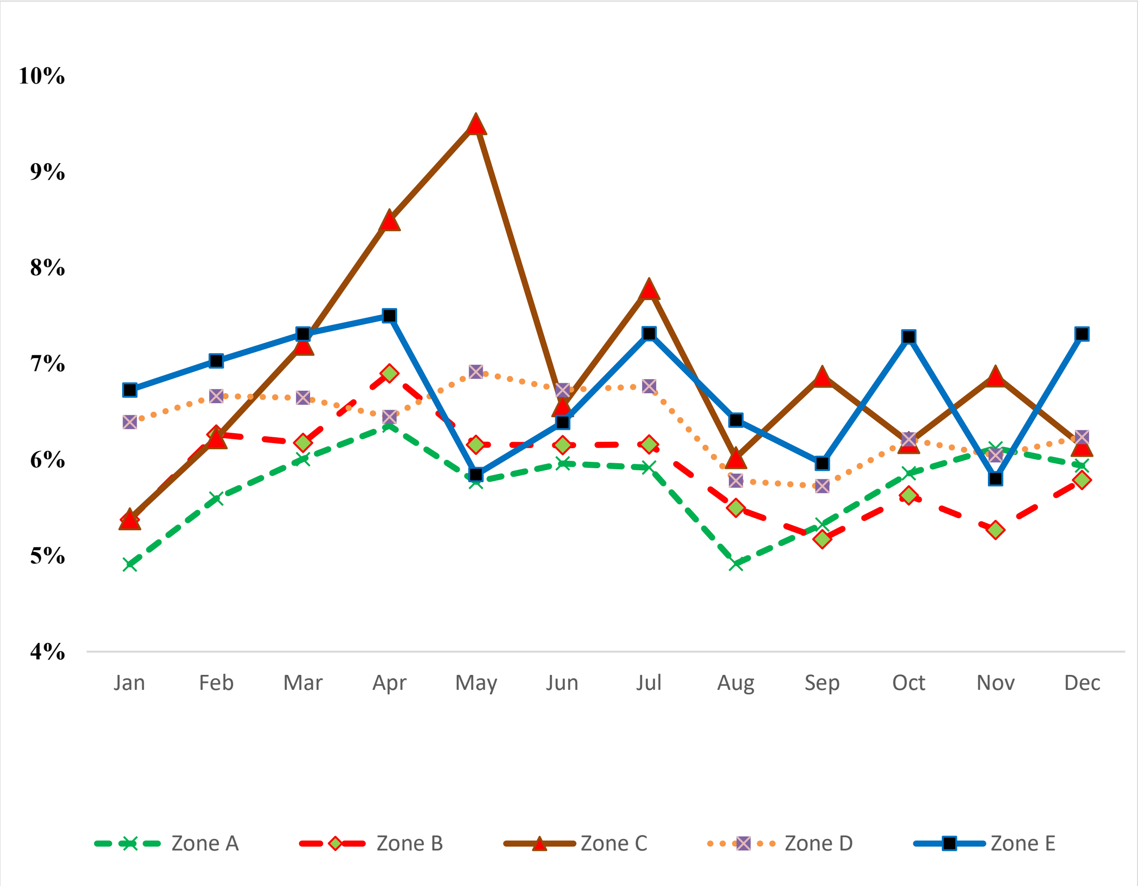


Figure 3.15: Monthly HH Expenditure Share for Other Non-Food in Urban Zones

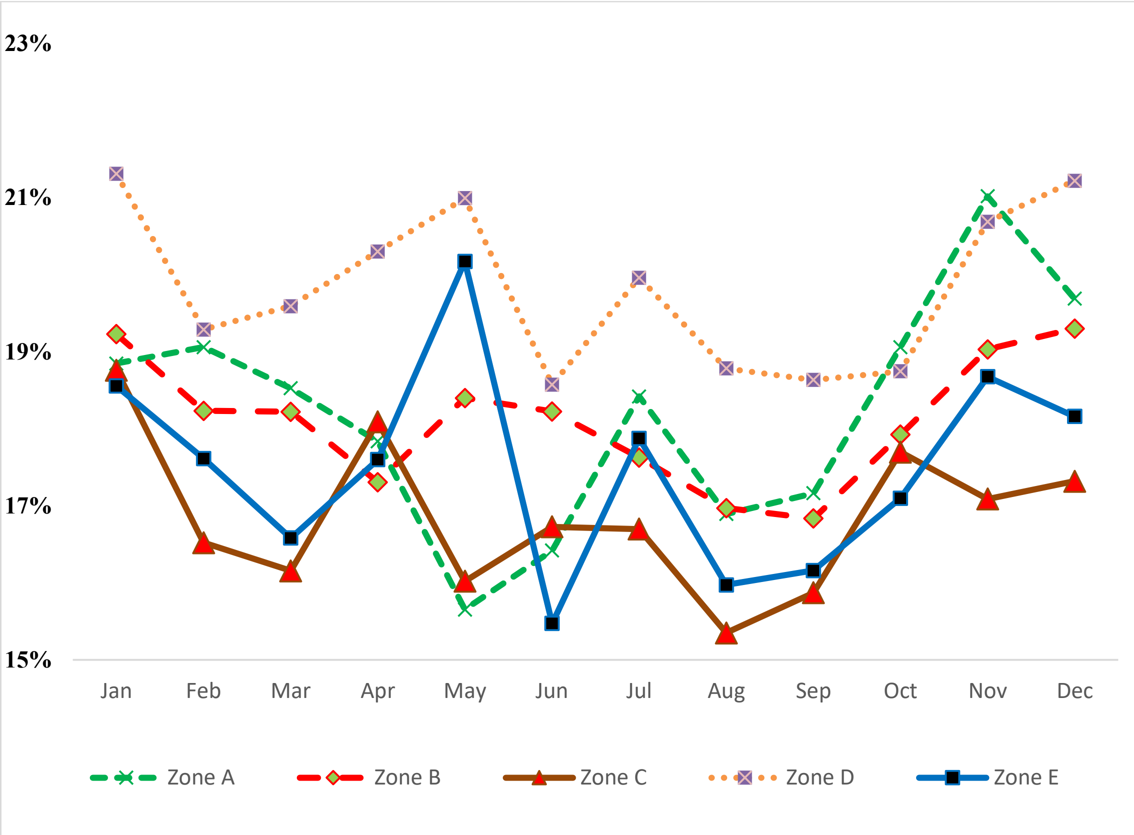
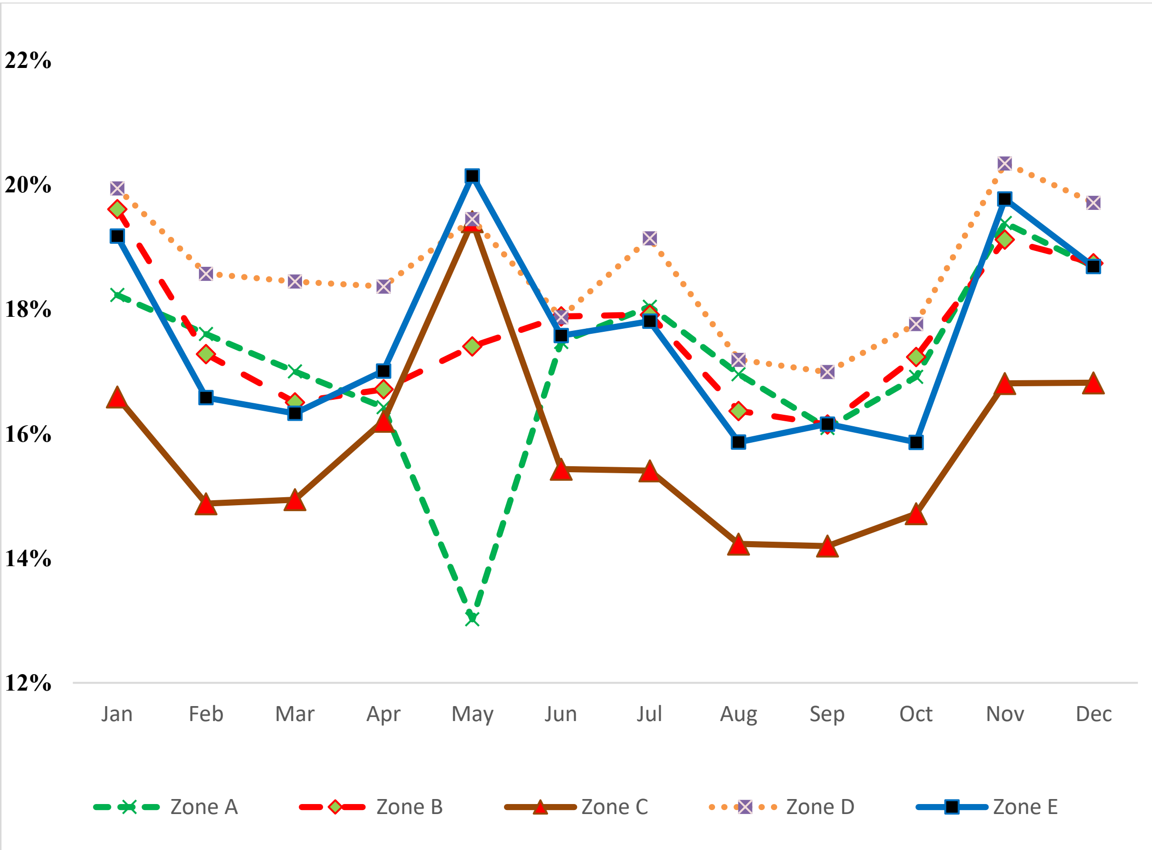


Figure 3.16: Monthly HH Expenditure Share for Other Non-Food in Rural Zones



3.5 CONCLUDING REMARKS

This study explores the role of atmospheric conditions in influencing household consumption pattern in Pakistan. For this purpose, the study distinguishes between climate and weather, the former referring to atmospheric conditions of a region that prevail over a long period of time, while the latter representing atmospheric conditions of a geographical region prevailing during a short span of time like months.

The study is based on pooled data available in household surveys for nine different survey years spanning from 2001 to 2016. With each observation point tagged to a specific month, the entire data belong to 108 months across the nine years for which prices data are also available from independent sources. The entire data are first classified into urban and rural categories and then each set is further classified into five climatic zones and 12 calendar months. Using climatic zone and month dummies along with their interaction, household income, prices and macroeconomic conditioning variables, the study estimates AIDS for urban and rural samples and traces out the profiles of expenditure shares across months and climatic zones.

The study finds that household demand contains systematically seasonal variations as well as the variations across climatic zones, and the seasonal pattern and its relationship with household demand varies systematically across different climatic zones.

The seasonal variations in expenditure pattern can be related to weather conditions and the associated cultural factors such as wedding seasons, eating and drinking patterns, local production of fruits and vegetables. These seasonal variations in household expenditure pattern are observed to vary considerably between the climatic zones where summers are prolonged to those areas where winters are prolonged. Another finding is that the climatic zone effects on households' expenditure pattern relate not only to climate itself; it can also be related to the cultural footprints of climatic zones such as eating habits, travel culture and quality of roads infrastructure. The study also finds that seasonal and climatic zone effects are not the same between urban and rural households.

The study has important policy implication for market regulators for essential consumer goods in Pakistan. Since demand conditions for various goods and services are not uniform across months and climatic zones, there can emerge significant demand supply gaps unless markets are efficient and information flow is smooth and symmetric. This is true not only in case of perishable food items like fruits, vegetables and poultry but also in case of non-perishable foods like sugar, edible oil and wheat flour, and the non-food items like petroleum products, electricity, natural gas and health services. We often observe shortage of some of these items confined to some areas and prevalent during specific months. The northern areas in Zona A are especially vulnerable to such shocks because of difficult road access and frequent landslides blocking major highways for several days. Similarly, electric power and natural gas shortages and the resulting unplanned power blackouts/load shedding and supply cuts are more frequent and prolonged in some climatic zones and months than others.

The present study provides the firsthand evidence on the seasonal and climatic zones patterns of household demand for some broad categories of goods and services. It highlights how demand patterns can change significantly across months and climatic zones. Various public sector institutions like Ministry of National Food Security & Research, Provincial food departments, NEPRA (National Electric Power Regulatory Authority, OGRA (Oil and Gas Regulatory Authority) can benefit from this study or other more focused studies on the same line to better manage supply demand balance of essential goods and services across the country.

APPENDIX 3

Figure A3.1: Mapping of the Climatic Zones of Pakistan

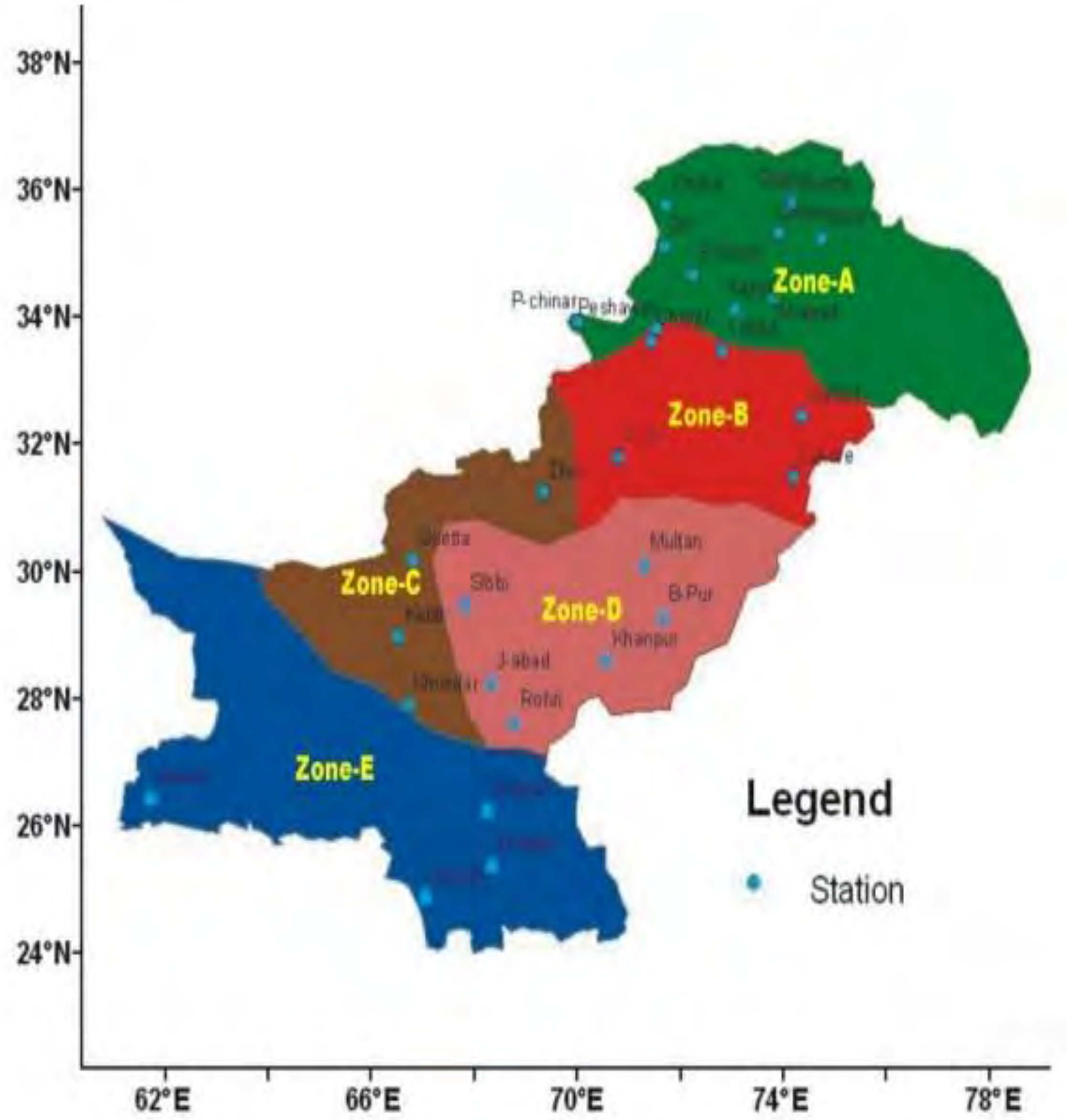


Table A3.1: Parameter Estimates of AIDS for Urban Pakistan

Variables/ Parameters	Grains	Milk, meat & oil	Other foods	Housing	Clothing	Fuel & lighting	Transport & com	Other non-food
α_i	-0.516*	-1.139*	1.336*	1.410*	0.509*	0.974*	-1.216*	-1.358*
β_i	-0.006*	0.037*	-0.037*	-0.016*	-0.008*	-0.010*	0.017*	0.023*
γ_{i1}	0.014*	0.005	-0.014*	-0.005	-0.018*	0.000	-0.006	0.024*
γ_{i2}	0.005	0.008	-0.034*	-0.049*	0.015*	0.003*	0.064*	-0.012*
γ_{i3}	-0.014*	-0.034*	0.034*	0.014*	0.037*	-0.001*	-0.016*	-0.020*
γ_{i4}	-0.005	-0.049*	0.014*	0.088*	-0.029*	0.004*	-0.019*	-0.004
γ_{i5}	-0.018*	0.015*	0.037*	-0.029*	0.001	-0.002*	-0.050*	0.046*
γ_{i6}	0.000	0.003*	-0.001*	0.004*	-0.002*	-0.004*	-0.002*	0.002
γ_{i7}	-0.006	0.064*	-0.016*	-0.019*	-0.050*	-0.002*	0.036*	-0.007
γ_{i8}	0.024	-0.012	-0.02	-0.004	0.046	0.002	-0.007	-0.029*
Inf_A	-0.001*	-0.002*	0.001*	-0.001*	0.003*	0.003*	0.002*	-0.005*
Inf_U	0.001	0.003*	-0.003*	0.01	0.005*	-0.002*	0.001*	-0.005*
LY_A	0.044*	0.086*	-0.082*	-0.084*	-0.026*	-0.063*	0.085*	0.040*
LY_U	-0.047*	-0.450*	0.205*	0.197*	-0.218*	0.196*	-0.018	0.135*
G_Y	0.017	0.160*	-0.194*	0.078*	0.238*	-0.163*	-0.055*	-0.081
M02	0.007	-0.022*	0.013*	0.01	0.01	0.009	-0.009	0.002
M03	0.004	-0.012*	0.017*	0.012*	-0.001	-0.004	-0.013*	-0.003
M04	-0.004	-0.030*	0.038*	0.002	0.01	0.016*	-0.012*	-0.01
M05	-0.005	-0.024*	0.014	0.016*	0.028*	0.013	-0.011	-0.031*
M06	0.000	-0.036*	0.035*	0.011	0.020*	0.006	-0.011	-0.025
M07	0.004	-0.040*	0.014*	0.021*	0.013*	0.003	-0.01*	-0.005
M08	0.001	-0.014*	0.013*	0.004	0.021*	0.006	-0.012*	-0.019
M09	0.004	-0.004	0.007	0.016*	0.009	0.01	-0.014*	-0.018
M10	0.004	0.001	0.009	0.002	0.014*	-0.005	-0.027*	0.002
M11	0.01	-0.016*	0.005	-0.011*	-0.012*	-0.004	0.007	0.021
M12	0.006	-0.007	0.006	-0.017*	-0.002	0.008	-0.002	0.008
Z2	0.01*	0.039*	-0.017*	-0.012*	-0.031*	0.001	0.006	0.004
Z3	0.011*	0.022*	-0.014*	-0.007	-0.011*	-0.003	0.003	-0.001
Z4	0.021*	0.012*	-0.019*	-0.012*	-0.023*	-0.006	0.004	0.023
Z5	-0.001	0.042*	-0.017*	0.004	-0.023*	-0.016*	0.015*	-0.004
M02*Z2	-0.015*	-0.002	0.003	0.022*	0.014*	0.01	-0.01	-0.012
M03*Z2	-0.011*	0.006	-0.006	0.01	0.009	0.015*	-0.005	-0.008
M04*Z2	-0.006	0.016*	-0.030*	0.013*	0.022*	0.002	-0.009	-0.008
M05*Z2	-0.001	-0.011	-0.002	-0.003	-0.006	0.009	-0.01	0.024
M06*Z2	-0.012	-0.004	-0.027*	0.006	0.006	0.022*	-0.005	0.014
M07*Z2	-0.015*	0.020*	-0.008	-0.005	0.003	0.019*	-0.002	-0.012
M08*Z2	-0.013*	0.012*	-0.013*	0.003	0.007	0.009	-0.002	-0.003
M09*Z2	-0.012*	-0.004	-0.008	0.009	0.013*	0.011*	-0.002	-0.007
M10*Z2	-0.014*	-0.007	-0.002	0.012*	0.004	0.012*	0.01	-0.015
M11*Z2	-0.011	0.011*	-0.007	0.021*	0.017*	0.005	-0.013*	-0.023
M12*Z2	-0.009	0.008	-0.009	0.019*	0.005	-0.007	0.01	-0.007
M02*Z3	-0.023*	0.036*	0.009	0.007	0.005	-0.011	0.001	-0.024*
M03*Z3	-0.019*	0.018*	0.003	0.014*	0.005	-0.004	0.005	-0.022
M04*Z3	-0.008	0.024*	-0.026*	-0.014	0.018	-0.012	0.015	0.003

Table A3.1: Parameter Estimates of AIDS for Urban Pakistan

Variables/ Parameters	Grains	Milk, meat & oil	Other foods	Housing	Clothing	Fuel & lighting	Transport & com	Other non-food
M05*Z3	-0.002	0.014	0.018	-0.035*	-0.006	-0.009	0.015	0.005
M06*Z3	-0.011	0.054*	-0.020*	-0.011	-0.007	-0.015	0.006	0.004
M07*Z3	-0.014*	0.049*	0.001	-0.031*	-0.009	-0.005	0.025*	-0.016
M08*Z3	-0.007	0.043*	-0.009	-0.01	0.01	-0.014*	0.012	-0.015
M09*Z3	-0.014*	0.025*	0.003	-0.025*	0.018*	0.003	0.003	-0.013
M10*Z3	-0.015*	0.026*	0.004	-0.016*	-0.016*	0.005	0.025*	-0.013
M11*Z3	-0.008	0.035*	0.01	-0.011	0.016*	0.008	-0.012	-0.038*
M12*Z3	-0.006	0.027*	-0.01	0.006	-0.001	-0.004	0.011	-0.023
M02*Z4	-0.02*	0.007	0.016*	0.021*	0.006	0.001	-0.008	-0.023
M03*Z4	-0.018*	0.01	0.007	0.002	0.016*	0.012*	-0.005	-0.014
M04*Z4	-0.011	0.026*	-0.021*	0.005	0.019*	-0.015*	-0.003	0.01
M05*Z4	-0.008	-0.002	0.003	-0.021*	-0.021*	0.021*	-0.002	0.03
M06*Z4	-0.015*	0.011	-0.009	-0.008	-0.004	0.021*	0.008	-0.004
M07*Z4	-0.022*	0.030*	0.001	-0.015*	-0.002	0.014*	0.004	-0.01
M08*Z4	-0.018*	0.012*	0.001	0.008	0.003	0.002	-0.004	-0.004
M09*Z4	-0.016*	0.002	0.001	0.006	0.006	0.01	0.001	-0.01
M10*Z4	-0.017*	-0.005	0.008	0.018*	0.003	0.006	0.013*	-0.026
M11*Z4	-0.021*	0.001	0.004	0.027*	0.016*	0.005	-0.004	-0.028*
M12*Z4	-0.017*	-0.001	0.001	0.029*	0.007	-0.007	-0.002	-0.01
M02*Z5	-0.015*	0.006	0.002	0.009	0.012*	0.001	-0.003	-0.012
M03*Z5	-0.015*	0.007	-0.009	-0.002	0.017*	0.016*	0.001	-0.015
M04*Z5	-0.003	0.002	-0.026*	0.003	0.032*	-0.002	-0.006	0.01
M05*Z5	0.000	-0.025*	0.012	-0.007	-0.017	-0.008	-0.004	0.049*
M06*Z5	-0.008	0.015*	-0.018*	0.006	-0.01	0.011	0.011	-0.007
M07*Z5	-0.011*	0.026*	0.01	-0.017*	-0.002	0.011*	-0.005	-0.002
M08*Z5	-0.011	0.035*	-0.013*	-0.002	-0.004	0.001	-0.001	-0.005
M09*Z5	-0.01	0.004	-0.006	-0.007	0.020*	0.007	-0.001	-0.007
M10*Z5	-0.015*	0.007	-0.002	-0.001	0.003	0.012	0.013*	-0.017
M11*Z5	-0.01	0.012	-0.006	0.005	0.023*	0.007	-0.01	-0.021
M12*Z5	-0.006	0.009	-0.004	0.014*	0.007	-0.004	-0.004	-0.012
R^2	0.45	0.08	0.07	0.11	0.17	0.12	0.08	0.39

Note: Parameters significant at 5% level are shown by*. Z2,Z3,Z4 and Z5 are Zone B, Zone C, Zone D and Zone E, respectively while Zone A (Z1) is base category. M2,M3..........M12 are monthly dummies from February to December, respectively. Month of January (M1) is base category.

Table A3.2: Parameter Estimates of AIDS for Rural Pakistan

Variables/ parameters	Grains	Milk, meat & oil	Other foods	Housing	Clothing	Fuel & lighting	Transport & com	Other non-food
α_i	-0.001*	0.005*	-0.004*	-0.002*	0.002*	0.001*	0.002*	-0.003*
β_i	0.000	-0.002*	0.001*	0.002*	0.003*	0.001*	-0.002*	-0.003*
γ_{i1}	0.051*	-0.124*	-0.021*	0.031*	-0.001	0.011*	-0.038*	0.091*
γ_{i2}	-0.061*	0.475*	-0.213*	-0.246*	-0.255*	-0.072*	0.177*	0.195*
γ_{i3}	-0.021	-0.477*	0.151*	0.256*	0.231*	0.111*	-0.075*	-0.176*
γ_{i4}	-0.008*	0.015*	0.013*	-0.012*	-0.002	-0.008*	0.007*	-0.005
γ_{i5}	-0.006*	0.015*	0.004	-0.008*	-0.005	0.001	0.011*	-0.012
γ_{i6}	-0.010*	0.023*	0.021*	0.001	-0.018*	-0.014*	0.014*	-0.017
γ_{i7}	-0.014*	0.014*	0.046*	0.016*	-0.017*	-0.001	0.009	-0.053*
γ_{i8}	-0.008*	0.025*	0.027*	-0.001	-0.028*	-0.018*	0.011*	-0.008
Inf_A	-0.009*	0.018*	0.023*	-0.014*	-0.016*	-0.01*	0.010*	-0.002
Inf_U	-0.008*	0.005*	0.023*	-0.002	0.003	-0.009*	0.000	-0.012
LY_A	-0.008*	0.002	0.031*	0.007*	-0.004	-0.012*	0.004	-0.02
LY_U	-0.010*	-0.006*	0.021*	-0.013*	0.013*	-0.002	0.009*	-0.012
G_Y	-0.002	-0.001	0.010*	-0.020*	-0.003	-0.008*	0.012*	0.012
M02	0.000	0.011*	-0.003	-0.016*	0.004	-0.011*	0.010*	0.005
M03	0.000	0.018*	-0.015*	0.001	0.023*	-0.046*	0.005*	0.014
M04	-0.003	0.003	0.001	-0.011*	0.078*	-0.057*	0.005	-0.016*
M05	0.000	0.012*	-0.01*	-0.007*	0.059*	-0.087*	0.015*	0.018*
M06	-0.007*	0.006*	-0.012*	0.014*	0.063*	-0.091*	0.018*	0.009
M07	0.002	0.009*	-0.007*	0.003	0.011*	-0.003	0.002	-0.017*
M08	-0.005	0.017*	0.003	0.001	0.013*	-0.007*	-0.003	-0.019*
M09	-0.003	-0.002	-0.009*	-0.014*	0.024*	0.014*	0.001	-0.011
M10	-0.007	0.014*	-0.064*	-0.030*	0.061*	-0.004	-0.001	0.0310*
M11	0.000	-0.004	-0.025*	-0.009*	0.037*	0.013*	-0.003	-0.009
M12	-0.003	-0.005	-0.018*	0.001	0.037*	0.005	-0.002	-0.015*
Z2	-0.003	-0.005	-0.012*	0.006*	0.024*	0.007*	0.001	-0.018*
Z3	0.000	-0.003	-0.023*	0.010*	0.029*	0.006*	-0.006*	-0.013*
Z4	0.006*	0.009*	-0.004	0.007*	-0.002	0.001	-0.007*	-0.01
Z5	0.002	-0.004	-0.008*	0.027*	0.010*	0.003	-0.013*	-0.017*
M02*Z2	0.000	-0.009*	0.004	0.015*	0.000	0.010*	-0.006*	-0.014*
M03*Z2	-0.004	0.017*	-0.015*	0.020*	0.004	-0.013*	0.002	-0.011
M04*Z2	0.000	0.024*	-0.005	0.003	0.000	-0.026*	0.007	-0.003
M05*Z2	0.002	0.025*	-0.047*	-0.012*	-0.014*	-0.004	0.036*	0.014
M06*Z2	0.018	0.037*	-0.111*	-0.062*	-0.012	-0.058*	0.108*	0.080*
M07*Z2	0.005	0.036*	-0.035*	-0.025*	0.044*	-0.023*	0.001	-0.003
M08*Z2	0.000	0.038*	-0.037*	0.014*	0.007	-0.026*	0.014*	-0.010
M09*Z2	0.004	0.023*	-0.015*	-0.023*	0.020*	-0.005	0.006	-0.010
M10*Z2	-0.002	0.033*	-0.035*	-0.017*	0.014*	-0.002	0.011*	-0.002
M11*Z2	0.011*	0.032*	-0.027*	0.001	-0.009*	-0.001	-0.002	-0.005
M12*Z2	0.017*	0.023*	-0.022*	-0.002	0.000	-0.010*	0.003	-0.009
M02*Z3	-0.003	0.003	0.000	0.023*	-0.008	-0.010*	-0.003	-0.002
M03*Z3	0.005	0.003	-0.010*	0.010*	-0.002	0.007*	-0.004	-0.009

Table A3.2: Parameter Estimates of AIDS for Rural Pakistan

Variables/ parameters	Grains	Milk, meat & oil	Other foods	Housing	Clothing	Fuel & lighting	Transport & com	Other non-food
M04*Z3	-0.004	0.005	0.004	0.010*	0.001	-0.005	-0.008*	-0.003
M05*Z3	0.001	0.017*	-0.022*	-0.024*	0.028*	0.012*	-0.014*	0.002
M06*Z3	0.014*	0.015*	-0.058*	-0.045*	0.031*	-0.001	-0.003	0.047*
M07*Z3	-0.004	0.026*	-0.034*	-0.022*	0.036*	0.019*	-0.007	-0.014
M08*Z3	0.001	0.004	-0.020*	-0.001	0.023*	0.006	-0.006*	-0.007
M09*Z3	0.000	0.001	-0.017*	0.015*	0.013*	0.009*	-0.006*	-0.015
M10*Z3	-0.003	0.004	-0.026*	0.009*	0.020*	0.014*	-0.011*	-0.007
M11*Z3	-0.002	0.004	-0.004	0.021*	-0.002	0.003	-0.011*	-0.009
M12*Z3	0.005	-0.001	-0.017*	0.030*	-0.003	0.009*	-0.016*	-0.007
M02*Z4	-0.003	-0.010*	0.001	0.027*	-0.011*	0.013*	-0.012*	-0.005
M03*Z4	0.000	0.006	-0.012*	0.010*	0.015*	0.005	-0.004	-0.020
M04*Z4	-0.005	0.006	0.000	0.007*	0.017*	-0.004	-0.005	-0.016
M05*Z4	0.002	-0.012*	-0.012*	-0.032*	0.042*	0.023*	-0.007	-0.004
M06*Z4	0.011	0.001	-0.028*	-0.064*	0.040*	-0.004	-0.017*	0.061*
M07*Z4	0.000	0.010*	-0.024*	-0.007	0.032*	0.012*	-0.014*	-0.009
M08*Z4	0.002	0.008*	-0.018*	-0.010*	0.030*	0.004	-0.004	-0.012
M09*Z4	-0.001	0.012*	-0.017*	0.005	0.019*	0.006*	-0.003	-0.021
M10*Z4	0.004	0.008*	-0.028*	-0.005	0.035*	0.005	-0.012*	-0.007
M11*Z4	0.002	0.021*	-0.022*	0.015*	0.008*	0.000	-0.004	-0.020*
M12*Z4	0.006	0.012*	-0.020*	0.010*	0.013*	0.007	-0.021*	-0.007
M02*Z5	0.001	-0.004	-0.003	0.009*	0.000	0.011*	-0.004	-0.010
M03*Z5	0.290	0.030	0.230	0.080	0.100	0.330	0.060	0.350
M04*Z5	-0.001*	0.005*	-0.004*	-0.002*	0.002*	0.001*	0.002*	-0.003*
M05*Z5	0.000	-0.002*	0.001*	0.002*	0.003*	0.001*	-0.002*	-0.003*
M06*Z5	0.051*	-0.124*	-0.021*	0.031*	-0.001	0.011*	-0.038*	0.091*
M07*Z5	-0.061*	0.475*	-0.213*	-0.246*	-0.255*	-0.072*	0.177*	0.195*
M08*Z5	-0.021	-0.477*	0.151*	0.256*	0.231*	0.111*	-0.075*	-0.176*
M09*Z5	-0.008*	0.015*	0.013*	-0.012*	-0.002	-0.008*	0.007*	-0.005
M10*Z5	-0.006*	0.015*	0.004	-0.008*	-0.005	0.001	0.011*	-0.012
M11*Z5	-0.010*	0.023*	0.021*	0.001	-0.018*	-0.014*	0.014*	-0.017
M12*Z5	-0.014*	0.014*	0.046*	0.016*	-0.017*	-0.001	0.009	-0.053*
R^2	-0.008*	0.025*	0.027*	-0.001	-0.028*	-0.018*	0.011*	-0.008

Note: Parameters significant at 5% level are shown by*. Z2,Z3,Z4 and Z5 are Zone B, Zone C, Zone D and Zone E, respectively while Zone A (Z1) is base category. M2,M3..........M12 are monthly dummies from February to December, respectively. Month of January (M1) is base category.

CHAPTER 4

QUADRATIC AIDS SPLINE: AN APPLICATION TO PAKISTAN HOUSEHOLD DATA

4.1. INTRODUCTION

In the theory of consumer behavior income and prices of goods are considered as the main variables influencing consumers' decisions. While proportional changes in prices do not induce reallocation of budget except to the extent that these price changes affect purchasing power of real income, it is the income variable that matters the most unless price changes also result in changes in relative prices. The influence of changes in income is also important because large changes in income can place households in different socioeconomic classes that can change their preference structure in fundamental ways. For example, transition of middle-class households to rich class will introduce them to new socioeconomic considerations. Many goods and services such as personal vehicles, world travel, hoteling, quality healthcare and education that used to be out of reach now become affordable.

Engel (1857) was perhaps the first economist to draw attention to how consumers change their behavior in terms of treatment of various categories of goods when their incomes increase. He asserted that as income levels of consumer's increase, they tend to increase consumption of non-food items by a greater percentage than the rate of increase in food items. In other words, the budget share of non-food items tends to increase and that of food items tend to decrease in response to increase in income.

Economic literature provides extensive tools to analyze the role of income on consumer demand. Almost Ideal Demand System of Deaton and Muellbauer (1980) has been considered most suitable for the positive and normative analysis of consumer behavior. However, Banks, *et al*. (1997) later pointed out that despite its flexibility, AIDS performs poorly at extreme ends of data and to overcome this deficiency a more flexible functional form of demand equations is needed. Rather than venturing into entirely new demand systems, Banks, *et al*. (1997) used AIDS as stepping-stone (apparently because of its already proven success in modeling consumer behavior) and extended it to Quadratic AIDS or QUAIDS.

The present paper argues that even a highly flexible demand system like QUAIDS may not necessarily capture the changing behavior of consumers when their income levels change by large proportions. One option is to divides consumers into different income categories and estimate separate AIDS or QUAIDS for each income class. The weakness of this approach is that it requires the knowledge of threshold income levels where consumer behavior is expected to change. Another shortcoming of this approach is that if income groups are large, it may leave insufficient number of observations for efficient parameter estimation within some of the income groups.

In the light of these observations the present study proposes to extend QUAIDS to Quadratic AIDS Spline functions in such a way that a small number of parameters are added to the QUAIDS and the transition from one income group to the next one is smooth. Another feature of the proposed system is that it does not require prior knowledge of the threshold levels of income, which are rather estimated within the system with the help of a thorough grid search procedure.

The system of Quadratic AIDS Spline is then estimated for Pakistan's households to analyze how households changes their consumption basket when their real incomes increase over long-run. The analysis is based on nine sets of survey data pooled together. A system of demand functions represented by Quadratic AIDS Splines is estimated for eight commodity groups including three food and five non-food categories in two phases. In the first phase the system is estimated with grid search to determine the existence and locations of successive threshold levels of real income. Once all the significant threshold levels are located, the system of demand functions is then estimated by Two-Step Iterative method for Seemingly Unrelated Regressions model.

Rest of the paper is organized as follows: A brief review of empirical literature on Pakistan regarding the role of income in household demand analysis is presented in Section 4.2. Quadratic AIDS Splines and the expressions for price and income elasticities are derived in Section 4.3. Data and estimation procedures are explained in Section 4.4 and the empirical results are presented in section 4.5. Finally, the study is concluded in Section 4.6.

4.2. LITERATURE REVIEW

Household income is an important factor determining how much is spent on consumption goods. Household income affects a household's decision making in different respects. Firstly, it determines the household's affordability regarding purchase of goods and services that affects the way it allocates given budget between different goods and services. Secondly, households can be categorized into different income classes such as low income, middle income or higher income based on level of incomes they have. These income classes do not just show different levels of income, these also indicate different socioeconomic classes representing different lifestyles compatible with their social statuses. In other words, large changes in income may also alter households' taste and as a result households' budget allocation may change on two accounts, which are change of income and the resulting changes in tastes.

The relationship between household income and household expenditure on a commodity or commodity group is known as Engel Curve. Engel's Law (Engel, 1857) states that as a household's income increases, the percentage of income spent on food decreases while the proportion spent on other goods increases. Engel curves are of two types. Budget share Engel curves describe how the proportion of household income spent on a good varies with income. Alternatively, Engel curves can also describe how real expenditure varies with household income.

Though the household demand has been analyzed both theoretically as well as empirically in Pakistan. The literature has improved in terms of models specified, explanatory variables included and estimation techniques used (See for example, Bussink, 1970; Cambell and Mankiw,1989; Arshad, 1990; Bouis, 1992; Khalid, 1994; Khan and Memon, 2012; Sher *et al*.,2012; Amir and Bilal, 2012; Ajmair and Akhtar, 2012; Nawaz *et al*., 2013; Akhtar *et al*., 2020). However, the literature focusing on consumption patterns at varying level of household income or analyzing household demand for consumption goods for different income groups is limited.

Shahzadi (2010) uses Pakistan Panel Household Survey (2010) and estimated Engel Curves for Pakistan. The study found that the estimated relationship between budget shares of food items and the log of total expenditures is negatively while the relationship between the budget shares of non-food items like utilities and durables are positively related to log of total expenditure.

Ahmad *et al*. (2015) analyzed the rural urban food consumption patterns for Pakistan using HIES data for year 1998-99. The households are divided into five income groups at national and provincial levels. They found that consumption patterns differ across different income groups in rural and urban regions and households in the low-level income groups spend a larger fraction of their income on wheat, pulses and vegetable while high income groups spend a larger budget share on rice, meat and fish, milk and milk products both in rural and urban areas.

Some studies have analyzed patterns of household expenditures on goods and services at varying levels of income in Pakistan through the specification of Engel equations and have also derived Spline Curves,[8] showing the relationship between expenditures on individual commodity or commodity group with the level of household total expenditures (total income). Ahmad and Arshad (2007) using HIES data for year 2001-02 for Pakistan estimate Engel equations for 22 commodity groups with quadratic spline specification. The number and locations of knots are found through a search procedure. The study finds that the resulting flexibility produces many interesting patterns of changes in the classification of goods into necessities and luxuries across different income ranges.

In another study Shamim and Ahmad (2007) analyzes the patterns of household consumption in urban and rural regions using HIES data for year 2001-02 for Pakistan. Engel curves are estimated by spline quadratic expenditure system for expenditures on 18 commodity groups. Results show significant differences in consumption patterns of food and non-food items at varying levels of total expenditure.

Some literature for Pakistan, especially the last two studies mentioned above, account for the role of income-related changes in tastes when analyzing Engel's Law by allowing parameters to change across income groups. But this treatment is confined to Engel Equations rather than the complete demand system. The main reason is that in the absence of worthwhile of panel data in Pakistan, the literature is mostly confined to cross-sectional analysis taking prices as given. A few studies that have employed time-series (Burki, 1997) or pooled cross-section and time-series data (Ahmad *et al*., 2013; Ahmad *et al*., 2020) to estimate the complete demand system do not have sufficient

[8] Poirier (1976) defines Spline functions as "In a simplest sense a Spline function is a piece-wise function in which the pieces are joined together in a suitably smooth fashion".

sample size to allow for changes in parameters across income groups to represent income related tastes changes.

The present study attempts to fill this gap by using pooled survey data belonging to nine survey years.

4. 3. QUADRATIC AIDS SPLINES

The idea of Quadratic AIDS Splines is motivated by the need of creating additional flexibility in the demand system. AIDS (Almost Ideal Demand System) of Deaton and Muellbauer (1980) is itself considered quite flexible. AIDS has been extended to an even more flexible system, QUAIDS (Quadratic AIDS) in Banks, *et al*. (1997), by suitably modifying the indirect utility function of Deaton and Muellbauer (1980) such that it yields expenditure share equations that are quadratic in log of nominal income. In this paper, starting with QUIAIDS we introduce additional quadratic terms in the system at some threshold levels of income in order to introduce more flexibility for the estimation of income and price elasticities.

4.3.1. DEMAND SYSTEM UNDER QUADRATIC AIDS SPLINES

Banks, *et al*. (1997) proposed the following indirect utility function.

$$u = \left[\left(\frac{\ln M - \ln a(P)}{b(P)}\right)^{-1} + \lambda(P)\right]^{-1} = \left[\frac{b(P)}{\ln M - \ln a(P)} + \lambda(P)\right]^{-1} \quad (1)$$

where

$$\ln a(P) = a_\circ + \sum_k \alpha_k \ln p_k + \frac{1}{2}\sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j \quad (2)$$

$$b(P) = \prod_k (p_k)^{\beta_k} \quad (3)$$

$$\lambda(P) = \sum_k \lambda_k \ln p_k \quad (4)$$

$$\gamma_{ij} = \gamma_{ji}, \quad \sum_i \alpha_i = 1, \quad \sum_i \beta_i = 0, \quad \sum_i \gamma_{ij} = 0, \quad \sum_i \lambda_i = 0 \quad (5)$$

To derive demand functions with the help of Roy's identity, the following partial derivatives are used:

$$\frac{\partial u}{\partial p_i} = -\left[\frac{b(P)}{\ln M - \ln a(P)} + \lambda(P)\right]^{-2} \left[\frac{b(P)}{\{\ln M - \ln a(P)\}^2} \left(a_i + \sum_j \gamma_{ij} \ln p_j \right.\right.$$
$$\left.\left. + \beta_i\{\ln M - \ln a(p)\}\right) + \lambda_i\right] \frac{1}{p_i} \qquad (6)$$

$$\frac{\partial u}{\partial M} = -\left[\frac{b(P)}{\ln M - \ln a(P)} + \lambda(P)\right]^{-2} \frac{-b(P)}{\{\ln M - \ln a(P)\}^2} \frac{1}{M} \qquad (7)$$

It follows that:

$$S_i = \frac{P_i X_i}{M} = -\frac{\partial u/\partial p_i}{\partial u/\partial M} \frac{P_i}{M}$$
$$= a_i + \sum_j \gamma_{ij} \ln p_j + \beta_i\{\ln M - \ln a(p)\} + \lambda_i \frac{1}{b(P)} \{\ln M - \ln a(P)\}^2 \qquad (8)$$

In this system of demand functions the expenditure shares are quadratic functions of real income and more general non-linear functions of prices. The system of equations is also non-linear in parameters. For proceeding towards further flexibility in the quadratic relationship between expenditure shares and real income, we consider a linear approximation (with respect to parameters) to QUAIDS by setting the price index *a(P)* equal to Stone price index (following the proposal of Deaton and Muellbauer, 1980 for the standard AIDS). Thus *a(P)* in the above system of equations is replaced by:

$$\log P^* = \sum_k S_k \log(p_k) \qquad (9)$$

where S_k denotes expenditure share of good k, to be calculated beforehand as the sample means from data.

In addition, we also set *b(P)* equal to a constant value, normalized to one. This results in the following QUAIDS, which we refer to as Linear Approximation to QUAIDS, or LA/QUAIDS.

$$S_i = a_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \{\ln M - \ln P^*\} + \lambda_i \{\ln M - \ln P^*\}^2 \qquad (10)$$

It may be noted that linear approximation is proposed with respect to parameters. Otherwise the system remains non-linear in income as well as prices.

We now allow parameters of the system to vary systematically across different ranges of real income so that the slope and curvature of each relationship in equation (10) may change across income ranges. Denoting log of real income $\ln M - \ln P^*$ by Y, we introduce T threshold level of real income Y_t, where t takes valued from 1 to T and define the following indicator functions:

$$I_{Y_T}(Y) = \begin{cases} 1 \; if \; Y \geq Y_{T,} \\ 0 \; if \; Y < Y_{T,} \end{cases} \qquad (11)$$

Using these indicator functions the LA/QUAIDS can be extended to the following general form.

$$S_i = a_i + \sum_j \gamma_{ij} \ln p_j + \beta_i Y + \lambda_i Y^2 + \sum_{t=1}^{T} (a_{it} + \beta_{it} Y + \lambda_{it} Y^2) I_{Y_T}(Y) \qquad (12)$$

This specification is somewhat like piece-wise regression equations except that the parameters directly associated with prices are not allowed to change. The expenditure shares estimated at the threshold levels of real income will be discontinuous. In order to ensure continuity, we impose the following limit conditions.

$$\underset{Y \to (Y_T)^-}{\text{Limit}} (S_i) = \underset{Y \to (Y_T)^+}{\text{Limit}} (S_i) \qquad (13)$$

The imposition of these limits on the demand system (12) will yield:

$$a_{it} = -\beta_{it} Y_t - \lambda_{it} \, Y_t^2 \qquad (14)$$

Substituting these parametric restrictions in equation (12) yields:

$$S_i = a_i + \sum_j \gamma_{ij} \ln p_j + \beta_i Y + \lambda_i Y^2$$

$$+ \sum_{t=1}^{T} [\beta_{it}(Y - Y_t) + \lambda_{it}(Y^2 - Y_t^2)] I_{Y_T}(Y) \qquad (15)$$

These functions are continuous but not differentiable on the threshold levels of real income. To ensure differentiability, we impose the following additional limit conditions on the above demand system (equation 15).

$$\underset{Y \to (Y_T)^-}{\text{Limit}} \left(\frac{\partial S_i}{\partial Y}\right) = \underset{Y \to (Y_T)^+}{\text{Limit}} \left(\frac{\partial S_i}{\partial Y}\right) \qquad (16)$$

This yields the following parametric restrictions.

$$\beta_{it} = -2\, \lambda_{it} Y_t \qquad (17)$$

When these restrictions are substituted in equations (15), the result after simplifications would be the follows:

$$S_i = a_i + \sum_j \gamma_{ij} \ln p_j + \beta_i Y + \lambda_i Y^2 + \sum_{t=1}^{T} \lambda_{it} (Y - Y_t)^2 I_{Y_T}(Y) \qquad (18)$$

Or, substituting for the log of real income,

$$S_i = a_i + \sum_j \gamma_{ij} \ln p_j + \beta_i (\ln M - \ln P^*) + \lambda_i (\ln M - \ln P^*)^2$$

$$+ \sum_{t=1}^{T} \lambda_{it} (\ln M - \ln P^* - Y_t)^2 I_{Y_T}(Y) \qquad (19)$$

This is the final form of our proposed demand system, which we refer to as Quadratic AIDS Splines. The system of demand functions is quite flexible as it allows smooth transition from one range of income to the next range separated by the threshold levels of real income. The threshold levels in spline setting are called knots. The number and location of knots may be decided before estimation or it can be made part of estimation. The estimation strategy followed in this paper will be discussed later on. The main advantage of the extra-ordinary flexibility allowed in the system is that it can track all fundamental changes in preferences across households belonging to various income classes such as poor, middle and upper middle classes.

Additional variables can be added directly in the equations. The study also uses month and climatic zone dummy variables. Monthly dummy variables are used to capture the effects of seasonal variations in weather on household demand for consumer goods using the month of March as base month. Climatic zone dummy variables are used to capture the climate effects on household demand for consumer goods using climatic zone A as the base category.

4.3.2. PRICE AND INCOME ELASTICITIES

To derive expressions for price elasticities for QUAIDS Splines we take natural log on both sides of the share equation (19) for good i and differentiating with respect to $\ln P_j$ keeping in view that the shares of all the goods appearing in Stone price index (equation 10) are also functions of prices. This differentiation yields the following result:

$$\frac{\partial \ln S_i}{\partial \ln P_j} = \frac{\gamma_{ij}}{S_i} - \frac{1}{S_i}\left[\beta_i + 2\lambda_i(\ln M - \ln P^*) + 2\sum_{t=1}^{T}\lambda_{it}(\ln M - \ln P^* - Y_t)I_{Y_T}(Y)\right]$$

$$\left\{s_j + \sum_k \ln p_j \frac{\partial s_k}{\partial \ln s_k}\frac{\partial \ln s_k}{\partial \ln P_j}\right\} \tag{20}$$

Now we denote the large term in square brackets by ϕ_i, that is;

$$\phi_i = \beta_i + 2\lambda_i(\ln M - \ln P^*) + 2\sum_{t=1}^{T}\lambda_{it}(\ln M - \ln P^* - Y_t)I_{Y_T}(Y) \tag{21}$$

The value of ϕ_i can be computed at sample mean or any other point from data before the calculations of elasticities. Now applying all the derivatives and denoting Kronecker delta (which is equal to 1 when i = j and zero when i ≠ j) by δ_{kj}, we can write the above equation as:

$$\eta_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{s_i} - \frac{\phi_i \, s_j}{s_i} - \frac{\phi_i}{s_i} \sum_k s_k \ln P_k \left(\eta_{kj} + \delta_{kj}\right) \tag{22}$$

These are m^2 equations for m^2 price elasticities appearing on both sides of the equations, where m is the number of commodity groups. To solve these simultaneous equations, we express all the elasticities in matrix form as:

$$E = A - (BC)(E + I) \tag{23}$$

where

E is the n × n matrix of price elasticities η_{ij}

A is the $n \times n$ matrix of elements $a_{ij} = -\delta_{ij} + \left(\frac{\gamma_{ij}}{s_i}\right) - \phi_i \left(\frac{s_j}{s_i}\right)$

B is the $n \times 1$ vector of elements $b_i = \phi_i / s_i$ in n x 1 vector B

C is the $1 \times n$ vector of elements $c_j = s_j \ln P_j$ in 1 x n vector C

Now it is possible to find reduced form solution for the matrix of elasticities E:

$$E = [BC + 1]^{-1}[A + I] - I \tag{24}$$

For income elasticities the share equation (19) for good i is differentiated after taking log on both sides to yield:

$$\eta_{iM} = 1 + \frac{\phi_i}{s_i} - \frac{\phi_i}{s_i} \left[\sum_k s_k \ln P_k \, (\eta_{kM} - 1) \right] \tag{25}$$

Or, in matrix form:

$$N = i + B - BC\lfloor N - i \rfloor \tag{26}$$

Therefore,

$$N = (I + BC)^{-1}B + i \tag{27}$$

where

N is the n × 1 vector of income elasticities η_{iM}

i is the n × 1 matrix of ones

Although expressions for the price and income elasticities are apparently the same as they appear in AIDS, yet they are different in substantive way. In standard

AIDS, the vector the B consists of the elements β_i/s_i, where β_i are parameters and s_i are the expenditure shares, which are normally computed at sample means. In the present context, β_i are replaced by ϕ_i that include various parameters as well as variables including real income and the indicator functions. While computing various elasticities since ϕ_i vary across real incomes, it makes sense to vary the expenditure shares as well. In case a single set of elasticities are to be computed at sample mean, then both ϕ_i and S_i may be computed at sample means. However, it makes more sense to estimate various sets of elasticities corresponding to various levels of real income such as specific income quantiles and, hence, to treat both ϕ_i and S_i as variables.

4.4. DATA AND ESTIMATIONS

4.4.1. DATA

The study utilizes monthly household expenditure data extracted from *Household Integrated Economic Survey* for the years: 2001-02, 2004- 05, 2005-06, 2007-08, 2008-09, 2010-11, 2011-12, 2013-14 and 2015-16. Pakistan Bureau of Statistics is responsible for the collection of HIES data for which different rounds of surveys have been carried out. Expenditures on more than 400 goods and services reported in the surveys are classified for the present study into eight different commodity groups. These commodity groups are: 1) Grains (rice, wheat, lentils, peas and flours); 2) Milk, Meat & Oil (sources of protein, fats and calcium); 3) Other Foods (including vegetables, fruits, herbs, spices, sauces, bakery products, confectioneries, drinks, cooked/readymade food and any other food item not included in the other two categories); 4) Clothing, Apparel, Textile and Footwear (all types of wears, linen and tapestry); 5) Housing (including fixture, furniture and other durables); 6) Fuel & Lighting; 7) Transport and Communication; and 8) Other Non-Food (consisting of those goods and services that are not included in any other commodity group considered.

The study measures household income in form of total expenditures as per the practice and convention in empirical literature. All the expenditures are expressed in per adult equivalent terms using OECD adult equivalence scales, where value of 1 is assigned to the first household adult member; 0.7 to each additional adult member and of 0.5 to each child.

The data on consumer price indices (CPIs) for eight commodity groups are taken from various issues of Pakistan Economic Survey. Where the CPIs are not directly given for any commodity group, the same have been calculated utilizing the sub-categories CPIs or individual items prices given in the same source. In order to control for the seasonal and climate effects on household demand, month and climatic zone dummy variables are also included in the demand equations. Month of January and climatic zone A are used as the base categories, respectively.

4.4.2. ESTIMATION PROCEDURE

The system of demand equations given in equation (19) can be treated linear in parameters if 1) all the expenditure shares to be used in Stone price index are computed beforehand and taken as given numbers; and 2) the number and locations of the knots of Splines are also given beforehand. While we maintain the first condition following the convention of linear approximation, we do not fix either the number of knots or their location. Therefore, we follow multi-rounds grid search and two-step iterative search procedure. The procedure is outlines as follows.

Step 1

To fix the first knot, arrange all data in ascending order of log of real income and leave n_0 values on both ends of the data. The number n_0 should be sufficiently large to allow estimation of parameters on both sides of the knot. Then starting at the observation point n_0 and ending at n - n_0 place a knot alternatively at successive intervals of 0.1 on the scale of log real income. For example, if the log of real incomes at the observation points n_0 and n - n_0 are 2 and 5 respectively then the alternative knots will be at the levels 2, 2.1, 2.2, …4.8, 4.9, and 5. Estimate the system of Quadratic Spline functions with each alternative knot. Select that knot that yields the maximum value of conditional log likelihood function.

Suppose the knot is located at the log of real income equal to Y_1. Now take a second round of search with successive intervals of 0.01 starting at $Y_1 - 0.01$ and ending at $Y_1 + 0.01$. Once the knot is chosen with the second round, apply Wald test on the null hypothesis that all the shift parameters λ_{i1} are jointly equal to zero. If the null hypothesis is rejected, then move to step 2; otherwise search is terminated with the conclusion Quadratic AIDS cannot be extended to Quadratic AIDS Splines.

Step 2

Given that the location of first knot is determined, search for the location of another possible knot following the same procedure as outlines in step 1. Again apply Wald test on the null hypothesis that all the shift parameters λ_{i2} are jointly equal to zero. If the null hypothesis is rejected, then move to step 3; otherwise search is terminated with the conclusion that just one shift in the Quadratic AIDS is permissible.

This step-wise search continues till all significant knots are found. After each successful step, the locations of knots found at earlier steps are searched again for fine tuning.

Final Estimation

Once the knots and their locations are found we will be left with a system of Seemingly Unrelated Regressions (SUR) model. This system is easily estimated following Zellner's Two-Step Iterative procedure for SUIR models.

4.5. RESULTS AND DISCUSSION

The first task in the estimation of demand system is to determine the number and locations of knots for the Quadratic AIDS Splines. Following the procedure outlined in section 3, six knots and their locations on log of real income per adult equivalent are found in urban sample and 11 locations are found in the rural sample. Since real income is obtained by deflating nominal income by consumer price index, it would be easier to understand the locations of knots on deciles scale.

The knots in urban sample are found approximately at percentiles of 0.4, 7.7, 12.8, 73.4, 96.0 and 98.5, while those in the rural sample are found approximately at percentiles of 0.3, 6.5, 11.5, 14.8, 18.6, 84.7, 87.2, 96.8, 97.4, 98 and 98,7. It is obvious from these results that the significant changes in the demand system occur at extreme ends of real per adult equivalent income. On extremely low income-levels, drastic changes in consumption behavior are expected as poor households are forced to adjust their budgets to survive. On the other side, at high income levels households tend to make fundamental changes in budget allocation as they find themselves in a position to include new products and product varieties in the budget and explore different lifestyles.

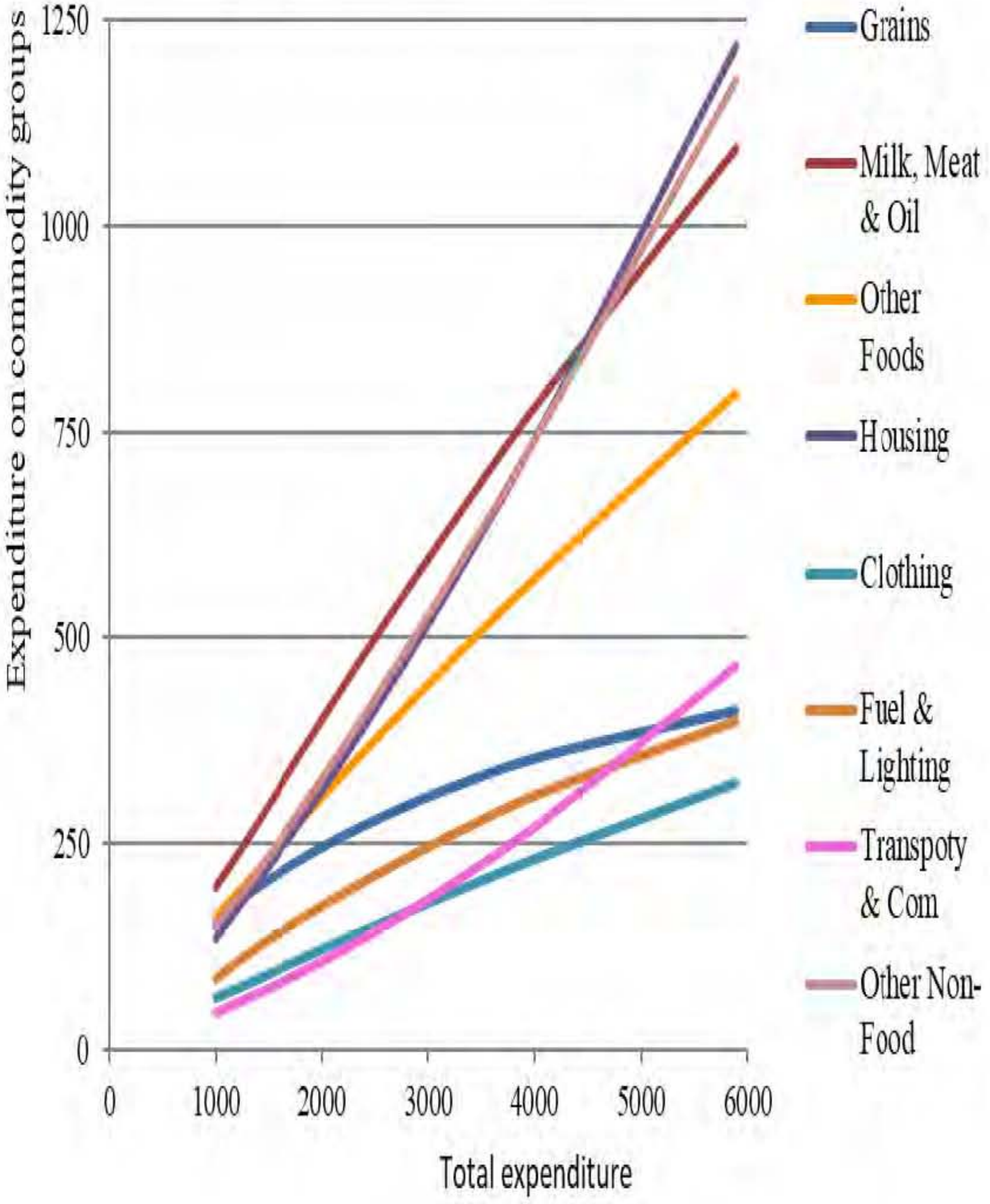
Once the knots and their locations are determined the system of Quadratic AIDS Spline is estimated by Two-Step Iterative Procedure for Seemingly Unrelated Regression Equations. The finally estimated parameters of the demand systems for urban and rural samples are reported in Tables A1 and A2, respectively. The two tables contain a large number of parameters, which are not all easily interpretable. Therefore, we try to explain the outcome of results by plotting Engel Curves and the income and own price elasticities at various deciles of the log of real income.

For plotting the Engel Curves, we first calculate sample means of all the variables other than real income. Then using these mean values, expenditure shares are estimated against different levels of per adult equivalent real income (proxied by total expenditure). These real income levels correspond to the nine deciles of per adult equivalent real income prevailing in the latest year of data. At the final step using sample means of prices, real income levels are converted to nominal income levels, both in per adult equivalent terms, which are in turn used to convert the estimated expenditure shares into per adult equivalent nominal expenditures on various commodity groups. The series of per adult equivalent nominal income (total expenditure) and per adult equivalent expenditure on each good are plotted as Engle Curves.

Figure 4.1 and Figure 4.2 show the relationships between per adult equivalent total expenditure and per adult equivalent expenditures on the eight commodity groups for urban and rural areas of Pakistan. The relative positions of Engel Curves in urban and rural areas show that in urban areas, Milk, Meat & Oil, Housing and Other Non-Food categories occupy more-or-less similar large shares in budget, while Grains, Fuel & Lighting, Transport & Communication and especially Clothing make up smaller shares. In rural areas, on the other hand, Milk, Meat & Oil occupy the largest share in budget, followed by Other Non-Foods. Clothing, Fuel & Lighting and Transport & Communications fall on lower side of the budget. One major difference between rural and urban samples is that urban households spend a large portion of their budget on housing because of expensive housing in cities.

Rural households allocate the largest amount on the most valued food, that is, Milk, Meat & Oil mainly because most of these households rely on their home production of milk and to some extent meats and oil. It may be noted that while rural

Figure 4.1: Spline Engel Curves for Urban Pakistan



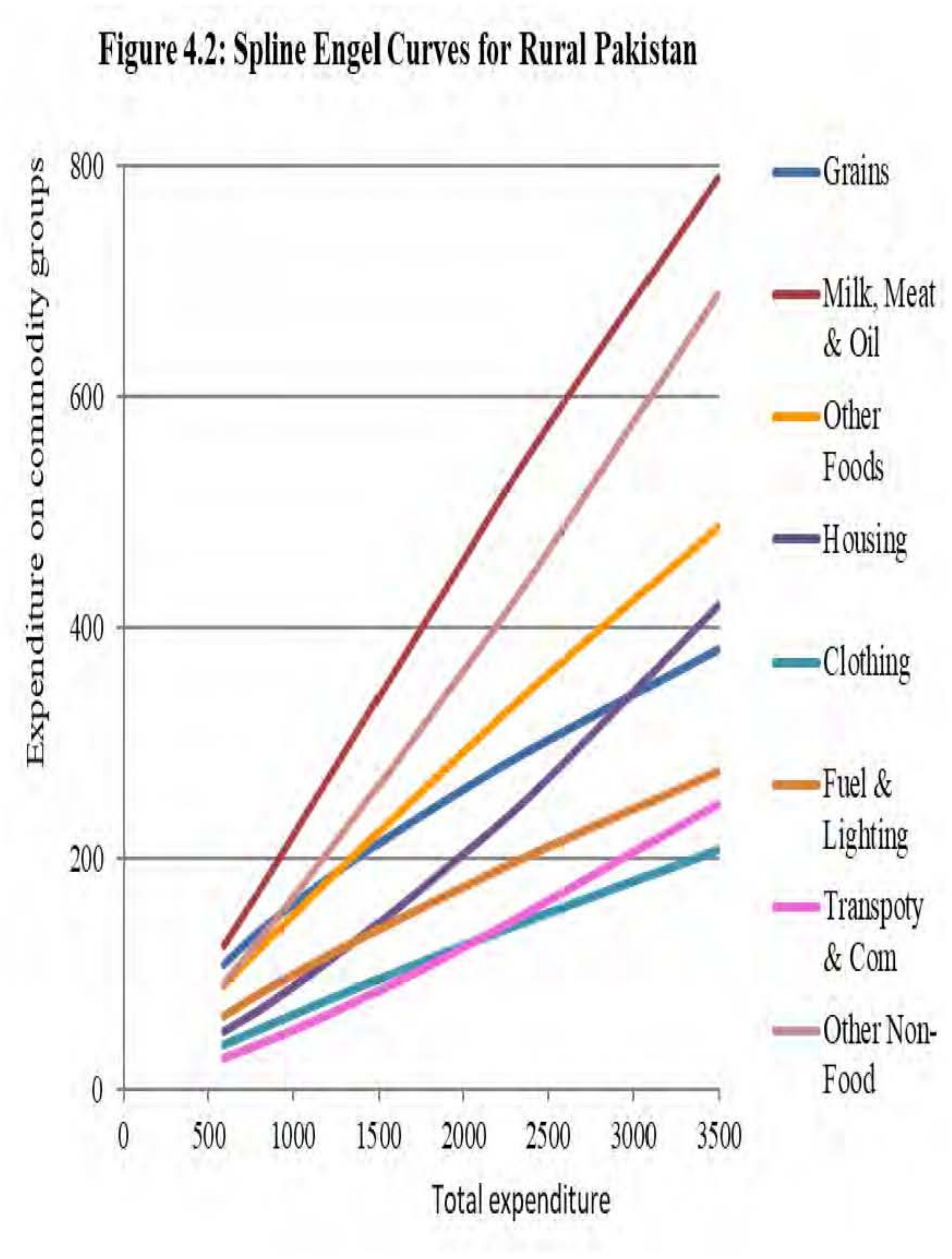


Figure 4.2: Spline Engel Curves for Rural Pakistan
Expenditure on commodity groups
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
3500
Total expenditure
Grains
Milk, Meat & Oil
Other Foods
Housing
Clothing
Fuel & Lighting
Transpoty & Com
Other Non-Food

households do not have to buy some important items in this category, the imputed values of these items are counted as their expenditures in the survey data.

All the Engel Curves slope upward from left to right, indicating that none of the goods is treated as inferior at any level of income from the first to the ninth decile. This is an expected pattern given that a large number of goods are pooled in various groups at fairly aggregated level.

As expected, the Engel curves are not straight lines and show substantial changes in slopes. As total expenditure increases, the expenditures on some of the commodity groups change at variable rates. In urban areas as the total expenditure increases, the expenditure on Housing and Transport & Communication and Other Non-Food increase at increasing rates, while the expenditures on Grains and Fuel & Lighting increase at decreasing rate. Curvatures of the two curves show that their expenditure shares are substantially lower at higher levels of total expenditure, especially in case of grains. The remaining three commodity groups, Milk, Meat & Oil, Other Foods and Clothing also show declining slope but at moderate rates.

In rural areas, Housing and to some extent Transport & Communication and Other Non-Foods show rising expenditure shares at higher total expenditure levels. The expenditure shares of Grains and Fuel & Lighting show declining trend with respect to total expenditure share but not as sharply as in case of urban areas. A plausible reason that among rural households the rate of increase in expenditure on grains does not fall as sharply with income as in case of urban areas. In their attempts to avoid the risks associated with price and availability, almost all households in rural areas hold a portion of their staple grains production or buy grains in bulk quantities from neighboring growers at the time of harvest. The quantity of grains that they afford to hold or buy in bulk depends crucially on their income levels. If the value of production and income is doubled, they will end up holding or buying grains in almost double the quantity.

The shape of an Engel Curve can be directly related to the pattern of income elasticity. However, to be more explicit, we have plotted income elasticities for the eight commodity groups at levels of per adult equivalent real income (total expenditure) corresponding to the nine deciles. Figures 4.3 and 4.4 show the patterns of income elasticities. Both the figures show substantial changes in the magnitudes of income elasticities at extreme ends of real income. However, the changes in income elasticities are more pronounced in urban areas as compared to rural areas.

Figure 4.3 shows that as real income rises, income elasticities of all the three food categories, clothing and Fuel & Lighting tend to decline at higher levels of income, while the income elasticities of Housing, Transport & Communication and Other Non-Food categories tend to increase. For on food Milk, Meat & Oil and one non-food category Fuel & Lighting, income elasticities are greater than one at lower income deciles and these elasticities turn to be less than one at higher income deciles. These result point to substantial differences in the way households belonging to different income classes respond to changes in income. For example, some of the expensive food and fuel categories that are considered luxurious items among low-income households are treated like necessities among richer households.

Coming to the pattern of income elasticities for rural households displayed in the Figure 4.4, we do not observe such stark changes in household demand pattern across different income deciles. Most of the income elasticities remain quite stable between the second and the eighth income deciles. It is only in case of Milk, Meat and Oil income elasticity turns from the values greater than one to less than when and that too when per adult equivalent real income crosses the eighth decile.

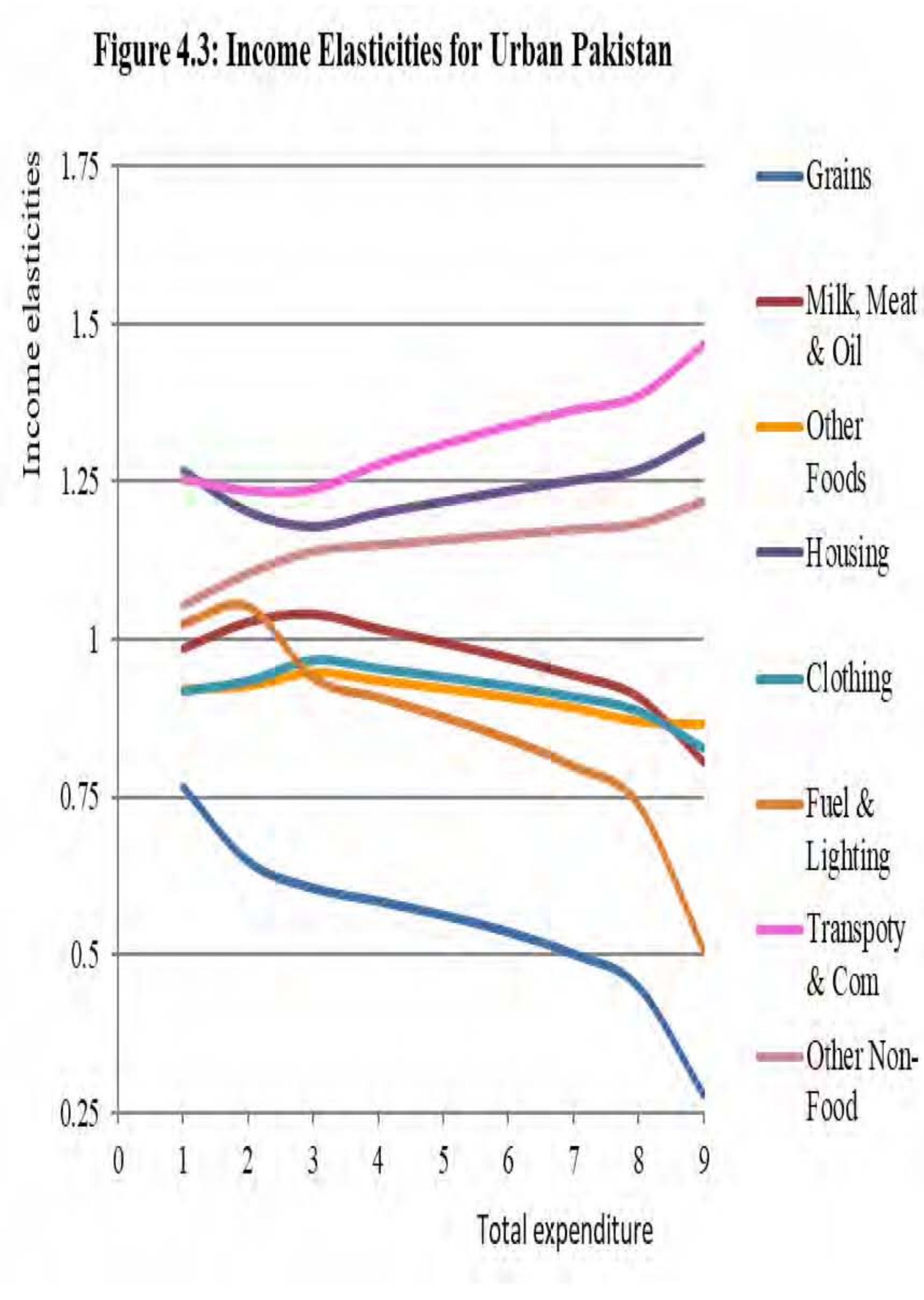


Figure 4.3: Income Elasticities for Urban Pakistan
Income elasticities
1.75
1.5
1.25
1
0.75
0.5
0.25
0
1
2
3
4
5
6
7
8
9
Total expenditure
Grains
Milk, Meat & Oil
Other Foods
Housing
Clothing
Fuel & Lighting
Transpoty & Com
Other Non-Food

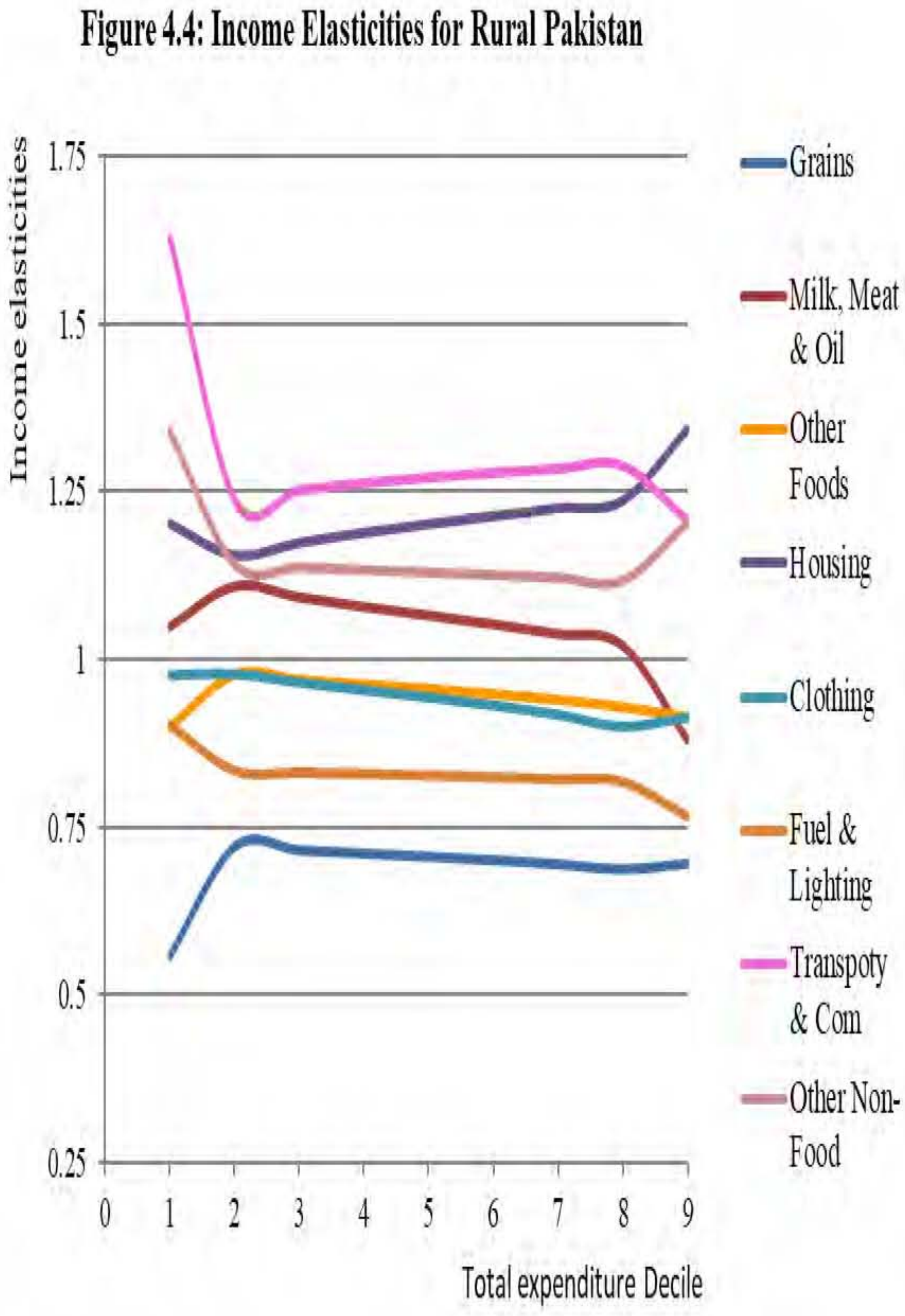


Figure 4.4: Income Elasticities for Rural Pakistan
Income elasticities
1.75
1.5
1.25
1
0.75
0.5
0.25
0
1
2
3
4
5
6
7
8
9
Total expenditure Decile
Grains
Milk, Meat & Oil
Other Foods
Housing
Clothing
Fuel & Lighting
Transpoty & Com
Other Non-Food

A notable result is that the income elasticities for grains at different real income deciles are relatively higher than expected; even higher than the corresponding values among for the urban sample except at very low level of real income where the elasticity is too low. Very low value of income elasticity among the extremely poor households indicates their lack of ability to increase consumption of grains in response to increase in income probably because they too preoccupied with fulfilling their other pending needs. Another notable result is that the income elasticity for Transport & Communication is exceptionally too high among the extremely poor households. These two results considered together indicate that when the budget is somewhat eased among very poor households, their first priority is to finance travels rather than increase consumption of grains.[9]

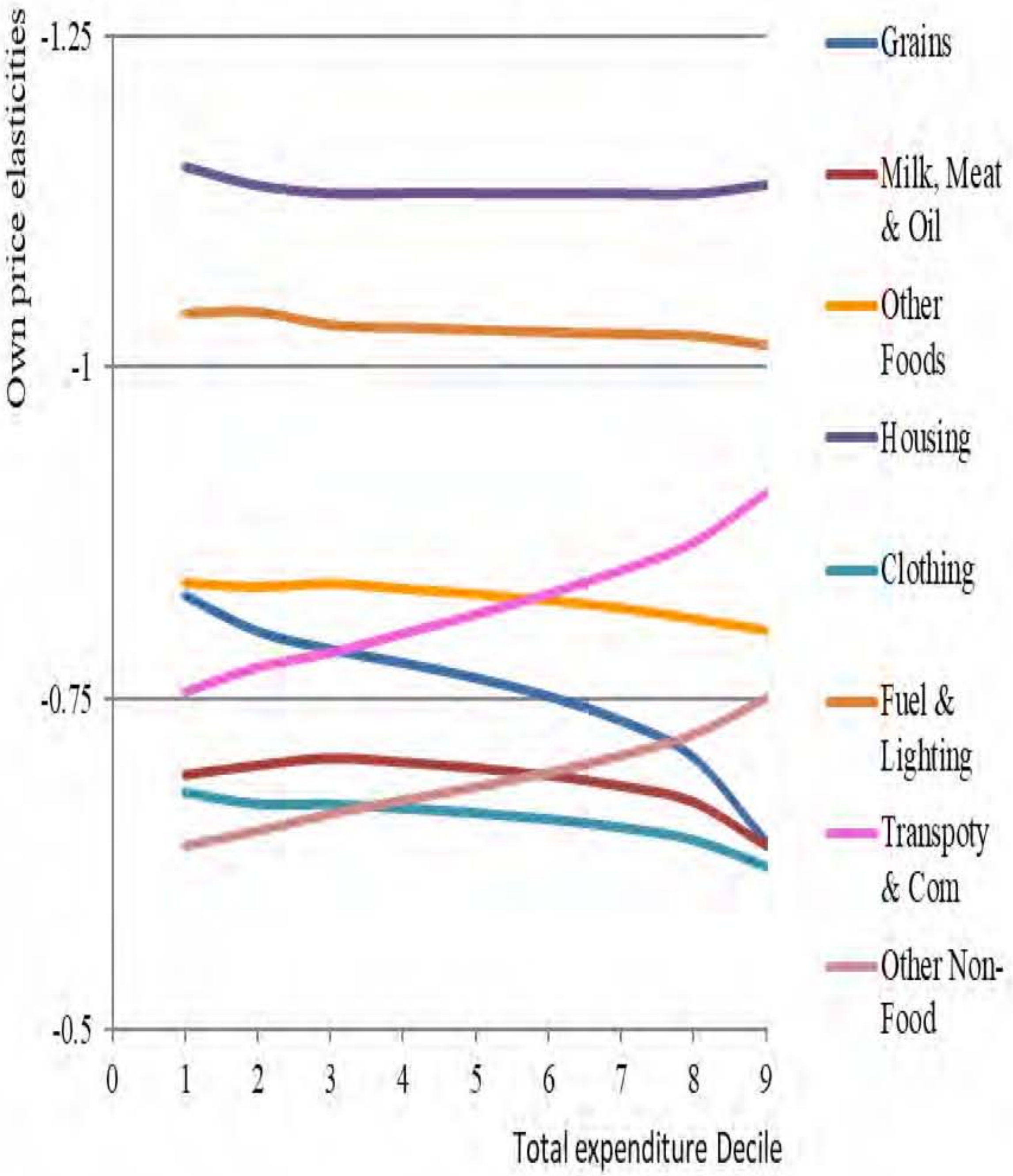
Coming now to price elasticities, Figures 4.5 and 4.6 show results of own price elasticities in urban and rural regions of Pakistan, respectively. We observe that in urban sample only two goods, Housing and Fuel & Lighting are relatively price elastic. The reason for high price elasticity in case of housing is that this category occupies the largest share in the budget and the households living in urban areas have options to shift their dwellings to outskirts of cities when rents get too high. The high price elasticity of Fuel & Lighting is difficult to explain given that income elasticity of this commodity group is on lower side except at low income-levels. A possible reason could be that the main source of energy, that is electric power has highly progressive pricing structure. When the average price increases by any given percentage, it will be translated to a higher (lower) percentage increase in price for those who consume more (less) than the

[9] Considering that during the period of analysis close to 30% of rural households were classified as poor, the households in lowest income decile must be extremely poor. It is therefore quite unlikely that their travel activities have any recreational component.

average. One way to lessen the burden of price increase is to confine consumption to low price brackets. Another reason could be that within this commodity group there are options to switch between expensive to relatively less expensive fuel types. The third reason could be that some of the households who can afford, can mitigate the burden of higher prices by replacing their old appliances like refrigerators, air conditioners, coolers, fans and heaters by new energy efficient appliances.

The results for rural households presented in Figure 4.6 show a quite different situation. Here three categories of goods, Grains, Milk, Meat & Oil and Fuel & Lighting show high price elasticities. The high price elasticity of grains could be explained on the same lines as offered for income elasticity. Since a large percentage of households in rural areas are producers of grains themselves. Their responses to price changes are motivated by their behavior as consumers (buyers) as well as producers (sellers). A price increase is an incentive not only to cut consumption but also to increase sale in the market. In case of Milk, Meat & Oil, the major food item is milk and other dairy products, and in this context also most of the rural households are consumers as well as producers of milk and dairy products and the same argument can be applied that is offered for the high price elasticity of Grains. Price elasticity of Fuel & Lighting is high because most of the rural households do not have gas connections and for them the energy sources of fuel are firewood, kerosene oil and portable gas cylinders, which are all more costly than natural gas. This explains the sensitivity of rural households to changes in fuel prices. The price elasticities for the remaining commodity groups follow usual expected trends and do not need detailed comments.

Figure 4.5: Own Price Elasticities for Urban Pakistan



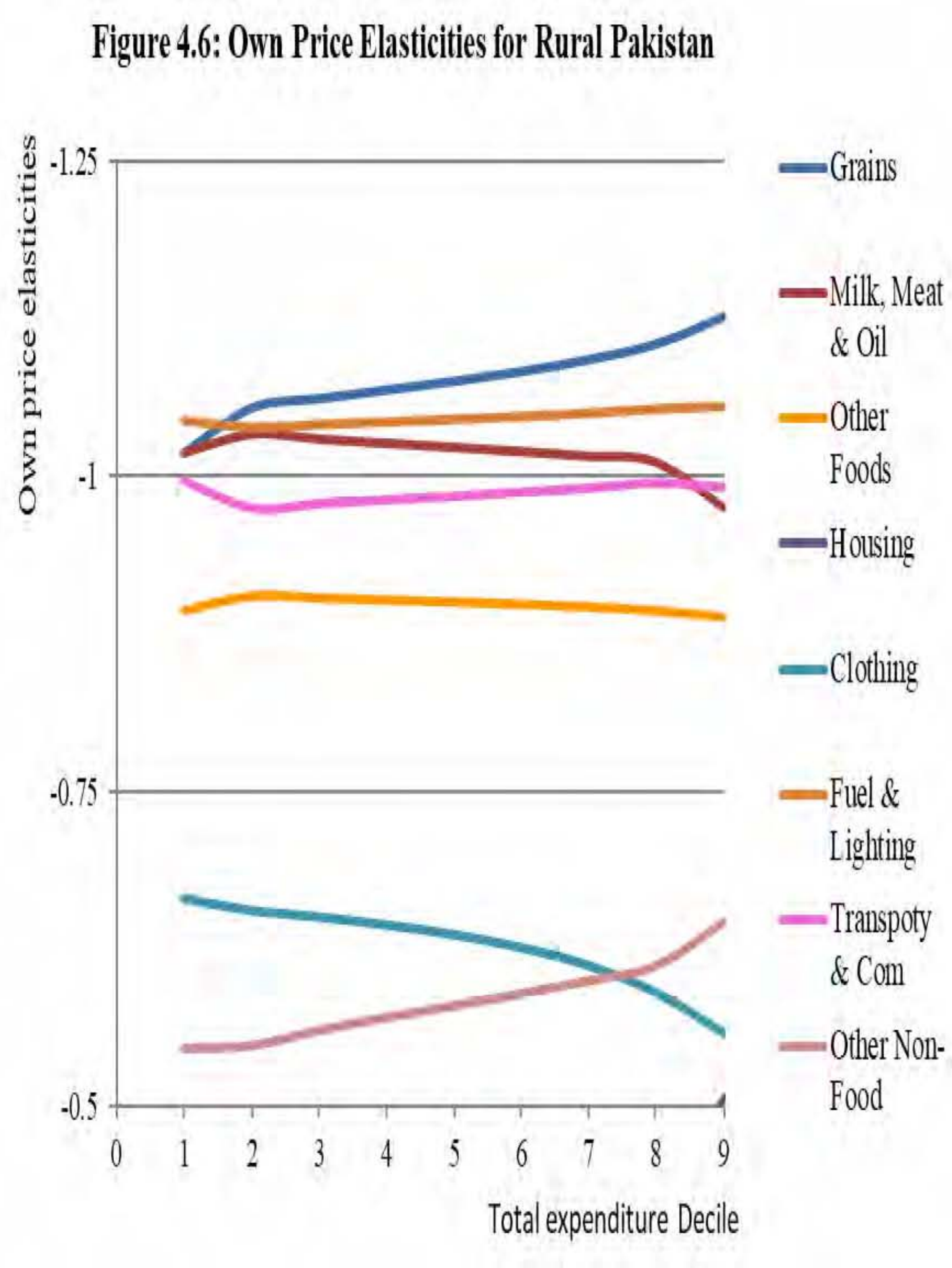


Figure 4.6: Own Price Elasticities for Rural Pakistan
Own price elasticities
-1.25
-1
-0.75
-0.5
0
1
2
3
4
5
6
7
8
9
Total expenditure Decile
Grains
Milk, Meat & Oil
Other Foods
Housing
Clothing
Fuel & Lighting
Transpoty & Com
Other Non-Food

4.6. SUMMARY AND CONCLUSION

This paper proposes to extend Quadratic AIDS to a system of Quadratic AIDS Spline functions which is expected to capture household spending behavior at tails ends of income distribution in a better way that AIDS or Quadratic AIDS. The proposed demand system is highly flexible, it allows key parameters to change with changes in real income and above all, it permits smooth transition of demand system from one class on income to the nest. The estimation strategy proposed in the paper allows multiple threshold income levels between which consumer behavior is expected to change. The study also proposes the estimation of these threshold levels as part of the estimation procedure through multi-round grid search procedure.

The proposed demand system is estimated separately for urban and rural households of Pakistan and the results are analyzed with the help of Engel Curves, income elasticities and own price elasticities. The study finds that for both the samples almost all threshold levels of real income are located at very low or very high deciles of real income. This indicates that the proposed system of demand functions works well to pick up the changing consumption behavior when households come out of extreme poverty or when households belonging to middle income class move to high income classes and explore major changes in their consumption baskets as they get exposed to new lifestyles.

This result is further supported by the shapes of Engel Curves and the estimates of income and price elasticities estimated at the nine deciles of real income. In this context also the study observes notable changes in households' demand behavior across income groups, especially at the two lowest and two highest real income deciles.

Two important conclusions come out of the analysis. First, the practice of estimating a single demand system representing all income categories is suitable when one attempts to analyze average behavior of households. However, in poor developing countries like Pakistan, the demand behaviors of households with extreme income levels, especially the extremely poor households do not fit well in the analysis of so-called 'average household'. The practice of dropping outliers in data because these do not fit in the given model presumes that the model is more reliable than the real-time data. This paper shows that an alternative approach that can be fruitful is to bring the given model closer to real-time data rather than dropping the outliers.

Another conclusion that we draw is that in case of Pakistan poor households have quite a different consumption pattern and their exposure to price and income shocks cannot be analyzed on the basis of standard empirical literature. It is important to conduct specific studies focusing on poor households for the sake of assessing social welfare implications of pricing and taxation policies.

APPENDIX 4

Table A2: Parameter Estimates of Spline Function for Urban Pakistan

Variable/ Parameter	Grains	Milk, Meat and Oil	Other Foods	Housing	Clothing	Fuel	Transport & Com	Other Non-Food
α_i	0.060*	0.101*	0.169*	0.184*	0.120*	0.159*	-0.005	-0.788 *
β_i	0.014*	-0.003	0.036*	0.021*	0.019*	-0.091*	-0.007	0.011
Y^2	0.016	0.023	-0.041*	-0.001	0.052*	-0.054*	0.001	0.000
$(Y-0.2)^2\, I_{0.2}$	-0.030	-0.007	0.011	-0.012	-0.08*	0.114*	0.008	-0.004
$(Y-1.3)^2\, I_{1.3}$	0.033	-0.059*	0.013	0.056*	0.063*	-0.118*	-0.020	0.032
$(Y-1.5)^2\, I_{1.5}$	-0.021	0.055*	0.018	-0.055*	-0.040*	0.051*	0.018	-0.026
$(Y-2.9)^2\, I_{2.9}$	0.003	-0.029*	0.015	0.018	0.001	0.029*	-0.020*	-0.017
$(Y-4.2)^2\, I_{4.2}$	-0.004	0.025*	-0.014	-0.029*	0.016	-0.027*	0.017	0.016
$(Y-4.7)^2\, I_{4.7}$	0.014	-0.039*	0.026*	0.083*	-0.006	0.020*	-0.046*	-0.052
γ_{i1}	0.020*	0.010*	-0.005*	0.009*	-0.028*	0.000	-0.016*	0.010 *
γ_{i2}	0.010*	-0.017*	-0.029*	-0.027*	0.024*	0.004*	0.032*	0.003
γ_{i3}	-0.005*	-0.029*	0.021*	-0.011*	0.029*	-0.002*	0.004*	-0.007 *
γ_{i4}	0.009*	-0.027*	-0.011*	0.06*	-0.034*	0.003*	0.010*	-0.010 *
γ_{i5}	-0.028*	0.024*	0.029*	-0.034*	0.024*	0.000	-0.003	-0.012 *
γ_{i6}	0.000	0.004*	-0.002*	0.003*	0.000	-0.003*	-0.001*	-0.001
γ_{i7}	-0.016*	0.032*	0.004*	0.010*	-0.003	-0.001*	0.012*	-0.038 *
γ_{i8}	0.010*	0.003	-0.007*	-0.010*	-0.012*	-0.001	-0.038*	-0.055*
M1	-0.001	-0.004*	0.000	0.000	0.004*	0.000	0.001	0.000
M2	-0.002	0.002	-0.001	-0.002	0.002	0.002	0.000	-0.001
M4	0.001	-0.004*	0.002	-0.001	0.001	-0.003*	0.002	0.002
M5	0.001	0.007*	-0.002	-0.005*	0.002*	-0.003*	0.003*	-0.003
M6	-0.001	-0.004*	0.002	-0.008*	0.011*	0.008*	0.002	-0.010 *
M7	0.001	-0.002	-0.003	-0.009*	0.024*	0.005*	-0.008*	-0.008
M8	-0.004*	-0.010*	-0.001	0.001	0.025*	0.008*	0.000	-0.019 *
M9	-0.003*	-0.002	-0.004*	-0.005*	0.010*	0.007*	0.001	-0.004
M10	-0.003*	0.009*	-0.007*	-0.004*	0.013*	0.003*	0.000	-0.011 *
M11	-0.001	-0.001	-0.007*	0.007*	0.010*	0.002	-0.002	-0.008 *
M12	-0.003*	0.003*	-0.001	0.000	0.007*	-0.001	0.000	-0.005
Z2	0.000	0.043*	-0.024*	-0.002*	-0.022*	0.009*	0.003*	-0.007 *

Table A2: Parameter Estimates of Spline Function for Urban Pakistan

Variable/ Parameter	Grains	Milk, Meat and Oil	Other Foods	Housing	Clothing	Fuel	Transport & Com	Other Non-Food
Z3	0.000	0.051*	-0.016*	-0.013*	-0.008*	-0.007*	0.013*	-0.020 *
Z4	0.005*	0.019*	-0.017*	-0.003*	-0.017*	-0.001	0.005*	0.009 *
Z5	-0.010*	0.053*	-0.023*	0.005*	-0.015*	-0.010*	0.014*	-0.014 *

Note: Parameters significant at 5% level are shown by*. Z2,Z3,Z4 and Z5 are Zone B, Zone C, Zone D and Zone E, respectively while Zone A (Z1) is base category. M2,M3..........M12 are monthly dummies from February to December, respectively. Month of January (M1) is base category.

Table A2: Parameter Estimates of Spline Function for Rural Pakistan

Variable/ Parameter	Grains	Milk, Meat and Oil	Other Foods	Housing	Clothing	Fuel	Transport & Com	Other Non-Food
α_i	0.102*	0.018*	0.209*	0.155*	0.089*	0.201*	0.015*	-0.789 *
β_i	0.017*	-0.043*	0.074*	-0.001	-0.027*	-0.064*	0.012	0.032
Y^2	0.004	-0.020	0.03*	-0.016	0.033*	-0.036*	0.004	0.001
$(Y-0.0)^2\ I_{0.0}$	-0.016	0.053*	-0.094*	0.032*	-0.006	0.065*	-0.013	-0.021
$(Y-1.0)^2\ I_{1.0}$	0.028	-0.061	0. 000	-0.089	-0.163*	-0.045	0.114*	0.216
$(Y-1.2)^2\ I_{1.2}$	-0.047	-0.112	0.549*	0.132	0.39*	0.034	-0.336	-0.610
$(Y-1.3)^2\ I_{1.3}$	0.056	0.277	-0.806*	-0.019	-0.389	-0.063	0.337	0.607
$(Y-1.4)^2\ I_{1.4}$	-0.026	-0.132	0.323*	-0.048	0.132	0.044	-0.103	-0.190
$(Y-2.83)^2\ I_{2.8}$	0.014	0.111*	0.009	-0.154*	-0.039	-0.001	-0.039	0.099
$(Y-2.9)^2\ I_{2.9}$	-0.015	-0.153*	-0.008	0.179*	0.071	-0.010	0.044	-0.108
$(Y-3.6)^2\ I_{3.6}$	0.192	0.971*	-0.21	-0.705*	-0.179	0.092	0.002	-0.163
$(Y-3.7)^2\ I_{3.7}$	-0.413	-2.797*	0.973	1.293	0.194	-0.139	-0.673	1.562
$(Y-3.8)^2\ I_{3.8}$	0.197	3.083*	-1.336	-0.856	-0.274	0.124	1.724*	-2.662
$(Y-4.0)^2\ I_{4.0}$	0.141	-4.451*	0.901	0.759	2.720*	-0.498	-3.449*	3.877
γ_{i1}	0.059*	-0.048*	-0.007*	-0.006*	-0.006*	-0.001	-0.024*	0.033 *
γ_{i2}	-0.048*	0.066*	0.016*	-0.025*	-0.012*	-0.006*	0.040*	-0.031 *
γ_{i3}	-0.007*	0.016*	-0.017*	0.025*	-0.014*	0.009*	-0.008*	-0.004
γ_{i4}	-0.006*	-0.025*	0.025*	-0.001	0.009*	0.002*	0.012*	-0.016 *
γ_{i5}	-0.006*	-0.012*	-0.014*	0.009*	0.014*	0.005*	0.021*	-0.017 *
γ_{i6}	-0.001	-0.006*	0.009*	0.002*	0.005*	-0.006*	-0.003*	0.000
γ_{i7}	-0.024*	0.040*	-0.008*	0.012*	0.021*	-0.003*	0.002	-0.040 *

Table A2: Parameter Estimates of Spline Function for Urban Pakistan

Variable/ Parameter	Grains	Milk, Meat and Oil	Other Foods	Housing	Clothing	Fuel	Transport & Com	Other Non-Food
γ_{i8}	0.033*	-0.031*	-0.004	-0.016*	-0.017*	0.000	-0.040*	0.075 *
M1	0.003*	0.001	-0.001	-0.001	0.002	-0.005*	-0.001	0.002
M2	0.000	0.003*	-0.001	0.000	0.000	-0.003*	0.004*	-0.003
M4	0.003*	0.001	-0.002*	-0.002	0.001	-0.006*	0.001	0.004
M5	0.000	0.007*	-0.001	0.000	-0.001	-0.004*	0.002	-0.003
M6	0.001	0.014*	-0.003*	-0.015*	0.000	-0.002	0.006*	-0.001
M7	-0.001	-0.004*	0.007*	-0.011*	0.028*	-0.006*	-0.003	-0.010
M8	-0.002	0.006*	0.008*	0.000	0.011*	-0.005*	-0.005*	-0.013 *
M9	-0.003*	-0.001	0.004*	-0.006*	0.014*	-0.005*	0.001	-0.004
M10	-0.003*	-0.002	0.000	0.002*	0.011*	-0.004*	0.000	-0.004
M11	-0.002*	-0.002*	-0.002	0.009*	0.011*	-0.005*	-0.001	-0.008 *
M12	-0.001	-0.006*	0.001	-0.003*	0.005*	0.000	0.004*	0.000
Z2	0.000	0.020*	-0.027*	0.006*	0.040*	-0.042*	0.001	0.002
Z3	-0.002	0.031*	-0.021*	-0.012*	0.084*	-0.068*	0.016*	-0.028 *
Z4	0.000	0.016*	-0.024*	0.002*	0.067*	-0.080*	0.008*	0.011 *
Z5	-0.006*	0.013*	-0.027*	0.015*	0.080*	-0.086*	0.012*	-0.001

Note: Parameters significant at 5% level are shown by*. Z2,Z3,Z4 and Z5 are Zone B, Zone C, Zone D and Zone E, respectively while Zone A (Z1) is base category. M2,M3..........M12 are monthly dummies from February to December, respectively. Month of January (M1) is base category.

CHAPTER 5

CONCLUSIONS

A number of conclusions follow from the study. The findings of the study support our main hypothesis that household demand is not only affected by household income and relative prices but also by other factors like region of residence of household, climatic conditions, seasonal variations and such variations in household income levels that place households in different socioeconomic classes. The results of household demand for consumption goods across eight urban and rural regions of four provinces of Pakistan show that no commodity group is inferior in any of the eight regions. Two food categories: Grains, Other Foods and two non-food categories: Clothing and Fuel & lighting are found to be necessities in all the regions. All own-price elasticities especially for non-food categories Clothing; Housing; Transport & Communication and Other non-food categories show significant variation across all the regions. It is concluded that the range of variation in own-price elasticities across regions is much greater than the range of variation in income elasticities. The divergence in cross-price elasticities across regions is even more pronounced.

Under ML forecast performance algorithm, the disaggregated analysis is observed to perform better in cross validation for the entire demand system as well as for each of the seven commodity followed by the province-wise disaggregate analysis. Aggregate Pakistan level analysis is found to be the worst performer.

The estimates of demand system based on commodity-wise disaggregate analysis for the rural and urban areas of each province are found to be relatively more reliable and the results for income elasticities are reasonably robust. Presence of aggregation bias seems to be affecting estimates of own price elasticities.

The results of tracing climate effects and seasonal effects on household demand for consumption goods show that household demand exhibits systematically variations across months and across climatic zones. These seasonal variations in household expenditure pattern are observed to vary considerably between the climatic zones where summers are prolonged and those areas where winters are prolonged. Another conclusion drawn is that the climatic effects on households' expenditure pattern not only relate to climate itself; these can also be related to the cultural aspects of climatic zones such as eating habits, travel culture and quality of roads infrastructure. The study also finds that seasonal and climatic zone effects are not the same between urban and rural households across climatic zones.

Finally, results of estimation of the proposed model: Quadratic AIDS Splines show that for both urban and rural households, almost all threshold levels of real income where parametric changes in demand are observed, are located at very low or very high deciles of real income, indicating that this model works well to explain changing consumption behavior of households when they come out of extreme poverty or enter into high income class. Two important conclusions come out of the analysis. First, the practice of estimating a single demand system representing all income categories ('average household' approach) does not fit well to analyze the demand behaviors of households with extreme income levels, especially the extremely poor households in poor developing countries like Pakistan. We conclude that an alternative approach to bring the given model closer to real-time data rather than dropping the outliers can be fruitful.

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