# RASTA

LOCAL RESEARCH
LOCAL SOLUTIONS

Volume VIII

## FARM PRODUCTIVITY & FOOD PRICES

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Edited by Nadeem Ul Haque and Faheem Jehangir Khan

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# RASTA: LOCAL RESEARCH LOCAL SOLUTIONS

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(Volume VIII)

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RASTA

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# PART I

## FARM PRODUCTIVITY & FOOD PRICES

*Research Papers*

# HOUSEHOLD MARKET PARTICIPATION, ACCESS, AND FARM PRODUCTIVITY IN AJK: EVIDENCE FROM FARM HOUSEHOLD DATA

Khush Bukhat Zahid

## ABSTRACT

The goal of the study is to get insight into agriculture production and market constraints in the AJK region. The objective of this research is to determine what factors influence agricultural productivity and market participation. The fundamental idea is to assess farm productivity within a given resource and technology and household market participation within a particular market access condition, to build a link between them. Both qualitative and quantitative methodologies were employed in this mixed methodology study. Cross-sectional farm data was used to test the specified relationship. A total of 1,200 farmers (120 from each of AJK's ten districts) and 40 key informants, including stakeholders, were interviewed for the survey.

To achieve the objectives of the study, in the first stage, we estimated the production function and obtained technical efficiency scores that are explicitly dependent on the farm and farm-specific variables. For this, single-step stochastic production estimation was applied. Tobit regression was employed in the second phase, with the market participation index as the dependent variable and market accessibility factors and efficiency as explanatory variables. The findings show that all inputs contributed favourably and considerably to farm production, with a mean technical efficiency of 58 per cent, indicating that sample farmers might achieve the maximum production frontier by raising their efficiency to 42 percentage points.

Among the determinants of technical efficiency farm size, land fragmentation and traction power negatively contributed to efficiency. Market participation was low as approximately 47 per cent of the sampled farmers had less than 50 per cent market participation and 20 per cent did not participate in the market. The major factors that affect market participation were production efficiency, distance from roads and the market, credit facility, training, experiences, and internet and refrigerator facilities. All the variables were positive and significantly contributed to market participation, while family size and processing had a negative effect. The study can be beneficial for policymakers and stakeholders, such as regulatory authorities and governing bodies.

# 1. INTRODUCTION

## The Baseline of the Study

Understanding barriers to market access and factors affecting production efficiency are key to overcoming market failures. Most of the small farmers in Azad Kashmir, whose access to the market is limited and the only farmers who have access to the market, participate in the agricultural market. Due to this market failure in this particular area, there is a dire need for government programmes in this area to invest in improving market access, infrastructure, and agricultural production. Improving productivity can help improve market participation as long as incentives and information for working capital are improved. Higher yields may increase market participation because higher yields may have additional crops to be sold.

AJ&K has abundant rich terrain and seasons that are ideal for various crops and fruits. Due to its climate-friendly nature, the traditional farming system has a distinct advantage. All of AJ&K's districts, which are located in distinct agro-climatic zones, provide ideal circumstances for growing multiple crops at the same time. However, agriculture's potential is not being completely realised since the AJ&K agricultural sector is beset by challenges. The development of the agricultural industry in Azad Kashmir is hampered by a lack of financial resources as well as agriculture-related enterprises, packing and value addition, storage facilities, and advanced research and development facilities.

According to Anwar (2020), the agricultural sector employed 8% of the active labour force. Around 72% of the households owned agricultural land. The average size of the farm was assessed to be 1.1 acres. Bhimber had the highest percentage of agricultural proprietors at 76 per cent, with around 87 per cent growing crops. Only 10% of households sold and contributed to market participation indicating that 90% of the households were subsistence farmers who grew crops for their consumption. Only 31% of subsistence farmers could meet their household consumption demands. The average income per harvest of commercial farmers was Rs. 81,086, which is low. In AJ&K, 77.2 per cent of the sampled farmers cultivated maize. Wheat was grown by 59.4 per cent of farmers, while pulses and rice were grown by 3.2 per cent. The growers of vegetables and fruits accounted for 18.4% and 12.8 per cent, respectively (SDG, 2021)

Weak marketing strategies have contributed to the peasant community's lack of interest. Standard seed production is also difficult. On a commercial scale, small farms holding have an impact on agricultural production. The overall farmland area in Azad Kashmir was around 47% of the total land area. Approximately 31% of the entire farmland was under cultivation. AJ&K's irrigation area was 6.2 per cent of the total agricultural area (P&DD 2020).

The wheat-maize-wheat cropping pattern is "mountain agriculture" as opposed to agriculture in the lowland plains. Crop and marketing promotion plans have not been devised. Due to a lack of infrastructure and financial assistance, the area is characterised by low productivity and limited market access. Market involvement is contingent on having access to the market. Smallholders sell from their farms or manually lug the produce to the closest local markets. An increasing body of evidence suggests that improving infrastructure, such as road conditions, and market information, has a positive impact on farmers' access to markets (Sigei et al 2014; Fraser, et al 2014). However, there is no actual data on the magnitude and scope of inefficiency. Our hypothesis is that farmers participate in the market with a high level of efficiency and have better market access. To overcome the problem of market failure in this specific sector, this must be investigated.

Although many other factors contribute to agricultural productivity, such as technological advancement, regulatory framework, and optimal use of material inputs, these elements may not have an impact on agricultural performance unless better marketing conditions prevail (Cabas, et al. 2010). Landowners in Azad Kashmir, who are often peasants, have limited financial and technical resources. Hence, policy intervention in this area is critical. To our knowledge, there is no systematic research on agricultural productivity and market participation in the Azad Jammu Kashmir (AJK) region. There are issues with the region's data availability and veracity. To compensate for these statistical flaws, it might be beneficial to limit international studies to a local environment.

### Purpose and Scope

The idea of the study is to evaluate farm productivity given resources and technology, and household market participation given market access conditions to establish a linkage between these in the agriculture market of the Azad Jammu Kashmir. Particularly, this study focuses on:

- Measuring the impact of farm variables on farm production and technical efficiency.
- Estimating the linkage between market participation and market access conditions in addition to farm-level efficiencies.
- Recommending policy options based on the outcomes of this study.

Apart from quantitative, the study traces the policy interventions that have been adopted by relevant departments to reduce farm inefficiency and support the farmers to link with the market and the challenges they face to implement their policy agenda.

The study aims to answer the following key questions related to the development strategy in this specific area.

- What are the reasons that cause production inefficiency at the farm level?
- Do farmers produce the optimum level of output to market it?
- Are they able to get the benefit of marketing their product and sell these at a reasonable price?
- What are the area-specific barriers to market access?
- Do improvements in farm productivity increase market participation, having better market access?
- Has the increase in the volume of agricultural sales increased due to improvements in agricultural production, even though access to the market is poor?
- On the contrary, do new roads and improved accessibility to the market increase commercialisation leading to continuous production?

### Relevance to Public Policy

The research provides policy alternatives for improving farm-level production efficiencies as well as food production and market participation. This would also be useful for developing food and marketing policies to address farm-level constraints and hurdles to market access. Finally, recommendations are made based on the findings after estimating the empirical model.

## 2. REVIEW OF LITERATURE

Many studies have been conducted to assess the technical efficiency of crops in underdeveloped nations. In Sudan, Adam et al. (2005) calculated the technical efficiency of sorghum yield, whereas Alemu et al. (2007) estimated it for agricultural output in Ethiopia. Similarly, Binam, et al. (2004) did a study on Cameroon to measure the technical efficiency of maize and sorghum production. There is no shortage of research on assessing technological efficiency in Sub-Saharan African countries (Fakayode, 2009; Kariuki, et al., 2008; Kibara, 2005). Rios and Shively (2005) calculated the technical efficiency of Vietnam's coffee yield. The measurement of technical efficiency for farmers has also been done using evidence from South Asian countries. Thiruchelvam (2005) conducted a study on Sri Lanka that estimated the technical efficiency of chilli and onion growers.

Similarly, for different crops, a large body of literature has studied farm efficiency in other South Asian countries. Hassan and Ahmad (2005) estimated farm efficiency in Pakistan (Punjab). Thus, creative literature exists in Pakistan that has measured farm efficiencies for various crops such as wheat, rice, vegetables, and citrus (Zahid and Ahmed; 2018; Javed, et al., 2009; Hussain, et al. 2012; Sohail, et al., 2012; Khan and Ghafar, 2013). The majority of these are focused on a particular crop and do not link farm productivity to market participation which limits their scope. Therefore, the focus of this research is on agricultural productivity and market participation. Surprisingly little research has been done on how these variables interact. Previous studies have investigated the relationship between market involvement and productivity (Govereh, Jane and Nyoro 1999; Strasberg et al., 1999; and Govereh and Jayne, 1999).

Few studies related to the current work that focused on a single crop in developing countries such as Africa, Latin America, and South Asia are Deaton (1989), Benjamin and Deaton (1993), Barrett and Dorosh (1996), Jayne, et al. (2001), Makhura, Kirsten, and Delgado (2001), Vakis, Sadoulet and de Janvry (2003), Renkow, Hallstrom, and Karanja (2004), Edmeades (2006), and Boughton et al. (2007).

A strand of research has also investigated crop market involvement. In West Africa, Strauss (1984) studied cereals, whereas Budd (1993) looked at food crops, and Strasberg et al. (1999) and Heltberg and Tarp (2001) looked at total crop production in East Africa. In Pakistan, recent studies on the technical performance of agriculture in Pakistan do not provide a clear picture of farmers' productive performance. The current study adds to this analysis. All crops should be combined with all measurable inputs and outputs and link them with the market. By summarising the preceding debate, the present study contributes to the literature on the AJK agriculture market's agro-climatic structure. It evaluates local farmers' farm inefficiencies and tracks their market involvement. The findings of the study would add to the literature on agriculture specifically related to farm efficiency and farmers' market involvement because the topography, cropping patterns, and adoption of technology differ from one region to another.

## 3. METHODOLOGY

The study research primarily focused on the use of mixed approaches to assess the defined objectives. This method is often used to combine the results of quantitative and qualitative instruments to provide a comprehensive picture of the study problem (Aramo-Immonen, 2011, 2013). The project followed a quantitative approach in which primary data was obtained from farmers in AJK using a detailed questionnaire. In addition to primary data, secondary data was used to establish facts and figures about the structure of the agriculture sector in the sampled areas. Secondary data was collected by conducting a desk review of secondary sources, such as government-published reports on the agriculture sector in the AJK.

Furthermore, the qualitative method was used to conduct key informant interviews (KIIs) to obtain expert opinions on policy activities related to the study's objectives. Questions about their views, subjective norms, perceived behaviour, future expectations, and attitude toward new technology adaptation, government backing, and input availability made up qualitative data. The following is a detailed discussion of qualitative and quantitative approaches.

## Quantitative Methods

The quantitative methods involved the use of primary data gathered from 1,200 farmers in all 10 districts of the AJK via a detailed questionnaire. All socioeconomic characteristics of farmers, farm features, and specific information on agricultural activities and market accessibility factors were included in the questionnaire.

### *Data Collection*

In the first step, the study area was divided into two regions[1] based on topography and climate to give due coverage to all types of heterogeneity in units of farm households in the AJK. In the second step, since all ten districts are located at different climatic zone, two tehsils were selected from each sampled district based on farm population for the household survey taking the total sampled tehsils to 20 (10*2). In the third step, two union councils (villages) were taken from each tehsil. Thus, there were 40 (20*2) UCs (villages) in 20 tehsils from which sampled respondents were taken. Details are given in Annexure-A. In the final step, 30 farmers were selected from each union council, giving us a sample of 1,200 farmers. Based on potential villages, a sample of farm households was randomly chosen from each union council. The geographical, agricultural, demographic, and socioeconomic characteristics can provide important understandings for our research questions. We concentrated on a diverse sample because these traits are almost similar within a certain place. Secondly, given time and money constraints, the sample size of 30 farmers from each UC was considered adequate to achieve our goals. We focused on Rabi (winter) and Kharif (summer) crops for the agriculture year 2020-21 for simplification because these crops are grown at a specific time of the year.

Two principal crop seasons were covered in our data set, i.e., Rabi, which stretches from October-December 2020 to April-May 202 and "Kharif," with sowing beginning in April-June 2021 and harvesting taking place in October-December 2021. Agriculture is a process that involves multiple crops and inputs. The production of several crops on each farm was merged into a single product to apply the production function technique. Farm products included all outputs of the farm including crops, livestock, fruits, and vegetables. We did not consider livestock and livestock products in our analysis for which representative data are hard to come by and need a couple of years to collect. Statistical data included information about household demographics, farm-specific characteristics, farm-level inputs, technical practices, and variables related to output production, geography, infrastructure, and market access. We employed field assistants and agriculture graduates from different tehsils to collect the data. Subsequent training was given to the selected enumerators. Trained enumerators conducted face-to-face interviews. Quantitative data were collected during November and December 2021 because the harvesting of summer crops starts in November. The primary data was then compiled, cleaned, and estimated to analyse the research questions.

### *Empirical Model*

After quantitative data collection, statistical analysis was carried out. Since the computation of farm inefficiency is purely econometric based, we used an empirical model to evaluate the objectives of the study.

The stochastic production frontier approach was preferred instead of using a simple production approach

[1] The Northern districts which are generally mountainous include Muzaffarabad, Jhelum Valley, Neelum valley, Bagh, Haveli, Poonch, and Sudhnoti while Southern are comparatively plain districts such as Kotli, Mirpur, and Bhimber. Map is given in Fig 1 appendix.

because it fitted the data the best, i.e., large units of cross-sectional data, separate form, biological, the inclusion of social features, non-observable characteristics of the farmer, and technological neglect (Kumbhakar and Lovell 2000, Salvo, et al. 2013). The stochastic approach was also found to be suitable for our objectives.

The study covered three aspects of the farm household. First, we evaluated farm-level technical performance scores using the stochastic production frontier. If there is a technical inefficiency, it means that the farmers are not producing at the maximum level of the production frontier curve but below and, therefore, the technical performance is less than one. Second, we gained access to the specific constraints and conditions of the region for market access to the sampled households. This test assumes that production efficiency increases market participation due to higher sales in the presence of improved market access conditions. Third, we analysed the relevance of production efficiency and market participation in terms of market accessibility, such as infrastructure, distance to roads, sources of market information, distance from markets, marketing experience, and other market-related variables. The Tobit model was used to determine the relationships. For market participation, the sales index was used as a fraction of the total sales. Farm-specific inputs (land, labour, capital, and materials) served as explanatory variables to determine their impact on farm production (gross value of vegetables, fruits, grains, and other food crops). The study considered the effects of different farmers' characteristics, such as experience, education, and farm size on farmer performance such as the 'technical ineffectiveness model' depending on the specific features of the farm as done by Battese and Coelli (1995).

***Specification of Empirical Model***

When analysing unit-level information like the household farm survey, the production frontier using the stochastic frontier approach is a better way to quantify production efficiencies (Hughes, et al. 2011). We can also use the stochastic frontier model to deal with specific random shocks (Thiam and Bravo-Ureta 2001). Traditional deterministic methods ignore the noise, which can lead to an overestimation of technical inefficiency. A 'composite error term' with two components is used in the stochastic frontier technique. The first is technical inefficiency, which is defined as "farm departures from the production frontier," and the second is statistical noise, which captures the influence of random shocks on each producer as defined by his or her operating environment (Coelli 1995). This method also enables the statistical testing of assumptions about the production structure and degree of inefficiency.

Various functional forms have been used in the literature to assess farm performance. Cobb-Douglas and translog functions are the most employed functional forms by academics to measure efficiency in the agriculture sector. The translog function has a more flexible functional form and is most represented in logarithm form such as:

$$ln\,(Y_i) = \alpha_o + \sum_k \beta_k lnX_{ki} + \sum_j \beta_j ln\,X_{ji} + \frac{1}{2}\sum_j \sum_k \beta_{jk} lnX_{ji} lnX_{ki} \ldots \ldots (1)$$

This function is viewed in three ways by Boisvert (1982). It is viewed, first as an exact production function, second, as a second-order Taylor series approximation to a general, but unknown production function, and, third, as a second-order approximation to a CES production function. Boisvert (1982) defined the exact production function in Cobb-Douglas functional form as

$$ln\,(Y_i) = \alpha_o + \sum_k \beta_k lnX_{ki} + \sum_j \beta_j lnX_{ji} \ldots \ldots\ldots\ldots (2)$$

We chose Cobb Douglas functional form because this study employed several exogenous variables and a large number of parameters to evaluate. Assuming that the number of production factors is n, the number of parameters to be estimated is n (n+3)/2, which increases the risk of severe multicollinearity, which could result in contradicting interpretation of parameters (Pavelescu 2011). Based on applied economic literature, the Cobb-Douglas function form is favoured because of its simplicity and ability to avoid collinearity among the independent variables. The linear form of the Cobb-Douglas production frontier function is as follows:

$$\ln(Y_i) = \alpha_o + \sum_k \gamma_k \ln X_{ki} + \sum_j \beta_j \ln X_{ji} + v_i - u_i \ldots i = 1, 2, 3, \ldots, N \ldots \ldots (3)$$

In Equation 3, ln denotes the natural logarithm to the base e, $Y_i$ is the ith farm output (gross value from all crops), $X_{ki}$ is the vector of k inputs, and $X_{ji}$ is the vector of $j$ inputs (land, labour, capital and material) of the $i^{th}$ farm. Technical inefficiency affects $u_i$ derived in the preceding equation is specified as:

$$u_i = d_o + d_1 Z_i + e_i \ldots \ldots . (4)$$

where $Z_i$ are the vectors of farmer and farm-specific characteristics of the $i^{th}$ household, and $e_i$ is the error term. $u_i = Z_i d' + e_i$ where $d'$ denotes the vector of parameters, d is the constant term with $d_0$ omitted, assumed that it is included in the expression $Z_i d'$

$$TE_i = \exp(-u_i) \ldots \ldots (5)$$

This demonstrates that the lesser the nonnegative inefficiency component u, the more efficient the ith farm. By construction, technical efficiency indices range from zero to one, and higher technical efficiency indices denote higher levels of efficiency. Households having a technical efficiency index of one are considered technically efficient. A single-step estimating technique was used to estimate the model (Battese and Coelli 1995). The maximum likelihood technique (MLE) was proposed by Battese and Coelli (1995) for the simultaneous estimation of parameters of the stochastic production frontier and the inefficiency model. The MLE technique employs the following variance parameters: $\delta^2$ is total error variation, $\delta^2 = \delta^2_{\ v} + \delta^2_{\ u}$, and $\gamma = \delta_\mu^{\ 2}) / \delta^2$, which represents the technical inefficiency contribution to total error variation.

The two-step modelling approach has been questioned by Battese and Coelli (1995) and Battese et al. (1996) because it violates one of the most crucial assumptions of the stochastic frontier model, i.e., identically independently distributed technical inefficiency effects. Various statistical tests can be used to determine the model's validity. The null hypothesis, $H_0 = \gamma = 0$, i.e., the technical inefficiency effects are not present in the model and are not random, is of particular importance. Furthermore, $H_0 = d' = 0$, expressed the null hypothesis that the household-specific attributes do not affect the technical inefficiency level. The generalized likelihood-ratio statistic λ is defined as λ= -2 ln [L.$(H_0)$/L.$(H_1)$], where $H_0$ and $H_1$ are the null and alternative hypotheses, respectively. If, $H_0$ is true, then is asymptotically distributed as a chi-square random variable (see Coelli 1995 and 1996)

***Market Participation***

Market participation was measured by sales as a fraction of the overall output of the household's entire agricultural crop production. This "sales index" would be zero for a household that sells nothing, more than zero for a household that sells their crops, and greater than unity for households that add value to their crop production through additional processing (Govereh and Jayne 1999). It is defined as:

$$sale\ index_i = \left[\frac{\sum_{j=1}^{J} Crop\ marketed_{ij}}{\sum_{j=1}^{J} Crop\ harvested_{ij}}\right] \begin{Bmatrix} Non\ seller & = 0 \\ seller & > 0 \end{Bmatrix} \ldots \ldots \ldots \ldots (5)$$

where a different jth crop is grown on an ith farm. The sale of crops involves transactions with people and organisations outside of the farm household. $Y_m$ is the amount marketed, $Y_h$ is amount harvested but it does not contain the portion used for household consumption, $Y_c$, the gift portion, Y_G, or stored as seeds, $Y_s$, for the next season.

$$Y_m = Y_h - Y_c - Y_s + Y_g$$

where $Y_h > 0$ if $Y_c, Y_s, Y_g > 0$, $Y\_m/Y_h = 1$ if the farmer sells all the crop harvested or, $0 < Y_m / Y_h < 1$ if the farmer distributes his crop and sells a portion of it in some market. Therefore, the value of the dependent variable is between 0 and 1.

The next analytical step involved identifying factors that influence market participation using regression analysis. The determinants of market participation are those that affect productivity and, hence, domestic market access conditions.

The general model can be written as $(MP)_i = f\{(u)_i, (MA)_i, (D)_i\} \ldots i = 1 \ldots N$ ... (6)

where MA is the vector of variables that determine market access conditions, u is the technical efficiency scores generated from the above model, D shows demographic conditions, and MP is market participation. We used the Tobit model to estimate this because of the truncation of market participation variables (Barrett et al.2001).

$$Tobit(MP_i) = \ln\left[\frac{Y_m}{Y_h}\right] = \beta_1 + \beta_2(MA)_i + \beta_3(D)_i + \beta_4(u)_i + \varepsilon_i \ldots (7)$$

## Qualitative Methods

The study implemented qualitative methods to accomplish the objectives related to the policy interventions by stakeholders. The study implemented the qualitative method to get information from the key informant interviews (KIIs), which contained the information about agriculture sector in the AJK. The objective was to ask them about the sort of support they provided to the farmers to reduce farm inefficiencies. Moreover, KIIs maintained focus on the problem faced during the provision of assistance to farmers, and how the relevant institutions provided help to farmers to participate in the market. Qualitative information was collected from different interlinked departments such as the agriculture department officials, Planning and Development Department (P&DD), Irrigation and Small Dams Department, Extension Service Management Academy (ESMA), Agriculture Tourism Development Corporation, and Crop Reporting Services (CRS).

### *Focused Interviews*

The qualitative data were collected following Yin (2003) to ensure the reliability of individual case study interviews, and personal observations using the focus group discussions (FGD) methods. Some crucial questions about agriculture productivity and marketing of the relevant sectors were included in the surveys. They were also given some specific questions about the reasons for agricultural inefficiencies and marketing faults, as well as their suggestions, roles, challenges, and expected policy recommendations.

To collect data, 40 key informant interviews (KIIs) and direct observations at various institutions at all levels were conducted. This group was made up of people from ten interconnected departments. Interviews were conducted with 36 field specialists and four members of a privately owned farm. Each interview lasted approximately one hour. Twenty per cent of the key informants (KIs) were female, and eighty per cent were male. Of those working on private farms, 68 per cent had M.Sc. (Hons) or higher education, 22 per cent had B.Sc. (Hons), and 10 per cent had intermediate education. Experts represented all agriculture sector departments from all districts. Fifty per cent had more than 14 years of experience in the agricultural sector. Four focus group discussions (FGD) with eight to ten participants were also held.

The overall goal of these interviews was to gather the most relevant information, opinions, experiences, and other issues. Additionally, we utilised these as a foundation for identifying issues, difficulties, future expectations, convictions, and driving forces associated with this particular sector.

# 4. RESULTS AND DISCUSSION

## Farm Household Characteristics

### *Socioeconomic Characteristics*

Descriptive statistics show that the average family size of the sampled farmers' households was 9 (Table 1). The dependency ratio ranged between 0 to 24 with a mean of 0.7. Farm household heads were, on average, 49 years old with ages ranging from 15 to 95. Overall, 53 per cent of the participants were under the age of 50, while 47 per cent were over 50. The household heads' literacy status ranged from illiterate to 18 years of education. An average household head had nine years of education, while 69.3 per cent of the sampled population had below intermediate education, 0.7 per cent was illiterate, and 30 per cent had above intermediate education.

The household head had 23 years of farming experience. The tenancy status of households revealed that 96 per cent of farmers were owners, while the remaining 4 per cent were owners cum tenants and renters. Only 27 per cent of the respondents had remained in the same location for up to 20 years, while 73% had worked for more than 20 years. Forty-five per cent of farmer household heads belonged to a union, 12 per cent to an association, 4 per cent to a non-governmental organisation, 33 per cent to a government organization, and 5 per cent were not affiliated with any organization.

*Table: 1 Socio-Economic Profile of Farmer Household Head*

| variables | Average | variables | Average |
|---|---|---|---|
| **Household head characteristics** | | **Farm Characteristics** | |
| Age (years) | 49 | Farm size *(kanal)* | 21 |
| *Education (years)* | 9 | Cultivated area *(kanal)* | 15 |
| Illiterate*(percent)* | 1 | | |
| Below intermediate*(percent)* | 69 | *Source of irrigation* | |
| Above intermediate*(percent)* | 30 | Rainfed*(per cent)* | 76 |
| | | Waterpipes *(per cent)* | 8.9 |
| Experience (years) | 23 | Directly from river and stream *(per cent)* | 2 |
| family size*(no)* | 9 | main or secondary canal*(per cent)* | 10 |
| dependency ratio*(percent)* | 70 | *Soil type* | |
| *Tenure status* | | loam*(per cent)* | 66 |
| owner*(percent)* | 96 | Clay *(per cent)* | 23 |
| Owner cum tenant*(percent)* | 3 | Sandy loam *(per cent)* | 4.3 |

| | | | |
|---|---|---|---|
| *Farming in the same area* | | *Soil fertility* | |
| Less than 20 years*(percent)* | 27 | Poor *(per cent)* | 21 |
| More than 20 years*(percent)* | 73 | Good *(per cent)* | 20 |
| member of union | | average*(per cent)* | 58 |
| Association*(percent)* | 12 | *Tube well* | |
| NGO *(percent)* | 4 | yes*(per cent)* | 97 |
| Govt organizations*(percent)* | 33 | no*(per cent)* | 3 |
| Nonmember*(percent)* | 5 | Traction source for cultivation | |
| *Farm inputs* | | Tractor (*per cent*) | 50 |
| Insect/weedicide(liter) | 5 | Bullock *(per cent)* | 23 |
| Fym (Trolley) | 20 | Both bullock and tractor *(per cent)* | 27 |
| Dap (kg) | 113 | *Location* | |
| Urea (kg) | 106 | Near water course *(per cent)* | 22 |
| NPK (kg) | 107 | No watercourse *(per cent)* | 78 |
| Irrigation(numbers) | 4.6 | | |
| Man-days (1 man-day=8 hour) | 30.1 | | |
| Seed (kg) | 14 | | |

***Farm Characteristics***

The average size of the sample respondent's farm was 21 kanals, or about 1 hectare or 2 acres, with a minimum of 1 kanal and a maximum of 360 kanals. Seventy-six per cent of the sampled farms were rainfed, whereas 2 per cent were irrigated with direct streams and rivers. 8.9 per cent came from water pipes, 10 per cent from main and minor canals, and the rest came from various sources. The average cultivated area was 15 kanal, ranging from 252 kanal to 0.7 kanal. In response to a question about the soil type, fertility, and soil issues, 23 per cent said they had clay soil, 66% had loam soil, 4.3 had sandy loam, and 4.7 had other types of soil.

Soil issues such as erosion, waterlogging, and salinity affected 21 per cent of the population. Only 3 per cent of had tube wells. Fifty per cent of the respondents said they solely used their own or hired tractors for land cultivation, while 27 per cent said they used both bullocks and tractors to cultivate their land. Bullocks were used for ploughing land by 23 per cent of the respondents. Only 10 per cent of the population had tractors. 78 per cent of farms were located in areas where there were no water courses or channels, while the rest were near water channels.

The average amount of weedicide and pesticide used was 5 litre. However, 45 per cent of farmers did not use any weedicide or pesticide. Fifteen per cent of farmers did not use any FYM at all, while 50 per cent used less than six carts. The average FYM was 20 trolleys. DAP and urea were the most commonly used fertilisers. Twenty per cent of farmers did not use any fertiliser, while 50% used less than 60 kg. The average amount of DAP and urea fertiliser used was 113 and 106 kg, respectively. These fertilisers provided 107 kg of NPK nutrients. The average number of irrigations was 4. The average seed used per kanal was 14 kg, with 30 man-days from hired labour. The mean gross value from crops was Rs. 352,238 annually from two seasons.

***Market-Related Characteristics***

Table 2 in the appendix gives descriptive statistics of the variables that represent market accessibility. Fifty-eight per cent of the households active in market participation were involved in value addition and processing activities, whereas 42 per cent were not. Wheat flour accounted for 35 per cent of the processed items, maize flour 48 per cent, and dried legumes and pulses 7.2 per cent. Oil/nuts accounted for 5 per cent, while spices/sauces/jams/others accounted for 3 per cent. Farmers have a tremendous opportunity to sell directly to the market and generate a profit because the function of the intermediary in this region is limited.

*Table 2: Market-related characteristics*

| **Market-related characteristics** | | | |
|---|---|---|---|
| *Value addition(percent)* | | *Distance of farm from the road* | |
| yes | 58 | at roadside | 51 |
| no | 42 | within 5 km | 38 |
| *Process products* | | within 15 km or above | 11 |
| wheat flour | 35.93 | *Source of information* | |
| maize flour | 48.19 | agriculture extension services | 60 |
| dried fruit | 0.39 | farmer organizations | 17 |
| dried legumes/pulses | 7.23 | radio and television | 15 |
| spices/jams | 2.67 | neighbour farmers and relatives | 8 |
| sauces | 0.55 | Credit facility | |
| oils/nuts | 5.03 | yes | 25 |
| *Sale channels* | | no | 75 |
| At roadside(percent) | 20 | *Source of credit* | |
| At market(percent) | 40 | commercial banks | 40 |
| At farm(percent) | 15 | friends and relatives | 45 |
| To processor(percent) | 4 | Other private people | 15 |

| | | | |
|---|---|---|---|
| Farmer organization(percent) | 2 | *Market training* | |
| Exporter (percent) | 4 | yes | 27 |
| Govt organization(percent) | 5 | no | 73 |
| Private wholesaler | 10 | *Marketing experience (year)* | 10 |
| *Distance from the nearest market* | | | |
| Within 15 km (per cent) | 80.7 | | |
| between 15 to 30 km (per cent) | 14.3 | | |
| above 30 km(per cent) | 5 | | |

In this region, 40 per cent of products were sold directly to the market. Other channels of sales were roadside (20 per cent), field or on the farm (15 per cent), direct delivery to private wholesalers (10 per cent), direct delivery to the processor (4 per cent), farmer organisations (2 per cent), directly to exporters (2 per cent), and government organisations (5 per cent).

The distance to the nearest market is a key determinant of market participation. 80.7 per cent of the sampled farms were within 15 kilometres, 14.3 per cent between 15 and 30 kilometres, and 5 per cent beyond 30 kilometres. Moreover, 90 per cent had less than 20 years of experience.

The distance of the farm from the road is an important determinant of market participation. According to the survey 51 per cent were living at the roadside, 38 per cent within 5 km, and 11 per cent within 15 km or above. The source of information about the market showed that 60 per cent received information about the market from agriculture extension services, 17 per cent from farmer organisations and associations, 15 per cent from radio and television and 8 per cent from other sources, such as neighbouring farmers and relatives. Among the respondents, 25 per cent availed of a credit facility, while 75 per cent did not avail of any such facility. The data show that 40 per cent availed of the credit facility from commercial banks, 45 per cent from friends and relatives, and 15 per cent from other private lenders. As regards training, 27 per cent received training in agriculture and marketing, while the rest (73 per cent) did not receive any training. Marketing experience, on average, was 10 years. Household assets and facilities in a specific area are important determinants of market accessibility (see Table 3).

*Table 3: Household Assets and Facilities*

| Household assets and facilities | yes | partially | No |
|---|---|---|---|
| Have concrete home | 78 | 17 | 5 |
| Road at village | 83 | 12 | 5 |
| Mobile and telephone | 93 | 3 | 4 |

| | | | |
|---|---|---|---|
| Radio | 33 | 27 | 40 |
| Newspaper | 21 | 40 | 39 |
| School | 74 | 10 | 16 |
| Television | 73 | 9 | 17 |
| Electricity | 93 | 3 | 4 |
| Gas | 11 | 30 | 59 |
| Water supply from pipes | 30 | 17 | 53 |
| Ownership of transport | 19 | 17 | 64 |
| Internet | 31 | 23 | 46 |
| Laptop/comp | 18 | 19 | 63 |
| Fridge/refrigerator | 60 | 10 | 30 |

### Stochastic Frontier Analysis Results

We first estimated the model by using all inputs to determine its fitness. Table 4 reports the results in the appendix. The gamma value was highly significant, so we rejected the null hypothesis, $H_0 = \gamma = 0$, that the technical inefficiency effects are not present in the model and are not random because the gamma is positive 0.51 and highly significant. In the second model (Table 5) we incorporated household and farm-specific characteristics as determinants of technical inefficiency. Most of the variables are significant so we also rejected the null hypothesis that the household-specific characteristics did have not any influence on the technical inefficiency level expressed by $H_0 = d_0 = dn'=0$, where $d'$ denotes the vector of parameters. LR value was 45 with df =8. chi- sq value of 8.6 and the p-value was 0.001658, given by likelihood-ratio statistics that was highly significant. Therefore, we rejected the model with OLS and no efficiency and support the model with an error component frontier (ECF).

*Table 4: Stochastic Production Frontier Estimation Results*

| | Estimate | Std. Error | z value | Pr(>\|z\|) | |
|---|---|---|---|---|---|
| (Intercept) | 9.08 | 0.19 | 47.23 | < 2.2e-16 | *** |
| Weedicide/insect (dummy variable) | 0.07 | 0.03 | 2.23 | 0.03 | * |
| FYM( trolleys) | 0.14 | 0.02 | 6.58 | 0.00 | *** |
| NPK (nitrogen and phosphorous nutrients, kg) | 0.17 | 0.02 | 8.89 | < 2.2e-16 | *** |
| Irrigation(numbers) | 0.16 | 0.03 | 5.74 | 0.00 | *** |

| | | | | | |
|---|---|---|---|---|---|
| Cultivated area(kanal) | 0.53 | 0.03 | 15.83 | < 2.2e-16 | *** |
| Seed(kg) | 0.04 | 0.03 | 1.60 | 0.11 | |
| Man days( for hired labour 1manday=8 hours) | 0.20 | 0.04 | 5.31 | 0.00 | *** |
| Tractor (dummy) | 0.30 | 0.07 | 4.13 | 0.00 | *** |
| District south (dummy) | 0.66 | 0.08 | 8.52 | < 2.2e-16 | *** |
| Sigma sq | 1.25 | 0.12 | 10.85 | < 2.2e-16 | *** |
| Gamma | 0.51 | 0.08 | 6.24 | 0.00 | *** |
| Log-likelihood value | -1598.984 | | | | |
| Mean efficiency | 0.5845371 | | | | |

*Significance: 0***, 0.001 **, 0.01*, 0.05 '.' 0.1 ' ' 1*

*Table 5: The Maximum Likelihood Estimates for Cobb-Douglas Production Frontier including Determinants for Technical Inefficiency*

| | Estimate | Std. Error | z value | Pr(>\|z\|) | |
|---|---|---|---|---|---|
| (Intercept) | 9.56 | 0.22 | 43.53 | < 2.2e-16 | *** |
| Weedicide/insect (dummy variable) | 0.10 | 0.03 | 3.26 | 0.00 | ** |
| FYM( trolleys) | 0.11 | 0.02 | 5.17 | 0.00 | *** |
| NPK (nitrogen and phosphorous nutrients, kg) | 0.16 | 0.02 | 8.35 | < 2.2e-16 | *** |
| Irrigation (numbers) | 0.16 | 0.03 | 6.22 | 0.00 | *** |
| Cultivated area (kanal) | 0.48 | 0.04 | 12.96 | < 2.2e-16 | *** |
| Seed (kg) | 0.01 | 0.03 | 0.49 | 0.63 | . |
| Man days (for hired labour one man-day=8 hours) | 0.17 | 0.04 | 4.68 | 0.00 | *** |
| Tractor (dummy) | 0.47 | 0.10 | 4.66 | 0.00 | *** |
| District south (dummy) | 0.42 | 0.08 | 5.08 | 0.00 | *** |
| Intercept | -0.23 | 0.81 | -0.29 | 0.78 | |
| Farm size | -0.02 | 0.01 | -1.94 | 0.05 | . |
| Farming experience | 0.01 | 0.01 | 1.83 | 0.07 | . |

| | | | | | |
|---|---|---|---|---|---|
| Education | 0.09 | 0.04 | 2.54 | 0.01 | * |
| Farming area | 0.66 | 0.26 | 2.50 | 0.01 | * |
| Irrigation sources | 0.10 | 0.05 | 1.90 | 0.06 | . |
| Land fragmentation | -0.61 | 0.27 | -2.31 | 0.02 | * |
| Traction power | -0.55 | 0.24 | -2.29 | 0.02 | * |
| Sigma sq. | 1.73 | 0.51 | 3.37 | 0.00 | *** |
| Gamma | 0.72 | 0.08 | 8.51 | < 2.2e-16 | *** |
| Log-likelihood | -1549.364 | | | | |

*Significance:  0***, 0.001 **, 0.01*, 0.05 '.' 0.1 ' ' 1*

To attain the objective, we selected the variables based on economic literature. The stochastic production frontier was estimated by using the gross value from all crops as the dependent variable and the set of inputs used as explanatory variables. However, the inefficiency sores generated were made explicitly a function of socioeconomic variables. The model was estimated in a single step following Battese and Coelli 1995). The elasticities of all inputs were positive and significant. All inputs contributed positively to the increase in the gross value of the crop produced. It shows that the inputs must be provided on time and in sufficient quantity and quality. Table 5 shows that 14 of the 15 parameter estimates for the stochastic production frontier are statistically significant at least at a one per cent level. All of the listed variables' coefficients have the anticipated signs. The cultivated area parameter estimate is 0.50, which is significant and has a positive sign, implying that a 1% increase in the area under cultivation would result in a 0.50 per cent improvement in farm productivity. This finding is in line with Chaudhry et al. (2008), Coelli and Battese (1996), and Battese and Broca (2001). The partial output elasticity of the labour variable is 0.17. This means that a 1% increase in labour allocation would improve farm output by 0.17 per cent. As a result, more labour availability during peak season would result in a higher output response.

The partial output elasticity of fertiliser is 0.16, which is statistically significant and has a positive sign. Tractor use (dummy) has a parameter estimate of 0.48, which is positive and statistically significant. The partial output elasticity of the seed variable is 0.019, which is also positive and statistically insignificant. The coefficient of pesticide and weedicide use is 0.10, which is statistically significant and positive. Farmyard manure has a positive coefficient of 0.11, which is statistically significant at the 5 per cent level of significance. Organic fertiliser (FYM) must be applied at the right time and in the right amount in combination with inorganic fertilisers to reap the benefits. Other empirical research has also found comparable results (e.g. Battese et al., 1993; Ahmad et al. 2002; Ahmad, 2003; and Hassan and Ahmad, 2005). The irrigation variables' coefficient is 0.16, which is positive and statistically significant at the 5% level. This result shows that reduced irrigation water supply under a changing climate, characterised by higher temperatures and lower rainfall, would severely harm agriculture in the AJK. This finding is consistent with Hassan and Ahmad (2005), Ahmad (2003), and Ahmad, et al (2002). The dummy variable for south districts with north districts as the base category has a favourable effect on farm productivity as well. As in the south, there is a huge area under cultivation and considerable agricultural crop potential. The cultivated area had a maximum elasticity of 0.50 per cent, which suggests that bringing more land under cultivation will result in a substantial improvement in agricultural productivity, while 40% of the land in this region remains uncultivated. When compared to other inputs, the usage of a tractor for ploughing had an elasticity of 0. 48 per cent. Only a small percentage of farmers owned tractors, while mostly rented this service, which could be because tractor availability is limited during peak agricultural seasons, resulting in late sowing and harvesting, causing farm output losses. Agriculture's performance will improve when more mechanisation is used. Districts dummy was included following Paul Strasberg, et al. (1999) for south districts. It captures the human, ecological, economic, and geographic conditions of households living in south districts taking north districts as the base category. The dummy is also positive, which shows that the southern region has more potential for agriculture production and market participation.

***The Analysis of the Determinants of Technical Inefficiency***

The findings demonstrate that farm-level technical inefficiencies exist. In the lower panel of Table 5, the parameter estimates of the factors affecting (in)efficiency by estimating Equation 4 are provided. We were able to use characteristics including farming experience, educational level, farm size, traction power, irrigation source, land fragmentation, and farming in a specific area with the data we had. The result shows that among the determinants of inefficiency, the variable education is positive and significant, implying that more educated individuals contributed positively to technical inefficiency at the farm. This is because higher education tends to divert people to other occupations, such as government positions, and they contribute less to increasing agricultural efficiency (Marcel and Agnes, 1999; Martey et al. 2012). Farming experience is also positive, which shows that older farmers with more experience in farming are less efficient than the younger and less experienced ones. The finding is consistent with the literature (Hussain, 2012; Bravo-Uretta Pinheiro, 1997; Ali et al., 1997; Ahmed et al., 2002; Bozoglu and Ceyhan, 2007; Oyewo et al., 2018). They may be unwilling to take risks and evade frequent experimentation with new technology, practices, and modern inputs. It is expected that higher age and, therefore, more experience in farming improves orientation to market participation. On the other hand, the experience can also be expected to be negatively associated with production efficiency as older household heads tend to have more dependents and hence more subsistence production activities (Ehui, et al, 2009).

The fact that the coefficient for the variable farm size is negative indicates that increasing farm size reduces technical inefficiency since it allows farmers to cultivate a wider variety of crops, use new technology and machines, and enhance production. This result is in line with Ahmad and Ahmad (1998), Ahmad et al. (2002), and Ahmad et al (2003). The explanation for this could be that larger farmers, because of their stronger financial and social standing, have more access to information, farm machinery, and extension services, and can undertake agricultural operations in a timely fashion and with higher precision. Furthermore, farm operations at a larger scale may be able to utilise inputs more efficiently (Ahmad, et al. 2002).

The irrigation dummy is positive, which indicates that inefficiency increases with irrigation. This could be because the irrigation sources not being available in appropriate amounts, or because the majority of the land is rainfed, which hurts agricultural efficiency. The negative coefficient of land fragmentation indicates that the more the land is separated and cultivated in parcels, the easier it is for farmers to manage and monitor, which reduces inefficiency. The coefficient of traction power sources, such as advanced machines and tractors, bullocks, or both, was negative, indicating that it reduces farm technical inefficiency. Access to traction sources allows land preparation at greater depth, improving pre-planting, weed control, and better rainfall infiltration of the soil profile instead of manual methods, i.e., hand hoeing. The effect of farming in a specific area for less than 20 years, captured by a dummy variable, is also positive. It implies that the lesser time they live in their native place increases inefficiency. Milan (2014) also found that farmers migrating away from agriculture severely reduces agriculture yield and result in inefficiency because they do not make any permanent improvements to land due to a lack of interest and labour availability.

***Technical Inefficiency Score***

The mean value of efficiency derived from the above model, as shown in Table 6, was 58 per cent, with a range of

7.5 per cent to 86 per cent. It indicates that farmers might achieve the maximum output frontier by raising their efficiency by 42 per cent. This could be accomplished through the use of current technology and other measures. This suggests that by utilising agricultural resources more efficiently, the gross value from crops might increase by 42 per cent. While 53 per cent of the sampled farmers were under 60 per cent efficient, there is still space for the average farmer to increase farm production by 40 per cent with the same level of inputs and technology by strengthening the farming community's managerial capacity.

*Table 6: Efficiency Estimates Distributiton Using CD -SFA Model*

| TE Range | Per cent of Farms |
|---|---|
| **<50** | 21 |
| **50-60** | 32 |
| **60-70** | 30 |
| **70-80** | 15 |
| **80-90** | 2 |
| **90-100** | 0 |
| **Total** | 100 |

## Market Participation Index

Market participation is calculated by the sum of all crops marketed divided by the sum of all crops harvested $[(\sum^{J}_{j=1}$ Crop marketed$_{iy}$ $)/(\sum^{J}_{j=1}$ Crop harvested$_{iy}$ $)]$. Its value ranged between 0 and 0.9 with a mean of 0.36. Zero means they marketed nothing, whereas a value close to 1 means that the share of the crop marketed in total production increased, which implies more market participation. 1 means that they sold the whole crop produced. On average, the farm output produced was 4,215 kg and the amount marketed was 2,319 kg. Forty-seven per cent of the farmers had less than 50 per cent market participation, while 20 per cent did not participate in the market at all. The remaining 30 per cent had market participation greater than 50 per cent. The distribution is shown in Table 7.

*Table 7: Market Participation Distribution*

| MP Range | Per cent of Farms |
|---|---|
| 0 | 20 |
| 0.01-0.10 | 5 |
| 0.10-0.20 | 13 |
| 0.20-0.30 | 12 |
| 0.30-0.50 | 17 |
| 0.50-0.70 | 17 |
| 0.70-1 | 16 |
| Total | 100 |

***Factors Affecting Market Participation***

We used the technical efficiency level generated from the above model along with other market accessibility factors and household characteristics, which include credit facility, agriculture, and a market training dummy variable as the determinants of market participation. For the distance dummy variable, the farm that was within 5 km from the road was taken as the base category. The other determinants of market participation included the processing or value addition dummy variable, the distance from the market between 15-30 km dummy variable, marketing experience in years, having a refrigerator for storage dummy variable, having the internet as a source of information dummy variable, and family size in numbers. The model fit was good as the sigma coefficient was highly significant and the log-likelihood value was also large (404) with df 12. The results are presented in Table 8. All the variables, except the family size and processing, were positive and significantly contributed to market participation. An increase in credit facilities along with training and an increase in technical efficiency at a farm increase market participation. Chandio et al. (2018), Ali, et al. (2014), and Mukasa et al. (2017) also found evidence to prove that credit increases agricultural gross domestic product in Pakistan. Marketing experience also positively contributed as experienced farmers have established customer bases who usually buy from them (Harriet, et al., 2018).

*Table 8: Analysis of Market Participation Determinants (Tobit Model)*

| | Estimate | Std. error | t value | Pr(> t) | |
|---|---|---|---|---|---|
| Intercept | -0.69 | 0.06 | -11.32 | < 2e-16 | *** |
| Credit (dummy) | 0.04 | 0.02 | 1.85 | 0.06 | . |
| Training (dummy) | 0.12 | 0.02 | 5.65 | 0.00 | *** |
| Technical efficiency index | 1.39 | 0.08 | 16.80 | < 2e-16 | *** |
| Distance from the road (within 5 km) | 0.08 | 0.02 | 4.29 | 0.00 | *** |
| Processing | -0.05 | 0.02 | -2.34 | 0.02 | * |
| Distance from the market (within 15-30km) | 0.11 | 0.02 | 4.77 | 0.00 | *** |
| Marketing experience (years) | 0.01 | 0.00 | 6.18 | 0.00 | *** |
| Refrigerator (dummy) | 0.06 | 0.02 | 2.91 | 0.00 | ** |
| Internet (dummy) | 0.04 | 0.02 | 1.90 | 0.06 | . |
| Family size(number) | -0.01 | 0.00 | -3.17 | 0.00 | ** |
| Log sigma | -1.21 | 0.02 | -51.16 | < 2e-16 | *** |
| Log-likelihood | -405.00 | | | | |

*Significance: 0***, 0.001 **, 0.01*, 0.05 '.' 0.1 ' ' 1*

The coefficient of efficiency was 1.39 indicating that one point increase in efficiency score increased market participation by 1.39 per cent. Rios, Shively, and Masters (2009), Abu, Issahaku, and Nkegbe (2016), Mekonnen (2017), and Alhassan, et al. (2020) observed that farm households who are more productive have higher market participation rates.

Similarly, closer distance from the roads and market also significantly increased market participation. Makhura et al. (2001) found that more distance to the market negatively influences both the decision to participate in markets and the proportion of output sold. Acheampong, et al. (2018) reported that access to improved roads encourages the use of modern farm inputs giving higher yields. The positive effect of the market on the community supports the argument that physical infrastructure reduces transaction costs associated with marketing and information, which increases the quantities sold (Abu & Issahaku, 2017). Since the internet is a source of information, having the internet also positively contributed. Other studies have also found a positive effect of market information on market participation (see, for example, Abu et al., 2016 & 2014; Siziba et al., 2011).

The family size and processing negatively contributed to participation because larger families mostly process products for their immediate consumption at home, such as spices, maize, and wheat flour. Therefore, an increase in family size increases household consumption and results in a decrease in the amount marketed. The result is consistent with Olwande & Mathenge (2012)

### Response Generated from KIIs

Two sections make up the qualitative questionnaire. We posed questions about farm efficiency in Section A and market involvement in Section B. The results are summarised here in percentage terms. One of the questions was, “How are you contributing/assisting the farmers to improve farm productivity?” Twenty per cent said that they provided instant information. Another 20 per cent said that by introducing efficient farm practices. Similarly, 25 per cent said that they assisted by educating, training, and demonstrating. Seven per cent helped with irrigation, while 27 per cent assisted with other measures such as enhancing soil fertility. Another question was “Your organisation is demonstrating/working on which impact-based policy type? Thirty-five per cent responded that they provided input support, 5 per cent output support, 50 per cent technical support, and 10 per cent financial assistance. In response to the question “Is your department playing a role in the timely provision of pesticides, fertilisers, and other inputs to farmers?” 42 per cent answered yes, while 58 per cent said no. Another question was “In the face of climatic shocks/disasters, what has been your role to assist the farmers?” Thirty per cent that they assisted with adaptation, 25 per cent with financial assistance, 45 per cent with climate change perceptions, and 22 per cent said they assisted with other measures. In response to the question “Does your department have any collaboration with some other department to assist the farmers?” 82 per cent said yes, while 18 per cent responded with no. The question “Is your department engaged in finding new research-based ways to increase the productivity of the farmers?” yes answers accounted for 55% of the total, while no answers accounted for 45%.

The question “Which extension teaching method, in your opinion, is most persuasive for farmers in terms of an innovation's adaptability?” was also asked. The responses show that individual interaction was preferred by 32 per cent, group contact by 55 per cent, and mass contact by 12 per cent. In response to the question “Is the district administration working with you to help farmers raise their output?” 37 per cent said yes, while 62 per cent said no. Similarly, to the question “Are you training farmers on how to gain market access?” 25 per cent responded with yes, while 75% responded with no. There was also a question that asked “Is your department encouraging farmers to go into commercial farming and switch from traditional to high-yield crops?” Eighty per cent responded with no, while 20 per cent with yes. Finally, a question asked, “Are you having difficulty carrying out your plan to enhance farmer market participation?” In response, 65 per cent said yes and 35 per cent said no. Annexure B contains the response charts.

# 5. THEMATIC ANALYSIS

We also reviewed relevant literature and publications produced by associated departments such as the Agriculture Census 2010 and reports on sustainable development in AJK and crop reporting services helped to substantiate the interview's findings. NVivo software was used to create the themes. The current study sought information on regulatory framework and intervention, district-specific marketing mechanisms, capacity building, inefficiencies, barriers to market access, monitoring, service delivery, market infrastructure, private-public partnership, funding gap, water management, research and extension coordination, the availability of modern machinery, technology, inputs, and policy outcomes. We looked at the concept of market involvement and production efficiency in the context of a department and farmers from several districts. We discovered several roadblocks and issues that keep farmers away from reaching an efficient level of production and, thereby, market participation. The study also identified institutional issues that government officials encounter in this sector, which have an impact on their duties and contribution to farm production efficiency, as shown in Figure 2.

## Production Factors

Based on in-depth interviews with stakeholders, it appeared that the **private-public collaboration** in delivering inputs to farmers is limited. Low-quality inputs are used, seeds are not certified, and fertilisers are not available in good quality and quantity. Our econometric analysis also shows that all farm inputs had a significant positive impact on farm production. Therefore, policy intervention that improves input availability could be constructive to raise production. Several government initiatives share 20 per cent of the cost of inputs but their reach is restricted to certain regions. Farmers in the AJK use low-quality fruit plant types and uncertified seeds because better fruit plant kinds and vegetable varieties are unavailable. According to reports from the agriculture department, 30–35 per cent of the crop experiences yield losses because of insect damage. Insect pests, weeds, plant diseases, and vertebrate pests all contribute to individual losses of 10–20 per cent, 3–10 per cent, 5–15 per cent, and 2-5 per cent, respectively. To reduce these losses, timely chemical spraying in the right quantity is also necessary. The yield potential and existing crop production of crops are significantly out of sync because of outdated and conventional farming methods. Under the current AJK conditions, mechanised farming must be preserved and redefined to make it viable and a source of income for educated jobless young to make agriculture profitable for agricultural communities. Therefore, there is significant potential to increase food production through the application of a farm mechanisation strategy, the expansion of the area under cultivation through the enhancement of cultivable wasteland (261,317 acres), and the preservation of the currently available cultivable land through various agronomic and engineering measures. Estimated results show that increased traction power improved efficiency, which suggests private-public partnerships to make power more available. Labour is available in the farmer community, but some people cannot afford wages and choose to work on their own. Due to a lack of financial resources, many lands remain uncultivated. There are not enough agriculture-related enterprises in rural areas to absorb unemployed workers.

To forecast weather conditions and obtain market information, field employees are not properly equipped with the latest technology or field gadgets such as tablets and internet access. In the AJK, there is no agriculture research unit. To provide food security for the state's rapidly growing population, food production must rise at a rate that is at least as rapid as population growth. This will call for a broad-based use of new and improved technologies as well as the development of region-appropriate, and improved, high-yielding and disease-resistant crop varieties. For on-demand/result-driven field research to be conducted and made available to farmers, the AJK must have **sufficient research facilities**. To create locally appropriate varieties. They typically adopt varieties that work well in Punjab and are suggested by PARC but do not perform well in particular AJK localities with varying climatic and geographic conditions. Agricultural production is significantly lower than that of the rest of the nation because of unprofitable landholdings, farmer illiteracy, and resistance to embracing contemporary technologies. Weak institutions and low employee morale are crucial when considering the whole spectrum of difficulties that the agriculture extension faces, which significantly impact its performance. Productivity is stagnant despite optimal environmental conditions. Field employees have **no transportation or mobility** options for their frequent visits.

Precipitation, whether it comes as rain or snow, has a significant impact on the amount of agriculture produced in the AJK. A vital resource for agriculture is rainwater. One of the key reasons for low per-acre production and the continuous use of antiquated agricultural practices is the lack of sustainable irrigation water infrastructure. The state does have a functional irrigation infrastructure, but it has been ignored ever since the state's creation, according to interviews with irrigation department staff. The Department of Irrigation-AJK is only starting to build irrigation infrastructure inside the state through federally funded projects. With the assistance of local communities, the agency is constructing structures to retain precipitation, enhancing surface and subsurface water resources, and working to line canals to use agricultural water more efficiently, lining streams, developing incredibly **efficient irrigation systems**, and using solar-powered pumping equipment to cut irrigation expenses. A key barrier to the AJK's potential to increase its agriculture is the fact that there are now only irrigation facilities available for 13 per cent of the total area that is cultivated.

The soil of the AJK is naturally **deficient in nutrients** needed to grow crops (M. K. Abbasi & Rasool, 2005). The ability to deliver nutrients constantly declines over time, even when it is amply provided in the early phases of land cultivation. The high-yield variety's full potential cannot be realised without the usage of balanced plant nutrition. Numerous studies have found that fertilisers increase crop productivity by 30 to 50 per cent. Due to a lack of resources and methods, only nitrogenous fertiliser is used in the state of AJ&K, depleting supplies of certain micronutrients such as zinc, iron, and copper as well as other essential elements like phosphorus and potassium.

The most essential production factor is the **availability and quality of inputs**. These are the primary drivers of market participation. If high-quality inputs are not made available to farmers on time, the output would suffer, which would negatively impact the ability of farmers who are currently involved in marketing. Therefore, focusing on crop quality may reduce the risk of crop loss. There are numerous problems in the management of the functions at the local level, including maintaining quality standards, enforcing regulations, and delivering seeds, fertilizer, and pesticides. Government programs have an **inherent fault** in that that the recipients are never selected scientifically. Instead, patronage and connections are frequently used as measurement methods for the allocation of government-sponsored schemes. As a result, the outcome cannot be accomplished, objectives are not fully met, and recipients have no reason or motivation to take the product on a commercial basis. Additional reasons that have weakened the agricultural sector of the AJK are that the farmers are influenced by alternative employment opportunities in the public and private sectors to abandon their fields of work and seek new employment in urban regions. Farmers who chose to engage in trading and commercial activities or who somewhat improved their situation. To do this, hundreds more farmers sold their land and relocated to cities, where they took part in a range of commercial and economic activities. A few of them truly achieved considerable success in their brand-new careers. Many farmers started working in the supermarket business, and some of them became fruit and vegetable dealers.

### Market Accessibility Factors

A vast variety of fruits are produced in the AJK, which are primarily consumed locally. There are very few traded fruits, such as citrus, apples, and walnuts. All vegetables, except for a few, primarily onion, tomato, okra, and Karam, are grown for livelihood. However, neighbourhood retail businesses serve as the primary trade mode for most of the excess marketable vegetables. Due to their long shelf lives, only onions and garlic are handled in substantial amounts through middlemen. Since there are no formal markets in the AJK, farmers are unable to bring their products there for an open auction to get fair prices. The contractors use farmers in several ways to increase their profit at little to no expense. **Infrastructure,** better roads, and farm gate roads all contribute to lower transportation costs and post-harvest losses. There are no dedicated storage and warehousing facilities where farmers can store their crops and sell them at a profit. As a result, the production quality is likewise poor. Estimated results also show the closer they are located to roads and markets the higher the market participation.

Public and non-governmental organisations (NGOs) should assist in providing training and information on **credit and access to other technology** to all farmers. All farmers ought to have access to knowledge, different types of technology, and instruction from governmental organisations and NGOs. If farmers are financially stable, they may be able to employ contemporary technology to raise more crops and sell them for a profit.

Farmers' market orientation can be influenced by **market information** such as current and prospective prices. Currently, the agriculture department is not involved in providing farmers with market information. Because the extension services provided by the department field assistance staff are not market-oriented, and in the AJK farmhouses are spread over far-flung areas, a public-private partnership is required to engage other companies and NGOs to keep farmers informed about changing circumstances. Farmers have limited access to alternative sources of information such as the internet, television, and radio, and they are financially unable to cover the costs of transportation to market. **Farmers' organisations and associations** are needed to assist farmers by assembling their agricultural produce in one location so that when items are transported and sold in bulk, transportation costs are evenly divided. As a large number of farmers become closer, it will also make administration easier.

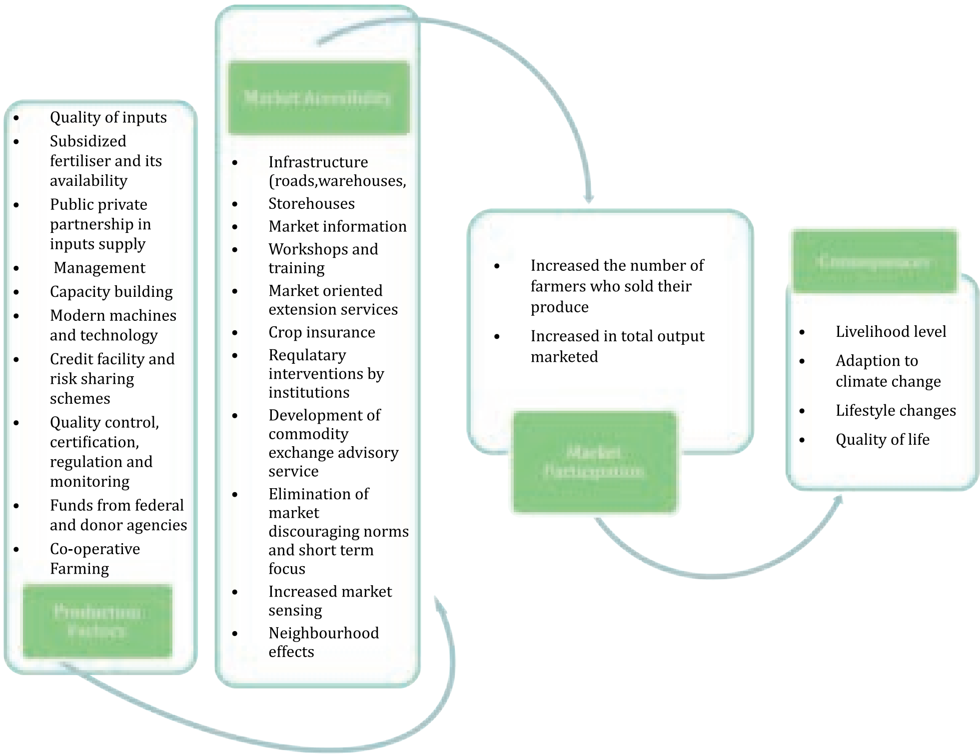
Field employees and farmers require workshops and training on market activities and product value addition. Likewise, the positive role of training in raising market participation suggests that certain training programmes could be constructive. Farmers are unable to obtain fair pricing for their produce due to weak regulatory involvement. Districts bordering Pakistan's big markets, such as Bhimber, Mirpur, and Kotli, which are adjacent to Rawalpindi markets, are more involved in market participation. These farmers have some experience with markets and are actively participating. Farmers in these districts have a lot of expertise and market information. Moreover, farmers have access to information on the types and attributes that buyers want and times when demand for their products is high through market sensing.

Farmers typically conduct **market sensing** through personal trips to the market, conversations with other farmers, travelling, and social gatherings. We generally found lower levels of market sensing in more distant marketplaces, such as the northern district of Neelum, Poonch, Hattian, and Haveli, where farmers have less experience in participating in the market, compared to locations closer to the markets. **Farmers' market responses** included crop variety selection and moving from low to high-value crops. (for instance, switching from cereals to vegetables and fruits) or a more popular product. In terms of market involvement, social and geographic factors were found to be more important than organisational factors. Farmers frequently conduct market research through personal visits. Farmers have adopted a **market-oriented** mindset, but they are hardly involved in predicting future demand or developing long-term plans to create and sell at a profit. They only appear in the market for a single season and then disappear. In this area, the **neighbourhood effect** is also more widespread. Farmers are more inspired and encouraged by the methods of their neighbouring farmers who sell their agricultural produce for a higher profit. It also encourages individuals to go to nearby markets for information, which is their first step toward market involvement. For example, if a farmer in the Neelam district sells walnuts at a fair price in a Lahore market, others might follow suit and bring their produce to the same market. **Market-discouragement norms** are also more prevalent in some places, where farmers are hesitant to sell their crops to the market and instead prefer to give their crops as a gift to neighbours and relatives. It further reduces the incentive to market their products.

## Market Participation

All those factors that affect production efficiency and market accessibility will ultimately affect market participation. The overall output produced in this area is below the optimal level of production for marketing. Farmers in places where market access is good, such as the south districts of the AJK, are encouraged to cultivate more and sell them.

*Figure 2 Antecedents and Consequences*




## Consequences

Local economic and agricultural characteristics may influence the relationship between market participation and productivity. Roads need to be built to enable farmers in producer organisations, provide literacy programs in rural areas, storage facilities for perishable crops, and provide access to markets. The growth in market response may mean that farmers live a more individualised lifestyle, rather than on a traditional basis.

As a result of the rise in production efficiency, market involvement alters the peasant economy. Those who use their earnings to make the transition from subsistence to monetised transactions, increase market involvement or production rates, or both, can boost their living standards. Farmers can become consumers of a variety of things, including manufactured goods, as their incomes rise. For example, the usage of mobile phones, the internet, and computers constitutes a substantial shift in farmers' lifestyles. They can check prices, new varieties and weather forecasts on their phones.

Farmers who are less market responsive are less responsive to climate change since selling is more difficult and less profitable for them. Farmers' market responses have an impact on their ability to respond to changes in natural conditions. These include adapting resistant varieties and hybrid seeds to anticipated changes in climatic circumstances, such as drought, at the time of planting. An increase in income will help to add value to the product.

Furthermore, FGDs and KIIs pointed out that increasing market access through local infrastructure investment, such as the construction of roads, warehouses and storage facilities, might lead to continuing agricultural production improvement. Moreover, increasing production through direct investment in irrigation, improved seed and subsidized fertilizers is likely to have a more consistent impact on both production and market participation.

## 6. CONCLUSION AND POLICY RECOMMENDATIONS

It is essential to strengthen this connection in the farmers' favour. Agricultural production is intimately correlated with both direct and indirect agricultural inputs, energy inputs, training, and the appropriate use of farm equipment. The AJK government must place a strong emphasis on the agriculture sector, which is frequently neglected. Market-driven public policy initiatives and high-yielding water- and energy-efficient production technology will help to increase productivity in this sector.

The positive coefficients of inputs on output, as previously mentioned, may indicate that measures to enhance input availability would be beneficial, or the fact that higher traction power increases efficiency may indicate the need for private-public partnerships to boost power availability. Similarly, the positive role of training in increasing market participation may imply that some training programmes are beneficial. Improvement of infrastructure by constructing local markets, roads and storage houses may also positively contribute to market participation.

The study's main goal was to establish a relationship between farm production, technical efficiency, and market participation. The research question was whether increasing agricultural production leads to increased market participation, having better market access conditions. To this purpose, the study demonstrates that farm-level variables and market accessibility factors have a significant impact on agricultural productivity and market participation. The findings also revealed that, in addition to market accessibility factors, production and technical efficiencies play a substantial impact in influencing market participation levels, with a positive coefficient of 1.39. There is room to increase the efficiency level by 42 per cent. Therefore, there is a need to take the following steps:

- To control the effects of farm inputs on production; the inputs should be available to every farmer timely and in good quality and quantity.
- Socioeconomic factors influence farm performance. Education and agriculture skills along with training should create awareness and interest so that more educated people are involved in agriculture.
- Innovative machines should improve the management capabilities of the agricultural community, which enhance technical efficiency and market participation by designing and promoting infrastructure support, i.e., roads, markets, storage and warehouses, and transport facilities.
- Create off-farm employment and investment opportunities to help extremely inefficient farmers to start agro-related enterprises.

- Increase the size of the farm by bringing more land under cultivation. Programmes that encourage landowners to utilise waste lands should be introduced.

- Poor monitoring mechanisms were noted. To evaluate the impact of development schemes, advisory support systems, monitoring and evaluation mechanisms can assist in reorganising schemes to achieve the desired goals.

- Credit and short-term loans have a significant impact on market participation. The loans are used to convert traditional agriculture to modern commercial farming, which increases market participation.

- Strategies need to be devised to equip farmers with marketing skills and opportunities so that their products can reach the market at a lower cost and in a shorter time.

- Higher expected returns encourage farmers to enter the market and increase sales volumes for those capable of generating marketable surpluses. Farmers' access to market pricing systems and information is very important for enhancing the agricultural sector's output.

- The agricultural extension should be market-oriented. Reorganise the agricultural extension system to meet the challenges of the market because extension agents are the ones who are in close contact with the community. Therefore, they should be well equipped with updated information about marketing. The farmers should be provided training to improve their management skills in the changing environment.

- The crops are already under water stress, and a temperature rise would increase the plants' water demand. As a result, increasing water storage capacity in the region is critical for ensuring the agricultural production system's sustainability and market participation.

- The study's findings also show that increasing production efficiencies increase market participation. As a result, greater infrastructure and farmer-friendly policies are required to remove input and output market inefficiencies, lowering production costs, and making the sector more competitive.

## REFERENCES


Abu, B. M., & Haruna, I. (2017). Financial inclusion and agricultural commercialization in Ghana: An empirical investigation. *Agricultural Finance Review,* 77(4), 524-544.

Abu, B. M., Issahaku, H., & Nkegbe, P. K. (2016). Farm gate versus market centre sales: A multi-crop approach. *Journal of Agricultural and Food Economics,* 4(21). doi:10.1186/ s40100-016-0065-6

Abu, B. M., Issahaku, H., & Nkegbe, P. K. (2016). Farmgate versus market centre sales: A multi-crop approach. *Journal of Agricultural and Food Economics,* 4(21). doi:10.1186/ s40100-016-0065-6

Abu, B. M., Osei-Asare, Y. B., & Wayo, S. (2014). Market participation of smallholder maize farmers in the Upper West region of Ghana. *African Journal of Agricultural Research,* 9(31), 2427–2435.

Acheampong, E. O., Sayer, J., & Macgregor, C. J. (2018). Road improvement enhances smallholder productivity and reduces forest encroachment in Ghana. *Environmental Science and Policy,* 85, 64–71.

Adam, E. A., et al. (2005) Analysis of Factors Affecting Sorghum Production in the Gezira Scheme – Sudan and Implications on the Household Food Security. *Conference on International Agricultural Research for Development*

Ahmad, M. (2003). Agricultural productivity, efficiency, and rural poverty in irrigated Pakistan: A stochastic production frontier analysis. *The Pakistan Development Review*, 219-248.

Ahmad, M., & Ahmad, A. (1998). An analysis of the sources of wheat output growth in the Barani area of the Punjab. *The Pakistan Development Review,* 231-249.

Ahmad, M., Chaudhry, G. M., Iqbal, M., & Khan, D. A. (2002). Wheat productivity, efficiency, and sustainability: A stochastic production frontier analysis [with comments]. *The Pakistan Development Review*, 643-663.

Alemu. B. A., H. Bola, and E.A. Nuppenau (2007) Technical Efficiency of Farming Systems across Agro-Ecological Zones in Ethiopia: An Application of Stochastic Frontier Analysis. *Medwell Journal of Agriculture Science*, 202- 207.

Alhassan, et al (2020) Access to Credit, Farm Productivity and Market Participation in Ghana: A Conditional Mixed Process Approach. *The Journal of Applied Economics Research*, 14 (2).

Ali, D. A., Deininger, K., & Duponchel, M. (2014). Credit constraints and agricultural productivity: Evidence from rural Rwanda. *The Journal of Development Studies,* 50(5), 649–665

Ali, M., Malik, I. A., Sabir, H. M., & Ahmad, B. (1997). *The mungbean green revolution in Pakistan* (No. 97). Shanhua, Taiwan: Asian Vegetable Research and Development Center.

Aramo-Immonen, H. (2011, September). Mixed methods research design. In *World Summit on Knowledge Society* (pp. 32-43). Springer, Berlin, Heidelberg.

Aramo-Immonen, H., Bikfalvi, A., Mancebo, N., & Vanharanta, H. (2013). Project managers' competence identification. In *Enhancing the Modern Organization through Information Technology Professionals: Research, Studies, and Techniques*(pp. 17-31). IGI Global.

Barrett, C.B., and P.A. Dorosh. (1996) Farmers' Welfare and Changing Food Prices: Nonparametric Evidence from Rice in Madagascar. *American Journal of Agricultural Economics* 78:656-69.

Battese, G. E. and T. J. Coelli. (1995). A model for technical inefficiency effect in stochastic frontier production functions for panel data. *Empirical Economics* 20, 325- 332.

Battese, G. E., Malik, S. J., & Gill, M. A. (1996). An investigation of technical inefficiencies of production of wheat farmers in four districts of Pakistan. *Journal of Agricultural Economics,* 47(1-4), 37-49.

Battese, G.E., Broca, S.S., 1997. Functional forms of stocha\tic frontier production functions and models for technical inefficiency effects: a comparative study for wheat farmers in Pakistan. *J. Productivity Anal.* 8, 395414.

Benjamin, D., and A. Deaton. (1993). Household welfare and the pricing of cocoa and coffee in Côte d'Ivoire: Lessons from the living standards surveys. *The World Bank Economic Review* 7*(3)*:293-318

Binam, J. N., J. et al. (2004). Factors affecting the technical efficiency among smallholder farmers in the slash and burn agriculture zone of Cameroon. *Food Policy* 29:5, 531-545.

Boisvert, R. N. (1982) The Translog Production Function: Its properties, Its several Interpretations and Estimation Problems. Cornell University Working Paper.

Boughton, D., et al.( 2007). Market participation by rural households in a low-income country: An asset-based approach applied to Mozambique. *Faith Economics,* 50.

Bozoğlu, M., & Ceyhan, V. (2007). Measuring the technical efficiency and exploring the inefficiency determinants of vegetable farms in Samsun province, Turkey. *Agricultural systems,* 94(3), 649-656.

Bravo-Ureta, B. E., & Pinheiro, A. E. (1997). Technical, economic, and allocative efficiency in peasant farming: evidence from the Dominican Republic. *The Developing Economies,* 35(1), 48-67.

Budd, J.W. (1993). Changing food prices and rural welfare: A nonparametric examination of the Côte d'Ivoire. *Economic Development and Cultural Change,* 41:587-603.

Cabas, J., A. Weersink, and E. Olale (2010). Crop yield response to economic, site and climatic variables. *Climatic Change* 101(3-4), 599- 616.

Chandio, A. A., Jiang, Y., Wei, F., & Guangshun, X. (2018). Effects of agricultural credit on wheat productivity of small farms in Sindh, Pakistan. Are short-term loans better? *Agricultural Finance Review*, 78(5), 592–610

Chaudhry, S., Hussain, M., Ali, M. A., & Iqbal, J. (2008). Efficacy and economics of mixing of narrow and broad-leaved herbicides for weed control in wheat. *Journal of Agricultural Research* (Pakistan).

Coelli, T. J. (1995). Recent developments in frontier modelling and efficiency measurement. *Australian Journal of Agricultural Economics* 39:3, 219 -245.

Coelli, T. J. (1996). A guide to FRONTIER version 4.1: A computer program for stochastic frontier production and cost function estimation (Vol. 7, pp. 1-33). CEPA Working papers.

Coelli, T. J., & Battese, G. E. (1996). Identification of factors which influence the technical inefficiency of Indian farmers. *Australian Journal of Agricultural Economics,* 40(2), 103-128.

Deaton, A. (1989). Rice prices and income distribution in Thailand: A non-parametric analysis. *Economic Journal* 99:1-37.

Edmeades, S.(2006). Varieties, attributes and marketed surplus of a subsistence crop: Bananas in Uganda. Paper presented at *International Association of Agricultural Economists Conference*, Gold Coast Australia, 12-18 August.

Ehui, S., Benin, S. and Paulos, Z. (2009). Policy options for improving market participation and sales of smallholder livestock producers: A case study of Ethiopia. *International Association of Agricultural Economists (IAAE), 16-22 August 2009, Beijing, China.*

Fakayode, S. B. (2009). Technical efficiency and factor productivity in upland and lowland rice production systems in Kwara State, Nigeria. PhD Thesis Submitted to the Department of Agricultural Economics and Farm Management. University of Ilorin, Nigeria.

Fraser, J., Fisher, E., & Arce, A. (2014). Reframing 'crisis' in fair trade coffee production: Trajectories of agrarian change in Nicaragua. *Journal of Agrarian Change,* 14(1), 52-73.

Govereh, J., and T.S. Jayne. (1999). Effects of cash crop production on food crop productivity in Zimbabwe: Synergies or trade-offs? MSU International Development Working Paper No.74, Michigan State University.

Govereh, J., T.S. Jayne, and J. Nyoro. (1999). Smallholder commercialization, interlinked markets and food crop productivity: Cross-country evidence in eastern and southern Africa. Unpublished, Department of Agricultural Economics and Department of Economics, Michigan State University.

Harriet, et al. (2018). *Potato market access, market efficiency and on-farm value addition in Uganda*. Elsevier

Hassan, S. and B. Ahmad (2005). Technical efficiency of wheat farmers in mixed farming system of the Punjab, Pakistan. *International Journal of Agriculture and Biology*, 7,431-435.

Heltberg, R., and F. Tarp. (2001). Agricultural supply response and poverty in Mozambique. Discussion paper #2001/114, World Institute for Development Economics Research (WIDER), United Nations University.

Hughes, N., K. Lawson, A. Davidson, T. Jackson, and Y. Sheng. (2011). Productivity pathways: Climate-adjusted production frontiers for the Australian broadacre cropping industry. In *2011 Conference (55th), February 8-11, 2011, Melbourne, Australia* (No. 100563). Australian Agricultural and Resource Economics Society.

Hussain, A., et al. (2012). Technical efficiency of wheat production in rain-fed areas: A case study of Punjab, Pakistan. Pak. *J. Agri. Sci,* 49:3, 411- 417.

Jasim, A,. (2020). *Role of productive sectors in socio-economic development of Azad Jammu & Kashmir.* Federal SDGs Unit, Ministry of Planning, Development & Special Initiatives (MoPD&SI), Islamabad.

Javed, M. I., et al. (2011). Analysis of technical and scale efficiency of smallholder farms of rice-wheat system in Punjab, Pakistan. *J. Agric. Res,* 49:1, 125 -137.

Javed, M. I., S.A. Adil, S. Hassan, and A. Al (2009). An efficiency analysis of Punjab's cotton-wheat system.

Jayne, T.S., et al. (2001). Do farmers really benefit from high food prices? Balancing rural interests in Kenya's maize pricing and marketing policy. Tegemeo Working Paper 2B, Tegemeo Institute of Agricultural Policy and Development, Egerton University.

Kariuki, D. K., C. N. Ritho, and M. Kimpei. (2008). Analysis of the effect of land tenure on technical efficiency in smallholder crop production in Kenya. The Tropentag University of Hohenheim, Conference on International Research on Food Security, Natural Resource Management and Rural Development.

Khan, R.E and S.Gaffar (2013). Technical efficiency of tomato production: A case study of district Peshawar, Pakistan. *World Applied Science Journal*, 28:10, 1389-1392.

Kibaara, B.W. (2005). Technical efficiency in Kenyan maize production: An application of the stochastic frontier approach. Colorado State University Fort Collins, Colorado.

Kumbhakar, S. C., and C.A.Lovell. (2000). *Stochastic frontier analysis.*

Makhura, M., J. Kirsten, and C. Delgado. (2001). Transaction costs and smallholder participation in the maize market in the northern province of South Africa. Paper presented at *Seventh Easter and Southern Africa Regional Maize Conference*, 11-15 February, pp. 463-67.

Marcel, R., Agnès, B., & Rimet, F. (2013). Influence of herbicide contamination on diversity and ecological guilds of river diatoms. *Cryptogamie, Algologie,* 34(2), 169-183.

Martey, E., Al-hassan, R. M. and Kuwornu, J. K. M. (2012). Commercialization of smallholder agriculture in Ghana A Tobit regression analysis. *African Journal of Agricultural Research,* 7(14), 2131–2141

Mekonnen, M. T. (2017). Impact of agricultural technology adoption on market participation in the rural social network system (MERIT Working Papers 008). UNU-MERIT

Mukasa, A. N., Simpasa, A. M., & Salami, A. O. (2017). Credit constraints and farm productivity: Micro-level evidence from smallholder farmers in Ethiopia (Working Paper Series No. 247). Abidjan: African Development Bank.

Olwande, J., & Mathenge, M. (2012). Market participation among poor rural households in Kenya. Paper presented at the *International Association of Agricultural Economists Triennial Conference,* Foz do Iguaçu.

Oyewo, I. O., Oladeebo, J. O., Adesope, A. A., & Raufu, M. O. (2018). Farm level indicators of sustainable land management: Effect on agricultural production in Oyo State, Nigeria.

P&DD. (2020). *Planning and development department statistical year book 2020.*

Paul Strasberg, et al. (1999). Effects of agricultural commercialization on food crop input use and productivity in Kenya. MSU Agricultural Economics working paper 71.

Pavelescu, F. M. (2011). Some aspects of the translog production function estimation. *Romanian Journal of Economics,* 32:1, 131-150.

Renkkow, M., D.G. Hallstrom, and D.D. Karanja. (2004). Rural infrastructure, transaction costs and market participation in Kenya. *Journal of Development Economics* 73:349-67.

Rios, A. R., Shively, G. E., & Masters, W. A. (2009, August). Farm productivity and household market participation: Evidence from LSMS data. Contributed Paper prepared for presentation at the International Association of Agricultural Economists Conference, Beijing.

Rios, A.R. and G.E. Shively. (2005). Farm size and nonparametric efficiency measurements for coffee farms in Vietnam. Selected Paper Prepared for Presentation at the American Agricultural Economics Association Annual Meeting, Providence, Rhode Island, and Purdue University ARP manuscript.17671.

Salvo, M., D. Begalli, and G. Signorello. (2013). Measuring the effect of climate change on agriculture: A literature review of analytical models. *Journal of Development and Agricultural,* 5:12, 499- 509.

SDG (2021). *Sustainable development goal mapping. The annual development programmes 2016-17 to 2020-21 with the SDGs.* UN.

Sigei, G., Bett, H., & Kibet, L. (2014). Determinants of market participation among small-scale pineapple farmers in Kericho County, Kenya.

Siziba, S., Kefasi, N., Diagne, A., Fatunbi, A. O., & Adekunle, A. A. (2011). Determinants of cereal market participation by Sub-Saharan Africa smallholder farmers. *Journal of Agriculture and Environment Studies,* 2(1), 180–193

Sohail. N.K, Latif, N.Abbas and M. Shahid. (2012). Estimation of technical efficiency and investigation of efficiency variables in wheat production: A case of district Sargodha Pakistan. *Growth,* 3:10.

Strasberg, P.J., et al. (1999). Effects of agricultural commercialization on food crop input use and productivity in Kenya. MSU International Development Working Paper No.71, Michigan State University.

Strauss, J. (1984). Marketed surpluses of agricultural households in Sierra Leone. *American Journal of Agricultural Economics* 66:321-31.

Thiam, A. and B. E. Bravo-Ureta. (2001). Technical efficiency in developing country agriculture: A meta-analysis. *Agricultural Economics* 25,235 -243.

Thiruchelvam, S. (2005). Agricultural production efficiency of bethma cultivation in Mahaweli system H. Srilanka. *Journal of Agriculture Economics,*7.

Vakis, R., E. Sadoulet, and A. de Janvry. (2003). Measuring transactions costs form observed behavior: Market choices in Peru. CUDARE Working Paper 962, Department of Agricultural and Resource Economics, University of California, Berkeley.

Yin, R.K., 2003. Case study research design and methods, 3rd edition. *Applied Social Research Methods Series,* vol. 5 Sage Publications.

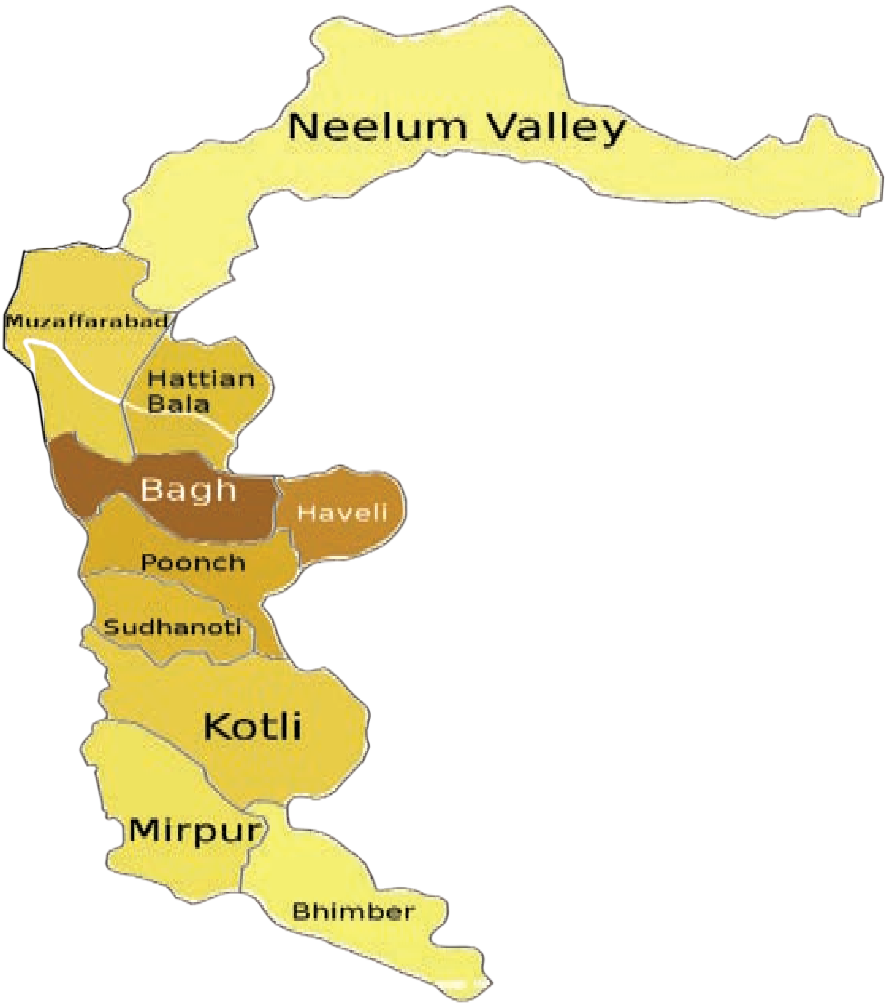
Zahid, K. B  and Ahmed .M(2018) Climate change and profit efficiency in Punjab, Pakistan: Evidence from household-level panel data. *Journal of economic library*.Vol :5 no 1 2018 Pp: 85-98.

# ANNEXURE A

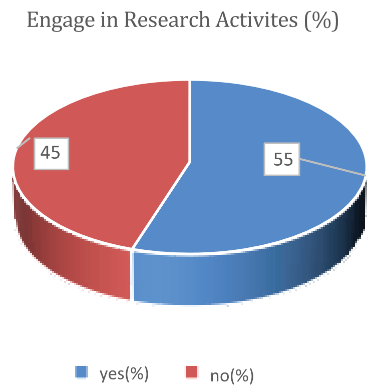
*Table: Name of Villages Selected from Each District*

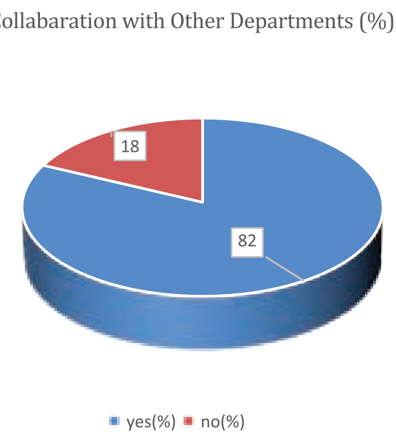
| S. No | District | Tehsil | Union Council(Villages) |
|---|---|---|---|
| 1 | Muzaffarabad | Muzaffarabad | Hattian Dopata |
| | | | Dana |
| | | Nasirabad | Noora Seri |
| | | | Kahori |
| 2 | Hatian Bala | Hatian Bala | Gujar Bandi |
| | | | Chak Hama |
| | | Leepa | Bana Mula |
| | | | Nokot |
| 3 | Neelum | Authmaqam | Authmaqam |
| | | | Neelum |
| | | Sharda | Guraiz |
| | | | Kail |
| 4 | Bagh | Bagh | Dharay |
| | | | Thub |
| | | Dhirkot | Chamiati |
| | | | Dhirkot |
| 5 | Havelli | Kahuta | Kalali |
| | | | Digwar |
| | | Mumtazabad | Badhal |
| | | | Sangle |
| 6 | Poonch | Rawalakot | Dhamni |
| | | | Town Area |
| | | Thorarr | Tain |
| | | | Thorarr |
| 7 | Sudhnoti | Plandri | Baral |
| | | | Jhanda Baglah |
| | | Trar Khal | Narian |
| | | | Pappay Nar |
| 8 | Kotli | Khui Ratta | Khooie Rata |
| | | | Khorr |
| | | Sahnsa | Sehar Mandi |
| | | | Kathar |
| 9 | Mirpur | Mirpur | Novagran |
| | | | Mirpur M/C |
| | | Dadyal | Khathar |
| | | | Anker Khadimabad |
| 10 | Bhimber | Samani | Samani |
| | | | Chowki |
| | | Barnala | Iftikharabad Janoobi |
| | | | Barnala |

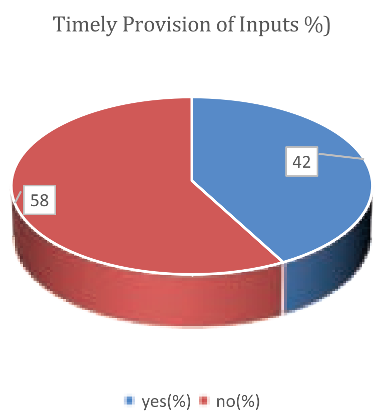
*Figure: Map of Sampled Districts*



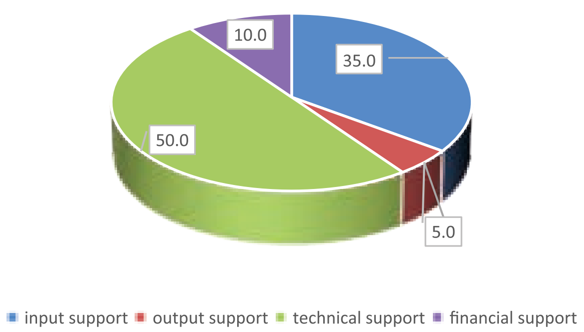
# ANNEXURE B RESPONSE CHARTS



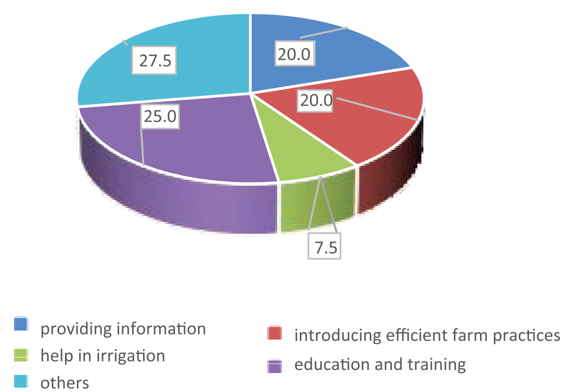



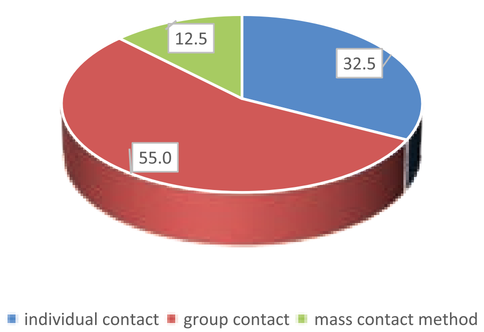
Impact by Policy Type (%)



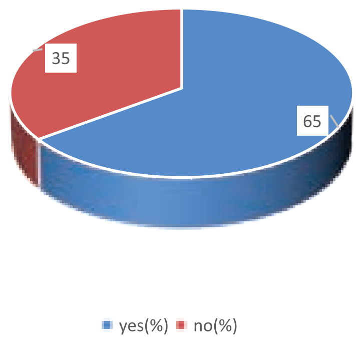

Contribution to Farm Efficiency (%)



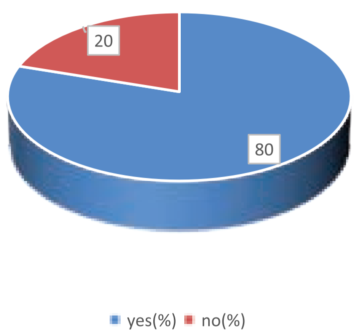

Best Extension Teaching Method (%)



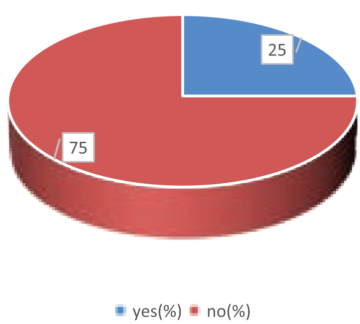
Problems Faced in Agenda Implementation (%)

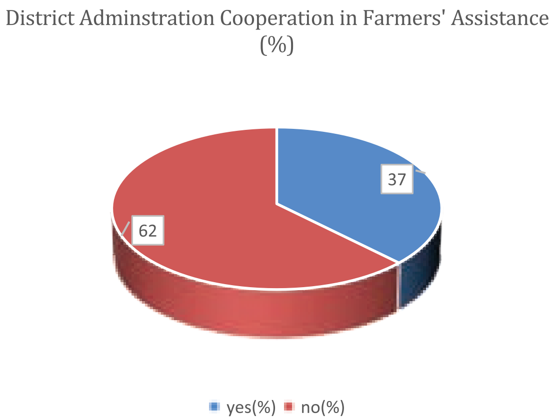


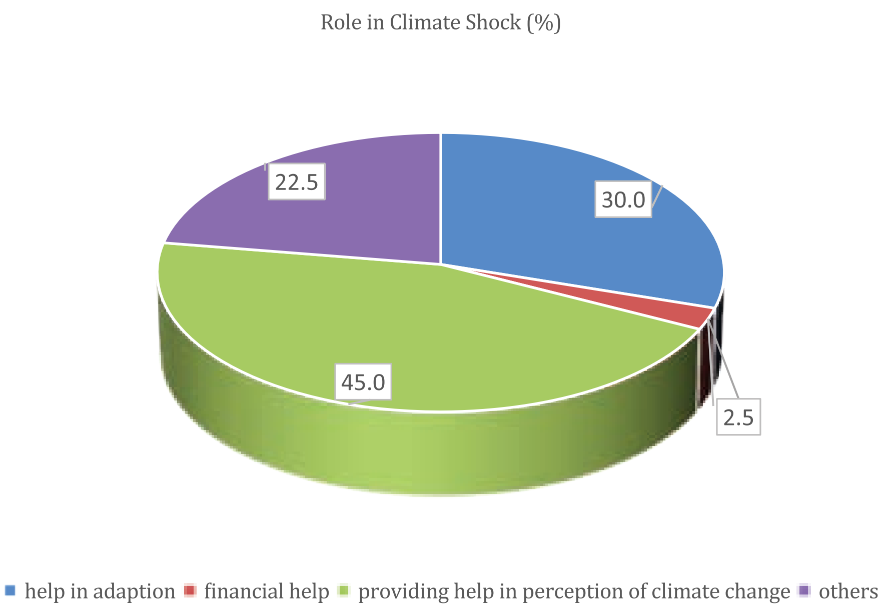

Motivating Farmers for Commercial Farming (%)




Education on Market Access (%)




District Adminstration Cooperation in Farmers' Assistance (%)
37
62
yes(%)
no(%)


Role in Climate Shock (%)
22.5
30.0
45.0
2.5
help in adaption
financial help
providing help in perception of climate change
others

# THE IMPACT OF MAJOR PUBLIC POLICIES ON COTTON PRODUCTION IN PAKISTAN

Irfan Ahmed Baig, Sami Ullah, Shoaib Nasir, and Wakeel Ur Rehman


## ABSTRACT

Pakistan, being an agro-based economy, relies on the agriculture sector for the provision of raw materials. The cotton crop not only contributes 0.6 per cent to the gross domestic product but also contributes 70 per cent to the export earnings of the country. Yet during the last two decades, the area under cotton cultivation and cotton production in the country are declining. Therefore, the current study adopted a holistic approach to evaluating the economic benefits, competitiveness of cotton, and its competing crops under the current set of policies. Similarly, it examined the various factors that contribute towards lower profitability of the cotton crop and the decrease in the area under cotton cultivation. For this purpose, data were collected from 856 farmers from six districts in three provinces of Pakistan, namely, Punjab, Sindh, and Balochistan. The results show that the cotton crop brought more pecuniary benefits to rural communities as compared to other competing crops. It also generated more revenue per cubic meter of water usage in the country. A policy analysis matrix was employed to evaluate the impact of a set of agricultural policies on cotton production. It is found that cotton producers across Pakistan were implicitly taxed, while sugarcane and rice producers were protected under the current set of policies. The estimates of the ordered probit model show that lack of access to extension services, weather information, pest-resistant varieties, and quality seeds were important factors that have discouraged farmers to grow cotton. To enhance cotton cultivation area by up to 4 acres, on average, farmers showed their willingness to pay an additional amount for quality pesticides, seed, and access to weather information. The study suggests that challenges in cotton production can be minimised by enhancing accessibility to weather information, extension services, premium quality seeds, and effective pesticides. Furthermore, price stability and availability of modern technologies to overcome labour constraints can significantly contribute towards higher cotton production. Similarly, exploring and converging on new potential areas for cotton production, especially in Balochistan, can enhance the overall cotton cultivation area and production in the country.

# 1. INTRODUCTION

## Background and Context

The agricultural sector is protected and supported by state institutions across the world through various policy measures. The policy support keeps the sector productive and competitive, ensures food security for the masses and the livelihood of farmers, and meets the requirements of agro-based industries (GOP, 2019). These policies broadly deal with farm inputs and outputs, trade facilitation/restrictions, the mechanisation of cropping systems, and investment in rural and agricultural infrastructure, such as water channels and R&D. Government interventions have resulted in various benefits for specific crops and also created social and economic externalities. Pakistan has also adopted several policy measures to cater for the needs of farming communities in the changing global scenario. These policies are sometimes crop-specific, but most of the time are designed to increase total crop productivity.

Pakistan is an agro-based economy. The agriculture sector contributed around 22.7 per cent to the GDP and almost 37.4 per cent to employment (GOP, 2021). The share of major crops in GDP is nearly 4.32 per cent of which cotton accounts for 0.6 per cent and 3.1 per cent of the total value added in agriculture. In the case of seed cotton, Pakistan is the fifth largest producer globally. Similarly, cotton has the longest value chain among all the crops with a major contribution to Pakistan's foreign exchange earnings. Pakistan exported $836 million (4.7 per cent) worth of raw cotton and yarn. Similarly, cotton-based exports accounted for $9.5 billion, which was more than half of the total exports of the country (GOP, 2020). Though cotton is considered Pakistan's major cash crop with strong backward and forward linkages, during the past couple of decades the crop's performance has been dismal in different aspects. The last five years can be considered devastating in terms of cotton area, production, and profitability. Table 1 below reflects the reduction not only in the cotton area in Punjab (which contributes around 70 per cent of the total cotton acreage) but also a decline in cotton production and yield. The data shows that since 2000 cotton has lost 12 per cent of its area, while its competing crops have gained the area under cultivation, especially sugarcane, which increased by 17 per cent.

The case of area replacement of cotton crop with its competitive Kharif crops, i.e., sugarcane, maize, and rice has many interesting insights from the policy perspective. There are diverging opinions at the policy level, i.e., whether the downfall of the cotton crop is due to adverse climatic conditions, the development of pest pressure in cotton growing areas, or frequent distortions in output and input markets. It has been observed that output prices among all factors remain the primary cause of reducing the profitability of the cotton crop.

*Table 1: Major Crops Area in the Cotton-Wheat Zone of Punjab ('000 hectares)*

| Year | Sugarcane | Rice | Maize | Cotton | Cotton Yield (40 kg/hc) |
|---|---|---|---|---|---|
| 2013-14 | 293.4 | 225.4 | 78.9 | 1,840.88 | 7.83 |
| 2014-15 | 282.88 | 277.61 | 75.9 | 1,930.29 | 8.11 |
| 2015-16 | 293 | 279.23 | 80.8 | 1,864.74 | 5.88 |
| 2016-17 | 338.72 | 295.83 | 158.6 | 1,554.36 | 7.38 |
| 2017-18 | 395.37 | 294.2 | 140.4 | 1,791.53 | 7.61 |

| | | | | | |
|---|---|---|---|---|---|
| 2018-19 | 338.9 | 313.61 | 204.1 | 1,686.3 | 7.15 |
| 2019-20 | 309.8 | 380.4 | 146.2 | 1,699.16 | 6.26 |

*Source: http://www.amis.pk/Agristatistics*

There are several causes of low cotton production reported in the literature including the higher cost of production, climatic changes, pest attacks, poor seed quality, adulterated inputs, and conventional farming practices (Aslam, 2016; Khan & Damalas, 2015; Zulfiqar & Thapa, 2018). Similarly, policy inconsistency has a significant impact on the decision of the farmers to grow a specific summer (kharif) crop in the context of Pakistan. These policies include certain incentives for competing crops, such as ensuring a consistent supply chain supporting the private business firms to procure from the farmers, indicative/support price, and subsidising input(s) (GOP, 2019, 2018; UNDP & GOP, 2021).

A significant number of stakeholders believe that there is a gradual drift of policy initiatives away from cotton, whereas an inclination of support towards the competing crops has resulted in developing a less conducive environment for the cotton crop. If agricultural policies in the major cotton-producing countries of the world are reviewed (Table 2) it emerges that Pakistan's cotton sector is least supported by policies and technological advancements. Major cotton-producing countries, such as China, India, and the USA provide subsidies on production, and India also has a minimum support price system for the cotton crop. Similarly, very little investment in cottonseed technologies has resulted in poor performance of the crop.

Keeping in view the importance of the cotton crop and the challenges being faced, a holistic analysis of the impact of the set of policies on the competitiveness and efficiency of cotton (vis-à-vis its competing crops) and factors resulting in the reduction of area under the cotton crop cultivation. Therefore, it is important to explore the possibilities to enhance cotton production to strengthen rural communities and ensure raw materials for the largest export-oriented sector (textile) of Pakistan.

*Table 2: Support to the Cotton Sector Among Major Cotton Producing Countries*

| Country | Certified Seed (%) | Cotton Subsidies* (Value of production) | Assistance to Cotton growers | MSP | Technology |
|---|---|---|---|---|---|
| China | 100 | 33% of the value of production | $4.7 billion | No MSP | Fusedg Cry1Ab Cry1Ac Stacked CpTi (1999) |
| India | 90 | Less than 10% | $600 million** | Up to 150 % of the cost of the production | Bollgard-II (2006) |
| USA | 100 | Nearly 9 % | $2 billion | No MSP | Bollgard-III (2017) |

| | | | | | |
|---|---|---|---|---|---|
| Turkey | 95 | -- | $5 billion | No MSP | |
| Uzbekistan | 95 | -- | $800 million | No MSP | |
| Brazil | 95-100 | 8% | $400 million | No MSP | Bollgard-II |
| Pakistan | 70 | 1% of the value of the production** | - | !No MSP | Bollgard-I (2010) |

**69% of world cotton production is under assistance. ** Most subsidies are provided in terms of a minimum support price. ! MnFSR has announced an indicative price for cotton @Rs. 5,000/40 kg in 2021*
*Source: (ICAC,2020; Embrapa, 2017; PCCC, 2018)*

Economic practicality, the competitiveness of production systems, technology adoption, the cost of farm inputs, the productivity of cropping practices, degree of product differentiation, share in the market, market distortions, and government interventions in economic activity are various factors reported in the literature (Kennedy et al., 1998; Pahle et al., 2016; Williams, 2010). Several studies have been conducted in Pakistan to evaluate the economic efficiency and profitability of cotton (Anwar et al., 2005; Kannapiran & Fleming, 1999; Quddus & Mustafa, 2011; Jawa & Salam, 2012; Salam & Tufail, 2016; Wei et al., 2020; Abro & Awan, 2020). However, none of the studies has adopted a holistic approach to investigate the impact of agricultural policies and other socioeconomic and market-related factors on cotton production in Pakistan.

### Purpose and Scope

The objectives of the study are:

- To evaluate the impact of the production of cotton and its competing crops on the livelihood of rural communities.
- To evaluate the impact of major public policies on financial economic benefits/ profitability, and costs associated with the production of cotton and its competing crops in the cotton-wheat zone.
- To investigate the water use productivity of cotton and its competing crops.
- To investigate the determinants of farmers' changing crop choices.

Moreover, it will assist policymakers in addressing the challenges to cotton production by designing policies based on empirical findings.

### Relevance to Public Policy

Public policies are often designed by governments to drive economies/societies towards desirable outcomes. However, it is also critical to evaluate whether the policy instruments have worked in the desired direction or have created undesired externalities. The case of cotton failure in Pakistan is often attributed to misdirected public policy instruments. Governments have tilted the balance in the cotton-wheat zone by providing certain incentives to the competing crops, especially sugar, through massive licensing in the cotton zone. Moreover, the policy failure regarding the acquisition of the new technology for cotton breeding, and not declaring/fixing indicative pricing have also contributed to an overall decline in the cotton area and production. Therefore, this study evaluates the impact of agricultural policies on the farm-level profitability of cotton and its competing crops, their impact on the economy, and the determinants of farming decisions while choosing alternative kharif crops.

The next section presents a review of the relevant literature, followed by methodology, including data collection, and a brief overview of empirical models employed for analysis. Section 4 discusses empirical findings, and the last section presents conclusions and recommendations.

## 2. REVIEW OF LITERATURE

The cotton sector's deteriorating performance for years on end has brought unrest among the farming community and relevant governmental organisations, especially in Punjab, who want to rectify the situation. A couple of good policy reports have also been produced over  (GOP, 2021). The reports were prepared by national and international experts. The reports presented a review of the prevailing condition in cotton, gauged the institutional strengths and weaknesses, evaluated the policies related to cotton, and framed a set of recommendations for the policymakers for structural reforms for improving the cotton sector. Some of the recent research, including international studies such as ICAC's Cotton Vision 2030 (ICAC, 2020), have employed various econometric tools to evaluate the impact of policy measures on the decisions of cotton growers in Pakistan and various other cotton-growing countries.

Policy analysis matrix (PAM) is a computational framework developed by Monke & Pearson (1989) for measuring the input use efficiency in production, the degree of government interventions, and comparative advantage. Many studies in the past have utilized PAM to evaluate the policy effects (Anwar et al., 2005; Kannapiran & Fleming, 1999; Mohanty et al., 2003; Najafi, 2005; etc.). They investigated the efficiency of both agricultural price policies and public interventions and found that these policies have a substantial impact on consumer satisfaction and domestic prices. Nelson & Panggabean (2011) found that even after substantial government and consumer transfers, sugarcane cultivation declined in Jawa.

Salam (2012) and Salam & Tufail (2016) reviewed the effect of policies on cotton and rice production in Pakistan by employing secondary data from 2010 to 12. They found that the competitiveness of cotton production was sensitive to fluctuations in cotton and farm input prices. Gürer et al. (2017) studied the impact of agricultural policies on cotton production in Turkey by employing PAM and found that the current set of policies did not provide satisfactory support to increase the competitiveness of the cotton sector. There is a rich body of literature that highlights the use of discrete choice modelling for evaluating the farmer's decisions in the specific context of socioeconomic conditions, availability and access to information, the available set of policy incentives/disincentives, and political support (Caviglia & Kahn, 2001).

Fang & Babcoc (2003) quantified the impact of China's agricultural policy and accession to WTO on cotton production and area in the country. China's cotton policy focuses on the supply and demand of cotton, prices, and textile output. The results suggest that WTO accession resulted in an increase in cotton imports by 670 thousand metric tons. Quddus & Mustafa (2011) reported that under an export price parity situation, the nominal protection coefficient ranged from 1.33 to 1.99. It shows that the prices received by farmers were greater than the export parity/economic prices which suggests that sugarcane cultivation for exports is not economical.

Suresh et al. (2014) studied the impact of technology and policy on cotton sector performance in India. They concluded that better agricultural policies and modern technologies resulted in a decrease in input use. Sadiq (2015) investigated the impact of India's economic policies on cotton production before and after liberalisation and concluded that better performance witnessed during the liberalisation period was mainly attributed to the adoption of modern technologies and sound political and economic policies. Macdonald et al. (2016) found that support prices to Chinese cotton farmers resulted in lower cotton production, which resulted in the policy shift:

direct subsidies to cotton producers. Their findings showed that lower Chinese' import quotas would reduce world cotton prices. Gürer et al. (2017) investigated the impact of Turkish agricultural policies on cotton production in the country. Using PAM, the study measured policy transfers, resource utilisation, costs, and private and social profits. They found that the agricultural policies turned cotton production into a profitable enterprise, and gave Turkey a comparative advantage.

ELsamie et al. (2020) evaluated the impact of agricultural policies on Egyptian cotton production by using PAM. They concluded that the economic performance of cotton growers was better than the financial performance. However, Egyptian cotton producers have a comparative advantage and earn foreign exchange for the country. Abro & Awan (2020) reported that the profitability of minor crops increased from 2011 as compared to major crops. Wei et al. (2020) estimated the economic viability of growing cotton in Pakistan and reported that smallholders were more prone to economic shocks and had low technical efficiency. They also reported that financial constraints and lack of extension services were the main factors for lower productivity.

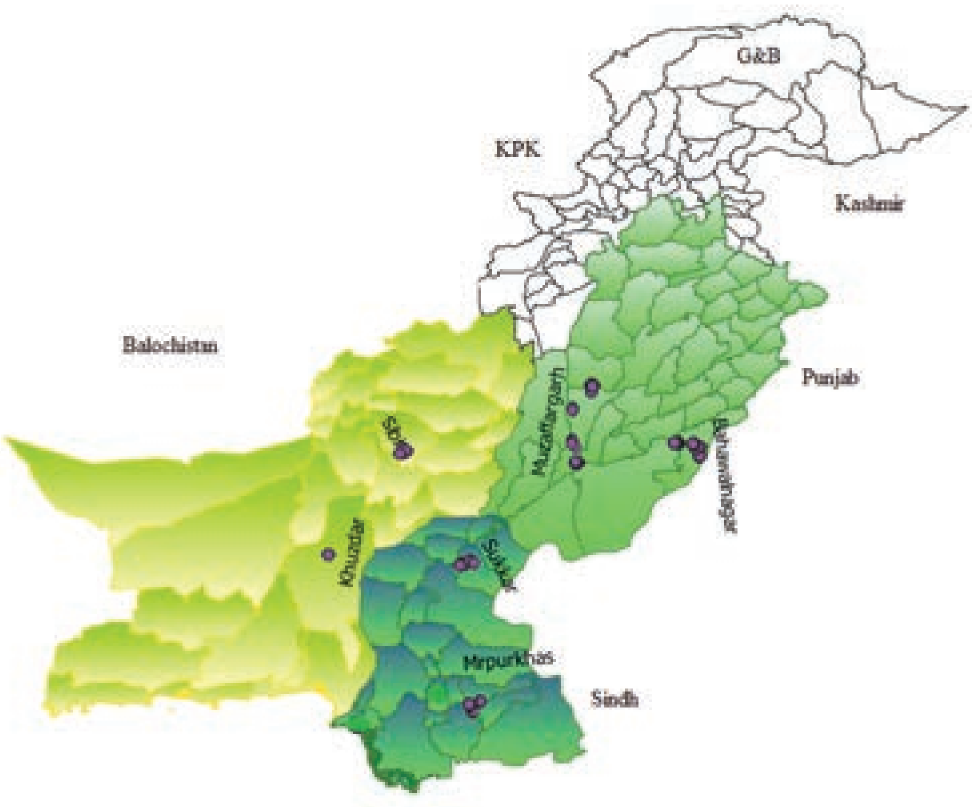
Wang et al. (2021) have analysed the impact of targeted price policy on cotton production in China. The study shows that the implementation of targeted price subsidies has stimulated cotton production by increasing the area, but yield has decreased over time. They suggested that policies should focus on crops that have a comparative advantage. Based on the above studies, it can be inferred that agricultural policies play a major role in the crop's competitiveness, profitability, and efficiency. Therefore, this study investigates the impact of major agricultural policies on cotton and its competing crops and also assesses the impact of the production of these crops on the overall economy.

## 3. METHODOLOGY

### Data Collection

The primary data was collected through a multistage stratified sampling technique from 856 farmers in Punjab, Sindh, and Balochistan using a structured digital questionnaire on cotton and its competing crops. In Punjab, data was collected from four tehsils, two each from Bahawalnagar and Muzaffargarh. In Sindh, data was collected from two tehsils of Mirpur Khas and one tehsil of Sukkar. Similarly, in Balochistan, data was collected from one tehsil each of Sibi and Khuzdar (Figure 1). Though the sample size is distributed generally based on shares of provinces/areas in the total production, however, in this study, respondents from Balochistan were included to investigate the policy impacts in new areas (and potential areas) of cotton production. Secondary data was collected from various published sources.

*Figure 1: GPS Coordinates of Data Collection Areas*




Likewise, focused group discussions (FDGs) were conducted with other stakeholders in the cotton value chain, including academics, researchers, pesticide and seed companies, and members of textile industries to better interpret the results and propose implementable policy recommendations.

A detailed questionnaire was developed by keeping in view the research objectives and pre-testing was carried out in the Kot Addu Tehsil of District Muzzafargarh. After corrections and modifications, the questionnaire was digitised on the Kobocollect Android application. To collect data, three teams were selected to collect data in each province. Data collection teams were selected from respective provinces to ensure a smooth collection of data by reducing linguistic and cultural barriers. Similarly, to ensure the quality of data, teams were given training on survey techniques and data collection methods.

## Econometric Techniques

Various econometric and mathematical techniques were employed for the analysis. PAM is an important tool to evaluate the competitiveness and economic and social profitability of crops. It also reports the comparative advantage of crop production by comparing international prices. PAM was employed to analyse the competitiveness of cotton and its competing crops by using a mix of primary and secondary data, while to explore the determinants of changing cropping patterns the ordered probit model was used. Similarly, for crop water use efficiency and income generation by various crops, the relevant mathematical techniques that are reported in the literature were used.

## 4. RESULTS AND DISCUSSION

### Descriptive Analysis

Descriptive statistics are given in Table 3 below.

*Table 3: Province-/District-/Tehsil-Wise Data (n=856)*

| **Punjab** | | | | **Sindh** | | | **Balochistan** | |
|---|---|---|---|---|---|---|---|---|
| Muzzafargarh | | Bahawalnagar | | Mirpur Khas | | Sukkar | Sibi | Khuzdar |
| Kot Addu | Ali Pur | Chishtian | Haroonabad | Kot Ghulam Mohammad | Digri | Rohri | Kurak | Khuzdar |
| 122 | 125 | 103 | 101 | 115 | 115 | 95 | 55 | 50 |

Table 4 presents the socioeconomic characteristic of farmers. It shows that average education, age, farming experience, and cotton cultivation experience were 5.59, 41.9, 22.6, and 20 years, respectively in the sample, while the average distance from a metaled road was 2.6 kilometres.

*Table 4: Socioeconomic Indicators of Cotton Producers*

| **Variables** | **Mean** | **St. Dev.** | **Min.** | **Max.** |
|---|---|---|---|---|
| Education (years) | 5.59 | 5.07 | 0 | 18 |
| Age (years) | 41.91 | 12.85 | 17 | 78 |
| Farming experience (years) | 22.66 | 12.85 | 1 | 60 |
| Cotton cultivation experience (years) | 19.98 | 13.42 | 1 | 60 |
| Distance to agricultural market (km) | 11.66 | 7.49 | 0 | 35 |
| Distance to city (km) | 11.33 | 7.54 | 1 | 35 |
| Distance to a metaled road (km) | 2.62 | 3.04 | 0 | 27 |

The data reveals that 22 per cent of the farmers were registered with the agriculture department and 35 per cent of the farmers received messages from the agriculture department through SMS. Only 15 per cent of the farmers received training regarding agricultural practices and 30 per cent of the farmers had access to loans (Table 5).

*Table 5: Access to Services*

| Services/Access | Yes | No |
|---|---|---|
| Registered with the agriculture department* | 22% | 78% |
| Farmer card* | 10% | 90% |
| Avail subsidy on fertilisers and seed | 11% | 89% |
| Subsidy on machinery | 2% | 98% |
| Receive SMS regarding farming services | 35% | 65% |
| Access to weather information | 46% | 54% |
| Training on cultivation practices | 15% | 85% |
| Training on cotton cultivation | 12% | 88% |
| Access to loan facilities | 30% | 70% |

**Only in Punjab*

The descriptive statistics show that access to water and extension services were major issues faced in cotton production, while high prices of fertilisers, seeds, and energy were other important factors reported. Similarly, the quality of seeds and pesticides were reported to be causing hindrances in cotton production (Table 6).

*Table 6: Farmer's Perceptions of Issues in Cotton Production*

| Factors | | Major Issue | Minor Issue | No Issue |
|---|---|---|---|---|
| Access to | Water | 63% | 20% | 18% |
| | Seed | 39% | 32% | 29% |
| | Fertilisers | 33% | 39% | 27% |
| | Pesticides | 39% | 33% | 27% |
| | Energy | 37% | 30% | 32% |
| | Machinery | 35% | 28% | 36% |
| | Labour | 14% | 31% | 54% |
| | Markets | 37% | 30% | 32%s |
| | Extension | 50% | 37% | 13% |
| | Weather information | 49% | 36% | 12% |

| | | | | |
|---|---|---|---|---|
| High price of | Seeds | 43% | 33% | 22% |
| | Fertilisers | 47% | 32% | 18% |
| | Pesticides | 54% | 27% | 16% |
| | Energy | 78% | 17% | 2% |
| | Machinery | 78% | 17% | 2% |
| | Labour | 33% | 32% | 32% |
| Quality issue of | Seeds | 73% | 19% | 5% |
| | Fertilisers | 53% | 22% | 21% |
| | Pesticides | 27% | 30% | 39% |
| | Machinery | 44% | 34% | 19% |

The average area, production, and yields of cotton, sugarcane, rice, and maize are reported in Table 8. It shows that in the sampled areas the average area of cotton and sugarcane was almost the same. The acr eage of rice (3.22) and maize (2.66) is reported in Table 7.

*Table 7: Area, Yield, and Revenue from Crops*

| Variables | Cotton | Sugarcane | Rice | Maize |
|---|---|---|---|---|
| Average area (acres) | 6.89 | 6.76 | 3.22 | 2.66 |
| Average yield (maunds) | 19.0 | 896 | 53 | 81 |
| Average output price (Rs./40kg) | 6,372 | 260 | 1,583 | 1,500 |
| Average production cost (without land rent) | 41,393 | 10,8579 | 52,563.58 | 65,673 |
| Average revenue | 119,364 | 234,432 | 115,751.5 | 117,000 |
| Average profit | 77,970 | 125,852 | 63,187.96 | 51,326 |

## Empirical Findings

### *Income Generated for Rural Labour from Various Crops*

To explore the contribution of the major crops to rural communities, per-hectare man-days required to perform various agricultural activities were taken. The activities, for example, include planting, weeding, spraying, and harvesting of a specific crop. Per-hectare man-days were multiplied with per-hectare labour charges of a specific activity per hectare to get per-hectare total labour income. The per-hectare labour income was then multiplied by the total land under cultivation of a specific crop to get the total income generated from that crop (Annexure 1). Table 9 shows that cotton generated Rs. 40,175/ha. in labour income and injected Rs. 100 billion into the rural economy, while rice generated Rs. 37,209/ha. of labour income and added Rs. 113 billion to the rural economy. Similarly, sugarcane generated Rs. 57,100/ha. in labour income and added Rs. 416 billion to the rural economy. The results show that the cotton crop adds a substantial labour per-hectare labour income over six months to the rural economy.

*Table 8: Income Generated by Rural Labour Engagement in Production Practices of Various Crops*

| | Labour charges (Rs./ha.) | Income to labour (Rs. Billion) |
|---|---|---|
| Cotton | 4,017 | 100.84 |
| Rice | 37,209 | 113.11 |
| Sugarcane | 57,099 | 416.68 |
| Maize | 25,529 | 37.74 |

*Author's calculation based on Government of Punjab, 2020 Statistics.*

***Competitiveness and Economic Efficiency of Major Crops under Export Parity Prices***

PAM developed by Monke & Pearson (1989) provides an important insight for analysing the competitiveness and efficiency of economic systems. It describes the degree of protection or (implicit) taxation resulting from a country's agriculture sector policies. These policies affect the input and output markets and trade of the sector.

*Table 9: Policy Analysis Matrix*

| Costs | | | | |
|---|---|---|---|---|
| Item | Revenue | Tradeable Inputs | Domestic Factors | Profit |
| Private prices | A | B | C | D |
| Social prices | E | F | G | H |
| Divergence | I | J | K | L |

Private profit measures the competitiveness of a given crop at given market prices. It is calculated as D = A – (B+C). A positive value shows that the crop under consideration is financially viable. Similarly, social profit for a given crop is calculated as H = (E-F-G). It shows the profit at social/economic prices of inputs and outputs and its positive sign indicates the viability of the crop.

The nominal protection coefficient (NPC) measures the protection provided to a crop. It is calculated as the ratio between A and E, i.e., dividing the total revenue calculated at actual market prices by the total revenue measured at social prices. When NPC > 1, it means that domestic production is protected and a value of NPC < 1 suggests implicit taxation on domestic producers.

The effective protection coefficient (EPC) evaluates the net effect of policy interventions in the inputs and output markets. It is measured by taking the ratio between the values added by a crop at private prices and social prices, i.e., (A – B)/(E- F). The EPC is interpreted similarly to the NPC.

The domestic resource cost (DRC) describes the ratio between the cost of domestic factors and value added at social prices of a crop, i.e., G/(E-F). If the value of DRC > 1, it shows that the country does not have a comparative advantage in the domestic production of that crop, while DRC < 1 shows that the country has a comparative advantage.

As discussed earlier, the NPC is the unit domestic price (DP) and the foreign price (PP) ratio, with both prices expressed in the national currency. The NPC of cotton, sugarcane, and rice are 1.02, 1.44, and 1.06, respectively. It shows that cotton was the least protected crop under the existing set of policies, while sugarcane was a highly protected crop. The level of protection of cotton among provinces was almost the same. However, sugarcane was more protected is Sindh as compared to Punjab. The rice crop was almost equally protected in Punjab and Sindh. The maize's NPC was 1.06. These results are similar to the estimates of Abdul & Sadia (2016). However, the protection of the sugarcane crop is found to be higher compared to previous studies (Quddus & Mustafa, 2011).

The effective protection coefficient (EPC) is the measure of private value added (PVA) compared to the social or economic value added. If the value of EPC is greater than one, it shows that the producers generate a value-added higher than under the optimal situation. Due to protection farmers are economically efficient, while the value of less than one shows that producers are implicitly taxed. Table 10 shows that cotton producers across Pakistan were implicitly taxed in Punjab (10 per cent) and Sindh (2 per cent), while sugarcane producers were implicitly subsidised to the tune of 63 per cent. However, maize producers had nominal protection of 2 per cent in implicit subsidies under the current set of policies. The rice growers were found to be neither implicitly taxed nor subsidised. In the case of sugarcane, it is quite evident from the EPC value greater than 1 that the domestic growers enjoyed huge protection as the prices they received were much higher than the corresponding economic prices worked back from export prices. Though, for cotton, rice, and sugarcane, the results of this study are similar to the previous studies (Quddus & Mustafa, 2011; Abdul & Sadia, 2016), the results show that the EPC for maize had increased over time as compared to previous reported results, due to which, maize cultivation area has significantly increased over time (Hasnain et al., 2014).

The domestic resource cost (DRC) is an indicator of the opportunity cost of the domestic resources and the social value added per unit of a crop. A country has a comparative advantage in the product under consideration if the value of DRC is lower than one and vice versa. The results show that DRC for cotton, sugarcane, rice, and maize were 0.44, 1.05, 0.49 and 0.34, respectively. Pakistan had a comparative advantage in the production of all crops except sugarcane production in Punjab. In this scenario, sugarcane had a higher DRC which means it consumed Rs. 1.05 of domestic resources to produce output worth about Rs. 1. The DRCs of cotton were found to be 0.44, 0.66, 0.28 and 0.34 for Pakistan, Punjab, Sindh, and Balochistan, respectively. It shows that by consuming Rs. 0.44, the farmers produced cotton worth Rs. 1. It further shows that Sindh had a higher comparative advantage in producing cotton, while Punjab had a lower comparative advantage in cotton production. On the other hand, maize had the least DRC, which means that it had a higher comparative advantage as compared to other crops in Punjab. These results are similar to the results of Hasnain et al. (2014).

*Table 10: Estimates of Policy Analysis Matrix*

| Economic Efficiency | Region | Cotton | Sugarcane | Rice | Maize |
|---|---|---|---|---|---|
| NPC | Pakistan | 1.02 | 1.44 | 1.06 | - |
| | Punjab | 1.00 | 1.40 | 1.06 | 1.08 |
| | Sindh | 1.00 | 1.49 | 1.05 | - |
| | Balochistan | 1.04 | - | - | - |
| EPC | Pakistan | 0.98 | 1.63 | 1.00 | - |
| | Punjab | 0.90 | 1.60 | 1.18 | 1.02 |
| | Sindh | 0.97 | 1.66 | 1.08 | - |
| | Balochistan | 1.00 | - | - | - |
| DRC | Pakistan | 0.44 | 1.05 | 0.49 | - |
| | Punjab | 0.66 | 1.33 | 0.71 | 0.49 |
| | Sindh | 0.28 | 0.80 | 0.37 | - |
| | Balochistan | 0.34 | - | - | - |

## Crop Water Productivity

Water is an integral input in agriculture as it is important to ensure nutrients' availability to crops. The whole world is water-dependent and facing the challenge of water shortage. Pakistan is also among the countries that are facing a severe shortage of water due to climatic changes. Thus, measuring water productivity (WP) can offer important insights for policymakers to design and support future cropping decisions of farmers. Water use productivity measures how a crop converts water into biomass or grains. It is the ratio of beneficial output to actual water consumed. It can be measured as:

$$WP = \frac{Grain\ yield\ ({}^{kg}/_{ha})}{Volume\ of\ applied\ water\ ({}^{m^3}/_{ha})}$$

The reported economic value of irrigation water per MAF (Figure 1) was the highest for sugarcane followed by cotton (175 million USD). Table 11 shows the results of crop water productivity. However, to make the results more meaningful, the revenue generated from per cubic meter of water consumption was also calculated. It measures how the resulting economic benefits define the importance of crops in terms of water usage. The results show that rice, cotton, and sugarcane generated Rs. 14.19, Rs. 11.07, and Rs. 7.98, respectively, per cubic meter of water usage in Punjab. It shows that cotton was more productive in terms of converting water into economic benefits. However, in the case of Sindh, rice and sugarcane generated more economic value as compared to cotton.

*Figure 2: Economic Value of Irrigation Water Per MAF (USD Million)*

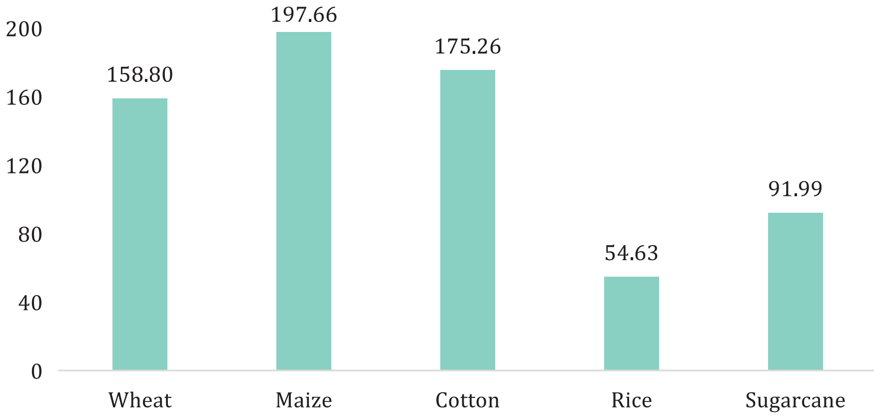



*Table 11: Water Productivity of Crops*

| Province | Cotton | | Sugarcane | | Rice | |
|---|---|---|---|---|---|---|
| | CWP | Rev./m3 | CWP | Rev./m3 | CWP | Rev./m3 |
| Punjab | 0.10 | 14.19 | 1.80 | 11.07 | 4.72 | 7.98 |
| Sindh | 0.14 | 20.84 | 4.28 | 28.08 | 18.84 | 30.05 |
| Balochistan | 0.04 | 7.4 | _ | _ | _ | _ |

***Determinants of Change in Area under Cotton Production***

To investigate the factors influencing the adoption of various strategies for deciding the area under cotton cultivation, a multivariate ordered probit model was employed which can be mathematically expressed as:

$$y_i^* = X^T + \varepsilon_{\square} \quad (1)$$

$y_i$* is an indicator of cotton area cultivation strategies, $x_{\square}$ represents the factors affecting the cropping decisions, and ε is the residual term. Although $y_i$* is an unobservable latent variable, but a series of observable ordered series are as follows:

$$y_i = F(y_i^*) = \begin{cases} 0 \; if \; y^* \leq 0, \\ 1 \; if \; 0 < y^* \leq u_1 \\ 2 \; if \; u_1 < y^* \leq u_2 \\ \vdots \\ N \; if \; u_{N-1} < y^* \end{cases} \quad (2)$$

In Equation (2), $y_i$ is a discrete array { 1, 2, ..., N}, indicating the cropping area decisions of the ith farmer, $0 < u_1 < u_2 < ... < u_N$ is the cut-point parameter to be estimated, and y is divided into N intervals.

Here the latent variable represents y = 0 if the farmers had decreased their cotton area in 2021 as compared to 2015, y = 1 if the area remained the same, and y = 2 if the acreage had increased. Table 12 gives the summary statistics for the dependent variable statistics and it further shows that, on average, 18 per cent of the area under cotton cultivation had decreased since 2015.

*Table 12: Changes in the Cotton Area Under Cultivation*

| | | y=0 | y=1 | y=2 |
|---|---|---|---|---|
| Average Cotton Area in 2015 (Acres) | Average Cotton Area in 2021 (Acres) | % of farmers whose area decreased<br>Y=0 | % of farmers whose area remained unchanged | % of farmers whose area increased |
| 8.41 | 6.89 | 35% | 36% | 29% |

The coefficients of the ordered probit model in Table 13 show that in Punjab the likelihood to increase/unchanged in the area under cotton cultivation decreased by 25 per cent as compared to the base category (Balochistan). Similarly, a one unit increase in education, cotton growing experience, and off-farm work reduced the likelihood of being a part of the strategies to keep the area under cotton cultivation constant or expand it. Moreover, access to weather information, labour, training and pest-resistant varieties, were major problems for farmers reducing the likelihood of expanding or keeping the area under cotton production constant. The probability of increasing or keeping the cotton area constant decreased by 24 per cent if the farmers were sugarcane growers.

On the other hand, a one-unit increase in the number of adult family members, cotton growing experience, distance to the city, extension visits, land area, and the number of cotton varieties increased the likelihood to expand or keep the cotton area constant. In this case, high prices of pesticides and seed quality were major issues that reduced the likelihood to increase/keep the cotton area constant by 11 per cent and 12 per cent, respectively.

*Table 13: Estimates of Ordered Probit Model With Marginal Effects*

| | **Ordered Probit Estimates** | | **Marginal Effects (Entire Sample)** | |
|---|---|---|---|---|
| | Coef. | Std. Err. | dy/dx | Std. Err. |
| Punjab Province | -0.916*** | 0.185 | 0.251*** | 0.043 |
| Sindh Province | -0.156 | 0.211 | 0.036 | 0.048 |
| Socioeconomic Factors | | | | |
| Education | -0.017* | 0.009 | 0.005* | 0.003 |

| | | | | |
|---|---|---|---|---|
| Adult Family Members | 0.061** | 0.0247 | -0.018** | 0.007 |
| Experience of Cotton Growing | -0.007* | 0.003 | 0.002* | 0.001 |
| Distance to City | 0.015*** | 0.005 | -0.005*** | 0.002 |
| Extension Visits | 0.0228*** | 0.008 | -0.007*** | 0.002 |
| Access to Weather Information | 0.237** | 0.099 | -0.069** | 0.029 |
| Access to Loan | 0.201* | 0.108 | -0.058* | 0.031 |
| Off-Farm Work | -0.300*** | 0.111 | 0.087*** | 0.032 |
| Area (Acres) | 0.005* | 0.002 | -0.001* | 0.001 |
| Cultivating Sugarcane | -0.770*** | 0.279 | 0.240*** | 0.088 |
| Cotton Varieties | 0.262*** | 0.051 | -0.076*** | 0.014 |
| Soil Fertility | -0.069 | 0.095 | 0.020 | 0.028 |
| Access to Service as Major Issues | | | | |
| Weather Information | -0.334*** | 0.107 | 0.097*** | 0.031 |
| Seed | 0.341*** | 0.105 | -0.099*** | 0.030 |
| Pesticides | -0.141 | 0.099 | 0.041 | 0.029 |
| Labour | -0.694*** | 0.113 | 0.201*** | 0.031 |
| Training | -0.093 | 0.094 | 0.027 | 0.027 |
| Drought Resistant Varieties | -0.036 | 0.108 | 0.011 | 0.031 |
| Pest Resistant Varieties | -0.242** | 0.109 | 0.070** | 0.031 |
| High Prices as a Major Issue | | | | |
| High Prices of Pesticides | -0.394*** | 0.113 | 0.114*** | 0.033 |
| Quality of Inputs as a Major Issue | | | | |
| Seed | -0.421*** | 0.107 | 0.122*** | 0.031 |
| Pesticides | 0.158 | 0.110 | -0.046 | 0.032 |
| /cut1 | -1.078 | 0.259 | | |
| /cut2 | 0.052 | 0.257 | | |
| Number of observations | 779 | | | |

| | | | |
|---|---|---|---|
| Prob > $chi^2$ | 0.000 | | |
| Pseudo $R^2$ | 0.157 | | |
| p-value: #p < 0.10; *p < 0.05; **p < 0.01; ***p < 0.001 | | | |

The marginal effects of the ordered probit models by categories show that farmers in Punjab had a likelihood of 31 per cent to reduce the cotton area as compared to farmers in Balochistan (Table 14). A one-unit increase in education and experience reduced the likelihood of increasing the acreage by 0.6 per cent and 0.3 per cent, respectively. Similarly, off-farm work and sugarcane cultivation reduced the likelihood of increasing the cotton area by 10 per cent and 19 per cent, respectively. Access to weather information, labour, pesticides, pest-resistant varieties, high prices of pesticides, and seed quality were found to be major issues and reduced the expansion of cotton area by 11 per cent, 23 per cent, 8 per cent, 13 per cent, and 14 per cent, respectively.

*Table 14: Marginal Effects of Individual Categories*

| | **Y=0 (Area Decreased)** | **Y=1 (Area Unchanged)** | **Y=2 (Area Increased)** |
|---|---|---|---|
| | Coef. | Coef. | Coef. |
| Punjab Province | 0.294*** | 0.020 | -0.314*** |
| Sindh Province | 0.037 | 0.024 | -0.062 |
| Socioeconomic Factors | | | |
| Education | 0.006* | 0.001 | -0.005* |
| Adult Family Members | -0.021** | 0.002 | 0.019** |
| Experience of Cotton Growing | 0.002* | 0.000 | -0.003** |
| Distance to City | -0.005** | 0.001 | 0.004*** |
| Extension Visits | -0.008** | 0.002 | 0.006*** |
| Access to Weather Information | -0.081** | 0.007 | 0.081** |
| Access to Loan | -0.067* | -0.002 | 0.070* |
| Off Farm-Work | 0.103* | -0.001 | -0.101*** |
| Area (Acres) | -0.002** | 0.003 | 0.002* |
| Cultivating Sugarcane | 0.295*** | -0.098* | -0.197*** |
| Cotton Varieties | -0.090*** | 0.001 | 0.089*** |
| Soil Fertility | 0.024 | -0.001 | -0.023 |

| | | | |
|---|---|---|---|
| Access to Services as a Major Issue | | | |
| Weather Information | 0.115*** | -0.002 | -0.113*** |
| Seed | -0.117*** | 0.002 | 0.115 |
| Pesticides | 0.049 | -0.001 | -0.048 |
| Labour | 0.238*** | -0.003 | -0.234*** |
| Training | 0.032 | 0.003 | -0.032 |
| Drought Resistant Varieties | 0.013 | 0.005 | -0.012 |
| Pest Resistant Varieties | 0.083** | -0.001 | -0.082** |
| High Prices as a Major Issue | | | |
| High Prices of Pesticides | 0.135*** | -0.002 | -0.133*** |
| Quality of Inputs as a Major Issue | | | |
| Seed | 0.145*** | -0.002 | -0.142*** |
| Pesticides | -0.055 | 0.003 | 0.052 |

Based on the regression results reported above, 90 per cent of farmers had shown a willingness to pay additional Rs. 722 per kg for quality seeds, while 84 per cent of the farmers were reported to pay an additional Rs. 1,110 per litre of quality pesticides. Similarly, 59 per cent of farmers showed their willingness to pay for access to weather information. These findings support the regression estimates.

*Table 15: Farmers' Willingness to Pay for Cotton Cultivation*

| **Inputs/ factors** | **Yes** | **Payment/ Additional Payment* (Rs.)** |
|---|---|---|
| Quality Seed (New and resistant varieties) | 90% | 722/kg* |
| Quality pesticides/ weedicides | 84% | 1,110/litre.* |
| Weather information | 59% | 26/month |
| Market information | 49% | 23/month |
| Cotton picking technology | 50% | 623/maund. |
| Watercourses | 85% | - |

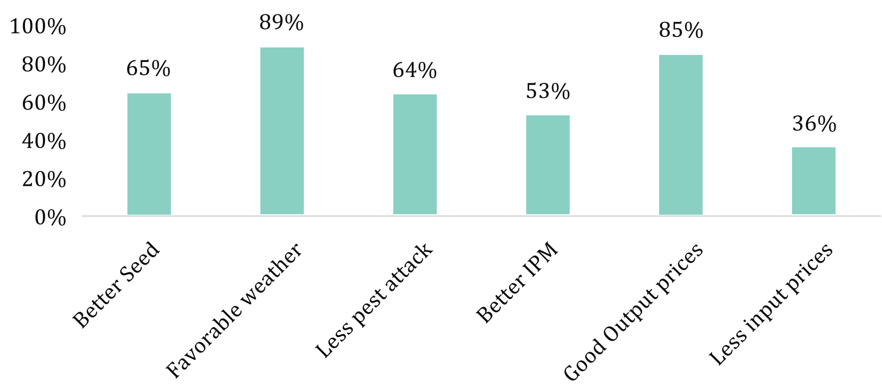
Table 16 presents the farmers' responses regarding various policy interventions. The availability of water, low-cost energy, and pest/insect-resistant varieties were found to be important factors to enhance the cotton area under cultivation.

*Table 16: Farmers' Willingness to Cultivate Additional Acres of Crop in Response to Various Policy Interventions in the Cotton Sector*

| How many additional acres will be cultivated if | Cotton | Rice | Maize | Sugarcane |
|---|---|---|---|---|
| Govt. Subsidizes fertilizer | 3.90 | 0.03 | 0.02 | 0.77 |
| Govt. Subsidizes energy | 4.32 | 0.07 | 0.02 | 0.79 |
| Govt. Subsidizes pesticides/ insecticides/ weedicides | 3.79 | 0.04 | 0.10 | 0.80 |
| Pest and insect-resistant varieties are introduced | 3.79 | 0.04 | 0.10 | 0.80 |
| Water availability is enhanced | 4.49 | 0.23 | 0.07 | 1.57 |
| Training and extension services are provided properly | 3.85 | 0.07 | 0.08 | 0.98 |
| Crop insurance is introduced | 4.00 | 0.11 | 0.05 | 1.14 |

During 2020, farmers reported good production of the cotton crop. Major factors responsible for good yield were favourable weather conditions and less fluctuation in the output market. Similarly, the availability of better-quality seeds also played an important role.

*Figure 3: Causes of the Better Yield of Cotton – Reported by Farmers*



# 5. CONCLUSION AND RECOMMENDATIONS

Cotton plays an important role in the national economy by providing raw materials to export-oriented industries and employment to the rural population by providing Rs. 100 billion in terms of payments to labour. However, during the last decade, the area under cotton has declined to nearly 18 per cent. It has posed a threat to the provision of raw materials for industry and also resulted in reduced employment opportunities for rural labour, especially women. Similarly, Pakistan may lose well-experienced cotton growers if the trend continues. By keeping in view the challenges, the current study adopted a holistic approach to evaluating the economic importance of cotton and its competing crops for rural communities, and their competitiveness and profitability under the current set of policies. It also evaluated the crop water productivity of these crops to evaluate the economic value of produce in terms of water usage. Furthermore, the determinants of changes in the area under cotton cultivation to establish the major reasons for changing cropping patterns were investigated.

The results show that the cotton crop has been injecting more income to rural communities (labour) per hectare per six months (Rs. 40,175) as compared to sugarcane (Rs. 28,549), rice (Rs. 37,209) and maize (Rs. 25,529). Despite this fact, PAM shows that it is the least protected major crop in terms of the NPC under the prevailing scenario. In addition, the EPC show that cotton growers are implicitly taxed at 2 per cent, while maize and sugarcane growers are implicitly subsidised by 2 per cent and 63 per cent, respectively. However, rice growers are neither protected nor taxed. The results show that cotton growers received maximum protection of 4 per cent in the Balochistan region, however, they are implicitly taxed at 10 per cent in Punjab but receive no protection in this major cotton zone.

The DRC show that cotton has a comparative advantage as compared to sugarcane and rice. One unit of cotton was produced by the growers by consuming Rs. 0.44, while sugarcane growers produced one unit by consuming Rs. 1.05. Likewise, in terms of revenues per cubic meter of water used, the cotton crop generated Rs. 14.19 per cubic meter of water while sugarcane and rice produced Rs. 11.07 and Rs. 7.98 per cubic meter of water used, respectively.

Despite enjoying comparative and economics advantages, the area under cotton cultivation has been decreasing, especially in Punjab. Various determinants of changing cropping areas were explored. It was observed that in Punjab, the likelihood of a decrease in the cotton area was 31 per cent. The experience of growing cotton and off-farm activities also reduced the likelihood of increased cotton area, which shows that experienced farmers are quitting the cultivation of the cotton crop in Punjab. Similarly, poor access to weather information, labour, and pest-resistant varieties are significant factors that lead to a reduction in cotton area. High pesticide prices and unavailability of quality seeds were other significant determinants of decreasing cotton area.

An analysis of the farmers' willingness to pay to increase the cotton area shows that 90 per cent of the farmers were willing to pay additional Rs. 722 per kilogram for quality seeds and 84 per cent of farmers expressed their willingness to pay Rs. 1,110 per litre of quality pesticides. Similarly, farmers also expressed their willingness to pay for access to weather information, market information, and cotton-picking technologies to overcome the labour shortage. If the provision of the above-mentioned important services to farmers is ensured, they expressed their willingness to increase the area of cotton, rice, maize, and sugarcane by 4.02, 0.08, 0.06 and 0.98 acres, respectively.

Considering these findings, it is suggested that by improving access to better extension services, weather information, and quality seeds and pesticides, government entities can revitalise the cotton crop in the country. It can be carried out through the development of a centralised efficient and trust-worthy database/mechanism using modern and smart technologies to provide trustworthy information to policymakers and farmers. Likewise, investment in the provision of SMART extension services, decision support tools, and market information in a desired format can effectively be used for making better management decisions for crop production and reducing supply-chain inefficiencies. Moreover, to overcome the issue of labour, investment in modern agricultural technologies, especially cotton picking machines, can increase not only the area but also the production of quality cotton in the country. The private sector, especially industrial involvement in R&D initiatives through institutional arrangements, can provide solutions to these problems. As water shortage and pest attacks are the main issues, climate-resilient agricultural practices through comprehensive plans are a need of the time. In the case of cotton, stability in output prices could greatly improve the farmers' trust in cotton production. Moreover, by exploring and targeting new potential areas for cotton production, for example in Balochistan, the production of the cotton crop can be enhanced. This can be achieved by strengthening the linkages among farmers, academia, and industry as cotton still has a comparative advantage over its competing crops.

## REFERENCES

Abdul, S., & Sadia, T. (2016). Economic Efficiency and Distortions to Incentives in Production of Cotton and Rice Crops in Punjab. *NUST Journal of Social Science and Humanities,* 2(1), 29–49.

Abro, A. A., & Awan, N. W. (2020). Comparative Analysis of Profitability of Major and Minor Crops in Pakistan. *Journal of the Saudi Society of Agricultural Sciences,* 19(7), 476–481. https://doi.org/10.1016/j.jssas.2020.09.001

Anwar, T., Qureshi, S. K., & Ali, H. (2005). Landlessness and Rural Poverty in Pakistan. *The Pakistan Development Review Part II,* 43(4), 855–874.

Aslam, M. (2016). Agricultural Productivity Current Scenario, Constraints and Future Prospects in Pakistan. *Sarhad Journal of Agriculture,* 32(4), 289–303. https://doi.org/10.17582/journal.sja/2016.32.4.289.303

Caviglia, J. L., & Kahn, J. R. (2001). Diffusion of Sustainable Agriculture in the Brazilian Tropical Rain Forest: A Discrete Choice Analysis*. *Economic Development and Cultural Change,* 49(2), 311–333. https://doi.org/10.1086/452504

ELsamie, M. A., Ali, T., & Eliw, M. (2020). Impact of Agricultural Policies on the Egyptian Cotton Sector Using Policy Analysis Matrix. *Asian Journal of Economics, Business and Accounting, May*, 50–59. https://doi.org/10.9734/ajeba/2020/v15i130207

Fang, C., & Babcoc, B. A. (2003). *China's Cotton Policy and the Impact of China's WTO Accession and Bt Cotton Adoption on the Chinese and U.S. Cotton Sectors.* http://www.card.iastate.edu/publications/dbs/pdffiles/03wp322.pdf

GOP. (2019). *Pakistan Economic Survey 2018-19*. https://www.finance.gov.pk/

GOP. (2020). *State of Pakistan's Climate in 2020.*

GOP. (2021). *Economic Survey of Pakistan 2020-21*. https://www.finance.gov.pk/survey/chapters_21/16-Climate change.pdf

GOP, G. of P. (2018). *Pakistan Economics Survey-2017-18.*

Gürer, B., Türkekul, B., Ören, M. N., Abay, C., & Özalp, B. (2017). The Impact of Turkish Agricultural Policy on Competitiveness of Cotton Production. *International Journal of Food and Beverage Manufacturing and Business Models,* 2(1), 20–30. https://doi.org/10.4018/ijfbmbm.2017010102

Hasnain, S., Akhtar, W., & Akmal, N. (2014). Competitiveness of Maize crop in Pakistan. *Maize for Food, Feed, Nutrition and Environmental Security, October,* 475.

ICAC. (2020). *Cotton Vision 2030: Vol. XXXVIII* (Issue 4). https://doi.org/https://icac.org/Content/PublicationsPdf%20Files/0af264f4_67ee_47c4_98f2_8df5d02693d4/RECORDER-December-2020-V1.pdf.pdf

Kannapiran, C. A., & Fleming, E. M. (1999). Competitiveness and Comparative Advantage of Tree Crop Smallholdings in Papua New Guinea by Chinna A . Kannapiran and Euan M . Fleming. *Agricultural and Resource Economics*, *February,* 1–40.

Kennedy, P. L., Harrison, R. W., & Piedra, M. A. (1998). Analyzing agribusiness competitiveness: The case of the United States sugar industry. *International Food and Agribusiness Management Review,* 1(2), 245–257. https://doi.org/10.1016/s1096-7508(99)80038-x

Khan, M., & Damalas, C. A. (2015). Farmers' knowledge about common pests and pesticide safety in conventional cotton production in Pakistan. *Crop Protection,* 77, 45–51. https://doi.org/10.1016/j.cropro.2015.07.014

Macdonald, S., Gale, F., & Hansen, J. (2016). *Cotton Policy in China* (Issue 70863).

Mohanty, S., Fang, C., & Chaudhary, J. (2003). Assessing the competitiveness of Indian cotton production: A policy analysis matrix approach. *Journal of Cotton Science,* 7(3), 65–74.

Monke, E. A., & Pearson, S. R. (1989). *The Policy Analysis Matrix for Agricultural Development Outreach Program.* Cornell University Press.

Najafi, B. (2005). Effects of government policies on wheat production in Iran: the application of policy matrix analysis. *Economic Research Forum, 12th Annual Conference*.

Nelson, G. C., & Panggabean, M. (2011). *Matrix Policy: Approach Analysis.* 73(3), 703–712.

Pahle, M., Pachauri, S., & Steinbacher, K. (2016). Can the Green Economy deliver it all? Experiences of renewable energy policies with socio-economic objectives. *Applied Energy,* 179(642147), 1331–1341. https://doi.org/10.1016/j.apenergy.2016.06.073

Quddus, M., & Mustafa, U. (2011). Comparative Advantage of Major Crops Production in Punjab: An Application of Policy Analysis Matrix. *The Lahore Journal of Economics,* 16(1), 63–94. https://doi.org/10.35536/lje.2011.v16.i1.a3

Sadiq, M. S. (2015). Impact of India's Economic Policies on Cotton Production vis-à-vis Comparison between Pre-Economic Liberalization Policy Period and Economic Liberalization Policy Period. *Agro-Economist,* 2(1), 57. https://doi.org/10.5958/2394-8159.2015.00010.9

Salam, A. (2012). *Review of Input and Output Policies for Cereal Production in Pakistan* (Issue July).

Salam, A., & Tufail, S. (2016). Economic Efficiency and Distortions to Incentives in Production of Cotton and Rice Crops in Punjab. *NUST Journal of Social Sciences and Humanities,* 2(1), 29–49.

Suresh, A., Josily, S., Shwetal, W., & P., R. (2014). Cotton Cultivation in India Since the Green Revolution: Technology, Policy, and Performance. *Review of Agrarian Studies,* 4(2). http://ras.org.in/cotton_cultivation_in_india_since_the_green_revolution

UNDP, & GOP. (2021). *Youth and Climate Change Perception*.

Wang, W., Zhang, C., Song, J., & Xu, D. (2021). The impact of target price policy on cotton cultivation: Analysis of county-level panel data from china. *Agriculture (Switzerland),* 11(10), 1–18. https://doi.org/10.3390/agriculture11100988

Wei, W., Mushtaq, Z., Ikram, A., Faisal, M., Wan-Li, Z., & Ahmad, M. I. (2020). Estimating the Economic Viability of Cotton Growers in Punjab Province, Pakistan. *SAGE Open,* 10(2). https://doi.org/10.1177/2158244020929310

Williams, D. (2010). Industrial policy. *Local Economy,* 25(8), 612–621. https://doi.org/10.1080/02690942.2010.533425

Zulfiqar, F., & Thapa, G. B. (2018). Determinants and intensity of adoption of "better cotton" as an innovative cleaner production alternative. *Journal of Cleaner Production*, 172, 3468–3478. https://doi.org/10.1016/j.jclepro.2017.09.024

# ANNEXURE A

*Table 1. Income Generated by Rural Labour Engaged in Cotton Production*

| NO. | Activity | (1) Labour employed (Man days/ha @550/day) | (2)=(1)*550 Labour charges (Rs./ha) | (3)=(1)*(2.51 M ha) Labour man days (Million) | (4)=(2)*(2.51 M ha) Income of labour (Rs. Billion) |
|---|---|---|---|---|---|
| 1 | Planting | 8 | 3,600 | 20.1 | 9.036 |
| 2 | Weeding | 10 | 4,500 | 25.1 | 11.295 |
| 3 | Spraying | 6 sprays with 15 man-days | 6,750 | 37.65 | 16.943 |
| 4 | Picking | 50 pickers @Rs.480/40 kg/picker | 25,325* | 125.5 | 63.566 |
| | Additional Total | | 40,175 | 208.35 | 100.84 |

**Calculated as Rs. 480*52.76 md/ha yield of seed cotton*
*Source: Authors' calculations based on Govt. of Punjab, 2020*

*Table 2. Income Generated by Rural Labour Engaged in Rice Production*

| NO. | Activity | (1) Labour employed (Man days/ha @550/day) | (2)=(1)*550 Labour charges (Rs./ha) | (3)=(1)*(3.04 M ha) Labour man days (Million) | (4)=(2)*(3.04 M ha) Income to labour (Rs. Billion) |
|---|---|---|---|---|---|
| 1 | Planting | 12 | 6,600 | 36.48 | 20.064 |
| 2 | Weeding | 4 | 2,200 | 12.16 | 6.688 |
| 3 | Spraying | 4 sprays with 10 man-days | 5,500 | 30.4 | 16.72 |
| 4 | Harvesting | 21 man-days @Rs.550/hectare | 22,909* | 63.84 | 69.645 |
| | Additional Total | | 37,209 | 142.88 | 113.117 |

**Calculated as Rs. 280 *81.82 md/ha yield of rice*
*Authors' calculations based on Govt. of Punjab, 2020)*

*Table 3. Income Generated by Rural Labour Engaged in Maize Production*

| NO. | Activity | (1) Labour employed (Man days/ha @550/day) | (2)=(1)*550 Labour charges (Rs./ha) | (3)=(1)*(1.40 M ha) Labour man days (Million) | (4)=(2)*(1.40 M ha) Income to labour (Rs. Billion) |
|---|---|---|---|---|---|
| 1 | Planting | 8 | 4,400 | 11.2 | 6.160 |
| 2 | Weeding | 2.47 | 1,359 | 3.5 | 1.902 |
| 3 | Spraying | 4 sprays with 9-man-days | 4,950 | 13 | 6.930 |
| 4 | Harvesting | 21 man-days @Rs.550/hectare | 14,820* | 29.4 | 20.748 |
| | Additional Total | | 25,529 | 57.1 | 35.74 |

**Calculated as Rs. 100 *148.2 md/ha yield of maize*
*Authors' calculations based on Govt. of Punjab, 2020*

*Table 4. Income Generated by Rural Labour Engaged in Sugarcane Production*

| NO. | Activity | (1) Labour employed (Man days/ha @550/day) | (2)=(1)*550 Labour charges (Rs./ha) | (3)=(1)*(6.01 M ha) Labour man days (Million) | (4)=(2)*(6.01 M ha) Income to labour (Rs. Billion) |
|---|---|---|---|---|---|
| 1 | Planting | 16 | 8,800 | 96.16 | 52.89 |
| 2 | Weeding | 2.47 | 1,359 | 14.85 | 81.68 |
| 3 | Spraying | 4 sprays with 9 man-days | 4,950 | 54.09 | 29.75 |
| 4 | Harvesting | 21 man-days @Rs.550/hectare | 41,990* | 126.21 | 252.36 |
| | Additional Total | | 57,099 | 291.31 | 416.68 |

**Calculate as Rs. 25 *1679.6 md/ha yield of sugarcane*
*Authors' calculations based on Govt. of Punjab, 2020)*

# ANNEXURE B

## Report of Focus Group Discussion with Farmers (Jamshoro-Sindh), 30 June 2022

A focus group discussion (FGD) was held on 30 June 2022 at the United States-Pakistan Centre for Advanced Studies (USP-CAS) Auditorium on water, Mehran University of Engineering and Technology, Jamshoro, Sindh. In the said FGD, nine participants, including one professor of extension from Sindh Agriculture University, one extension officer, and seven farmers participated. Dr Sami Ullah Ullah, Co-PI of the project, served as the moderator of the discussion, while Mr Abd Ur Rehman, Lecturer, Agribusiness at the MNS University of Agriculture Multan documented the outcomes of the discussion. The participants were the residents of Malwa distributary in Qazi Ahmad (a town situated between Hyderabad and Sukkur). Mixed responses were recorded regarding the land holdings: owned and contractual, the cost of production, yield, and major issues in cotton production and its competing crops. As farmers were growing the cotton crop along with sugarcane, wheat, rice, and other crops, therefore, discussion about challenges and concerns about cotton production were discussed in detail. The discussion was based on different open-ended questions. Participates were allowed to express their views in verbal form. At the end of the discussion, after each question, experts were asked to give their opinion regarding the points raised by the farmers.

On average the respondents grew cotton on approximately four acres and sugarcane on two acres of land. However, in Sindh, the farmers reported, on average, less than half an acre decrease in cotton area since 2015. The average experience of cultivating cotton among the participants was 16 years, while the average family size was 6 family members. The majority of the farmers were contractual farmers (Hari), however, two farmers also had their own land.

The question-wise discussion was as follows:

### 1. Why is growing cotton important for you?

Cotton is under cultivation in Sindh for a long time, there is a relatively good market for cotton and farmers have experience in growing cotton. Another important point is that the cotton output is sold gradually steps which supports the farmers for three to four months, while other crops are sold at once. Moreover, family labour, especially females, are involved in cotton growing and they also earn money. As compared to cotton, the other Kharif crops, especially rice, have much higher water requirements, which is the most scarce resource. Moreover, after cotton, the farmers can cultivate wheat, which is a staple diet.

### 2. What major issues do farmers face while getting the inputs and dispensing the output?

In the case of inputs, there are several issues, such as accessibility, prices, and quality. Though seeds are easily available but getting quality seeds is very hard. Soaring prices of energy, fertilisers, and pesticides is making it difficult to meet the requirements of the cotton crop in time. The majority of the farmers get inputs on loans from shopkeepers who charge much higher interest rates, even as high as 40 per cent of the actual price, which squeezes the farmers' profits. Getting loans from banks is a cumbersome process. Moreover, higher interest rates make it unfeasible for farmers to get loans for inputs. As far as the prices of cotton are concerned, volatility in prices creates uncertainty for cotton growers. Whenever the prices of cotton go down at the cotton picking time, farmers reduce the use of inputs, which ultimately leads to poor yield. Stability in cotton prices is much needed as in the case of wheat.

**3. What are the major issues related to access to water?**

The availability of canal water is mentioned as another important issue, especially for small farmers, who get canal water after 15 days. In many areas, underground water is not suitable, which makes it difficult to grow cotton, while the higher cost of energy makes it difficult to fulfil the water requirements from other sources.

**4. How does the extension department facilitate the farmers?**

Extension workers visit the farmers not so often and in majority of the cases sales agent of private companies visit farmers. However, their main focus is to sell their products. Farmers were of the view that cotton is a sensitive crop and regular technical support is needed to combat the threats.

**5. What are the major issues in picking cotton?**

Due to cotton varieties that mature early, cotton picking is carried out in extreme summer weather. The availability of labour for picking is a severe problem, due to which the cost of labour has been increasing every year. Therefore, cotton-picking technologies, tailored to the needs of small farmers, are much needed.

**6. How would you compare cotton to its competing crops in terms of challenges and opportunities?**

Though cotton is a good crop in terms of benefits, such as yield in phases, income for rural labour, especially female labour, fuel for the kitchen, and lint for home use. However, it is a very sensitive crop. It immediately gets affected by minor changes in weather, such as more rain or less availability of water. On the other hand, sugarcane is a resilient strong crop which can withstand vagaries of weather for up to two weeks or even a month. Even though sugarcane's yield decreases but the whole crop does not get damaged like cotton. But the sugarcane crop takes almost a year to mature and small farmers do not have the resources to feed a crop for a long year. That is why a mix of crops is preferred by farmers.

**7. How can farmers be assisted to overcome the challenges in cotton production?**

The majority of the farmers were of the view that on-time availability of inputs, especially water, can enhance cotton production. Another important thing is the availability of good quality and variety of seeds since current seeds cannot resist diseases and cope with weather fluctuations. Moreover, better extension services and cotton picking technology are important to reduce the constraints on cotton production.

These findings were validated by the experts in the discussion group.

## Report of the Focus Group Discussion on Cotton: Policy Perspective and Planning, January 06, 2022

The FGD was held at the MNS University of Agriculture Multan. Although South Punjab is the hub of cotton production in Pakistan, due to climate change and the intrusion of competing crops, the cotton area and production are on the decline. To revive cotton production in main cotton growing regions and in other zones where it can be grown efficiently, a comprehensive and holistic approach is required. The said consultative session was organised to take the expert opinion of all stakeholders along the cotton value chain and the concerned government institutions. The session was attended by 15 participants who were members of the extension department, academia, research institutions, industry, and farming communities. In addition, one member from the Shahid Javeed Burki Institute of Public Policy (BIPP) and one from the Asian Disaster Preparedness Centre (ADPC) also participated.

Prof. Dr Irfan Ahmed Baig, Dean, Faculty of Social Science and Humanities, and PI of the study opened the house for discussion and highlighted the importance of reviving the cotton crop in Pakistan through viable policy options. He said that globally many economies are protecting cotton growers and value chains through policy interventions to sustain cotton protection and enhance environmental protection. Therefore, developing a comprehensive policy framework by learning from stakeholders is required to revive cotton production in the region.

Mr Shahid Najam, Vice President of the Burki Institute of Public Policy (BIPP), said that to promote an agriculture-based policy framework, evidence-based policy recommendations are needed for an inclusive development paradigm. Unfortunately, the policy and institutional frameworks in our country have been characterised by fragmentation. He said that under changing climatic conditions robust, implementable, and comprehensive policy framework is required to increase agricultural production. He outlined the salient features of the policy framework:

1. A policy framework for climate resilient/climate-smart agriculture and livestock.
2. Climate-smart production to reduce greenhouse gas emissions.
3. National policy framework for climate-smart cotton production system or other viable options to ensure food security and farmers' profitability.

Prof. Dr Asif Ali Khan, Vice Chancellor, MNS University of Agriculture, Multan, said that there is a strong realisation at the governmental level to revive cotton production in South Punjab. However, a comprehensive policy framework has not been achieved yet. He said that to enhance the area under cotton production, it is necessary to enhance cotton yield for which new modern varieties of cotton are required. He endorsed institutional support for an effective mechanism that can assure the protection of new technology (especially biotechnology) and incentives for investment in the acquisition of technology. He also endorsed a mechanism for evidence-based policy interventions, especially for cotton which has one of the longest value chains in the country.

Dr Abid Mehmood, Chief Executive PARB, said that to enhance the area under cotton production, it is important to minimise price fluctuations/uncertainties in cotton. Similarly, cotton growers lack modern technologies, not in terms of seed but also production technologies. He said that under the current situation, it is difficult for the cotton crop to compete with other crops. Thus, zoning based on comparative advantage is also required to keep the cotton region intact. He also emphasised the training of farmers in modern production technologies.

Prof. Dr Irfan Ahmad Baig, Dean of the Faculty of Social Sciences, MNUSAM, said that Pakistan is the fifth largest producer of cotton but the cotton area, yield, and quality are on the decline over the last two decades. He said that 22 per cent of total cotton production in the world has policy support but Pakistani farmers are being implicitly taxed. He said that the availability of certified and quality seed is an important factor in the decline of the cotton area and yield. He said that the world has moved on to Bollgard-III seed technologies while we are still cultivating Bollgard-I varieties. He said that last year, the government announced an indicative price of cotton which encouraged farmers to cultivate cotton. He also emphasised cluster farming and hunting for new areas suitable for cotton production.

Dr Mehmood Ahmad, Member Advisory Council, BIPP and Ex. Advisor, FAO, said that under the current set of policies, cotton farmers are facing implicit taxation. As compared to competing crops, namely, sugarcane and maize, cotton has a policy disincentive. Cotton growers invest Rs. 45 to get Rs.100, while sugarcane growers invest Rs. 120 to get Rs. 100. However, heavy subsidies (especially on water and fertilisers) make sugarcane more profitable as compared to cotton. Similarly, research shows that cotton growers who use climate-smart agricultural technologies are more productive as compared to conventional growers.

Mr. Hassan Raza, Former Member Agriculture Commission and a progressive grower was of the view that subsidies and support prices are not durable solutions to revive cotton production and enhance yield. He said to enhance cotton yield, effective pest control measures, single timing for crop sowing to break the pest cycle, proper input use to avoid vegetative growth, and data-supported recommendations are important for concrete policy measures.

Dr Shafiq Ahmad, Country Director of Better Cotton Initiative, said that for cotton revival, better seed technology, modern production technology, crop management practices, effective procurement system, and value addition must be parts of policy measures. He also stressed the need for cooperative/cluster-based farming in Pakistan and policy support for such technical interventions.

Mr Sohail Kharral, a cotton ginner, said that cotton is not just a cash crop but also a major source of vegetable oil for human consumption, cotton seed cake for animal consumption, and cotton sticks for fuel. If the government gives policy support to cotton we can not only increase our textile exports but also can reduce edible oil imports and protect our environment. He said that it is important that policies are implemented in their true spirit to revive cotton production in South Punjab. He also emphasised the localisation of cotton production and post-harvest management machinery and technologies in Pakistan.

Dr Sagheer Ahmad, Director of the Cotton Research Institute, Multan, said that in 2002-21 cotton yield was 23 maunds per acre which has reduced to 18 maunds per acre in 2020. He suggested that zone-specific cotton varieties and their strict implementation is required to ensure cotton revival. Similarly, integrated pest management (IPM) practices and international collaboration in research and development to benefit from modern technologies must be a part of policy measures. He also emphasised investment in efficient mechanisation technology including smart technologies (suitable for small farmers), which can be achieved by promoting private sector investment.

Mr Muhammad Ilyas, a progressive grower from Multan, said that competing crops have support or contract with their related industries, such as potato and sugarcane, whereas cotton farmers do not have such support. He said that effective pest control measures for white flies and pink bollworms are required to enhance yield.

M. Shahid Akhtar, Secretary PCPA, mentioned that 200 cotton varieties are being sown but only three to four per cent are registered that shows a severe lack of registered seed varieties. He said that seeds of other crops are imported but in the case of cotton, we do not import its seeds. Ensuring certified cotton seed varieties is an important tool to enhance yield. Similarly, bio-pesticides are being recommended but these recommendations are not supported by scientific evidence. Therefore, research-based recommendations must be ensured.

Mr Ali Sufyan from GM (Tech.) SANIFA said that climate change is an important factor that is influencing cotton cultivation patterns. Thus, meteorological data should be collected from South Punjab and research-based recommendations should be given to farmers. He also emphasised the provision of certified seeds to farmers and strict compliance with certification laws to ensure quality seeds. Similarly, the distribution or leakage of immature and unregistered seed varieties should be avoided. He said that we should enhance the per-acre plant population from 17,000 to 25,000 or even more. The focus should be on the development of short-duration cotton varieties to avoid pest attacks and weather effects.

Dr Naveed Afzal, Director of CCRI, said the government and the private sector should enhance R&D in cotton seed production and crop management technologies. He said that cotton cultivation in new regions should be focused on, especially rain-fed cultivation in Balochistan. He also stressed the import of germplasm for cotton. Similarly, strict compliance with laws should be ensured in pesticides and seed markets to ensure quality inputs.

Dr Muhammad Ishtiaq, Assistant Professor, Department of Entomology, MNSUAM, said that modern technologies in cotton production should be ensured to reduce the cost of production and enhance yield. Similarly, the development of new varieties at regular intervals should be ensured as existing cotton varieties are not resistant to pest attacks and have poor yield potential.

Prof. Dr Nazim Labar, BZU University, Multan, said that the zoning of crops according to agro-climatic conditions is needed to save cotton production. Similarly, cluster farming should be promoted for better cotton production. He also emphasised enhancing the per-acre plant population in cotton to enhance yield. But for this, better germination of cotton seed is needed.

Dr Alamgir Khan, subject specialist, MNSUAM, said that mechanical control of pink bollworm is needed. This can be achieved through the localisation of the required machinery. Mr Haider Iqrar focused on the use of bio-control for pests mainly through the use of light and pheromone traps in the field. He suggested that IPM practices should be a part of the policy framework.

# ANNEXURE C

## Questionnaire Used for the Study

***Objectives:***

- To synthesise the major trends in the production (area and yield) of cotton (secondary data).
- To identify financial, social, and economic benefits and costs associated with cotton and its competing crops in the cotton-wheat zone
- To evaluate the impact of major public policies related to the agriculture sector on the competitiveness of competing Kharif crops, comparative advantage/profitability of farmers and willingness to adapt new technologies in cotton production.

Questionnaire serial number: ___________ Survey date: ______________________

Investigator: __________________________ Province: ________________________

District: _______________________________ Tehsil:__________________________

Village: ___________________________________________________________

**A. Socioeconomic characteristics (check the option where needed)**

A1. Name of Respondent: ___________________________

A2. Education: ___________________________________ years

A3. Age: _______________________________________ years

A4. Farming experience: ___________________________ years

A5. Cotton cultivation experience: ______________________years

A6. Family size: __________________________________ No.

A7. Senior family members (≥65): ______________________ No.

A8. Adult family members (≥16 and < 65): _______________ No.

A9. Children in the family (<16): ________________________ No.

A10. Distance to the nearest agricultural market: ______________ Km

A11. Distance to city: _____________________________ Km

A12. Distance to metaled road: ____________________________Km

A13. Are you a registered farmer with the agriculture department? Yes ☐ No ☐

A14. Do you have a Kissan card? Yes ☐ No ☐

A15. Do you receive a subsidy on fertilisers? Yes ☐ No ☐

A16. Do you receive a subsidy on cotton seeds? Yes ☐ No ☐

A17. Did you get subsidised farm machinery? Yes ☐ No ☐

A18. How many times govt. extension workers visited your field this season? ____ No.

A19. How many times have private companies' agents visited your field this season ___No.

A20: Do you receive messages from the agricultural department? Yes ☐ No ☐

A21: Do you have access to weather-related information? Yes ☐ No ☐

A22. Did you receive any training in cultivation practices? Yes ☐ No ☐

A23. Did you receive any training in cotton picking? Yes ☐ No ☐

A24: Did you get a loan from a bank or borrow money last year? Yes ☐ No ☐

A25: Loan for what purpose? (In case of yes to Q. A24)

1= Agricultural production 2= Farm implements and tractor

3= Car loan 4= Family medical 5= Household daily consumption

6= Wedding 7 = House construction 8= other

A26: What is your major source for loans or borrowing?

1= ZTBL 2= Commercial banks 3= Aarhti and shopkeepers 4= Friends and relatives
5= others ___________ (specify)

A27: If you don't get a loan from a bank, what are the reasons?

1=No need 2= Religious bindings 3=Difficult procedure

4= High interest rate 5= Others _____________ (Specify)

A28. Does any family member do a job? Yes ☐ No ☐

A29. Does any family member do business other than farming? Yes ☐ No ☐

## B. Farm Particulars

B1. Own area: ______________________ acres

B2. Area rented/shared: ________________ acres

B3. Area rented-out/shared-out: _______________ acres

B4. Rent of the land in the area: ________________ Rs./ acre

B5: Number of pieces of land? ___ No.

## C. Labour

C1. Number of adult family workers: Male: _____; Female: ______ No.

C2. Number of adult hired workers: Male: _____; Female: ______ No.

C3. Wages of permanent workers: ________________ Rs. / Month

C4. Wages of daily paid workers: _____________ Rs./ Day

C5. Seasonal labour hired: Male: _____ Female: _______ No.

C6. Wages of seasonal male workers: _______________ Rs./ Day

C7. Wages of seasonal female workers: _______________ Rs./ Day

**D. Tillage and Crop Management Practices (per acre)**

| | Cotton | | Rice | | Maize | | Sugarcane | | Others | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Practice** | **Qty.** | **Cost** | **Qty.** | **Cost** | **Qty.** | **Cost** | **Qty.** | **Cost** | **Qt.** | **Cost** |
| Nursery sowing (seed + labour) | - | - | | | - | - | - | - | - | - |
| Nursery transplantation | - | - | | | - | - | - | - | - | - |
| Machine hours - ploughing + planking | | | | | | | | | | |
| Machine hours - levelling | | | | | | | | | | |
| Machine hours - hoeing | | | | | | | | | | |
| Seed rate (Kg/acre) | | | | | | | | | | |
| Cost of sowing (if done manually with labour) | | | | | | | | | | |
| Cost of sowing (if done with a drill) | | | | | | | | | | |
| DAP (bags) | | | | | | | | | | |
| Urea (bags) | | | | | | | | | | |
| Nitrophos (bags) | | | | | | | | | | |
| SSP (bags) | | | | | | | | | | |
| Potash (bags) | | | | | | | | | | |
| Other fertilisers | | | | | | | | | | |
| FYM (Carts) | | | | | | | | | | |
| Canal irrigation (No.) | | | | | | | | | | |
| Tube well irrigation (No.) | | | | | | | | | | |
| Labour for irrigation (man-days) | | | | | | | | | | |
| Weedicides (No.) | | | | | | | | | | |
| Pesticides (No.) | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Labour/machine for weedicides/pesticides/ fertiliser application (man-days) | | | | | | | | | | |
| Harvesting/picking/ maund | | | | | | | | | | |
| Cutting sticks/acre | - | | - | - | - | - | - | - | - | - |

## E. Cropping Area and Yield

| Crops | 2015 | | | 2021 | | |
|---|---|---|---|---|---|---|
| | Area | Yield | Price / maund | Area | Yield | Price / maund |
| Cotton | | | | | | |
| Rice | | | | | | |
| Maize | | | | | | |
| Sugarcane | | | | | | |
| Other | | | | | | |

## F. Cotton Cultivation and Marketing (Tick the options where needed)

F1. How many cotton varieties you have cultivated in this season? ____________________ No.

F2. How is your cotton field fertility?

4 = Excellent 3 = Good 2 = Medium 1 = Poor

F3. How many times do you do cotton picking? __________________________________No.

F4. To whom do you mainly sell your cotton produce?

1= Aarhti 2= Commission agent 3= Company 4=Cooperative 5=Ginning factory 6= other

F5. What do you do with cotton sticks?

1=Home use 2=Sale out 3; Give it to friends/relatives/ workers 4=Burn in the field 5=Mulching

F6. What is the price of cotton sticks per acre? ____________ (Rupees)

F7. What is your main marketing strategy?

1= No strategy 2= Just go to the market and sell 3= You ask rates from different agents and then sell 4= You just sell to a single agent 5= You sell to an agent from whom you take inputs or advance money

**G. Issues in Cotton Production (Tick only one option in each row)**

| Factors | | Major Issue | Minor Issue | No Issue |
|---|---|---|---|---|
| Availability/ Access of | Water | | | |
| | Seed | | | |
| | Fertiliser | | | |
| | Pesticides/insecticides/weedicides | | | |
| | Electricity | | | |
| | Diesel | | | |
| | Machinery | | | |
| | Labour | | | |
| | Market | | | |
| | Training | | | |
| | Extension services | | | |
| | Weather information | | | |
| | Drought-tolerant varieties | | | |
| | Pest-resistant varieties | | | |
| High price/ rent/ Wage of | Water | | | |
| | Seed | | | |
| | Fertiliser | | | |
| | Pesticides/ insecticides/weedicides | | | |
| | Electricity | | | |
| | Diesel | | | |
| | Machinery | | | |
| | Labour | | | |
| | Drought-tolerant varieties | | | |
| | Pest-resistant varieties | | | |

| | | | | |
|---|---|---|---|---|
| Quality of | Seed | | | |
| | Fertiliser | | | |
| | Pesticides/ insecticides/weedicides | | | |
| | Machinery | | | |
| | Drought -varieties | | | |
| | Pest resistant varieties | | | |

**H. Crop Production Preference/Choice (Tick only one option in each row)**

| Scenario | How many acres of cotton you will cultivate? |
|---|---|
| H1. If the government subsidises seeds | |
| H2. If the government subsidises fertilizers | |
| H3. If the government subsidises energy sources | |
| H4. If the government subsidises pesticides/insecticides/ weedicides | |
| H5. If pest and insect-resistant varieties are introduced | |
| H6. If modern crop production and cotton-picking technologies are introduced | |
| H7. If water availability is enhanced | |
| H8. If the indicative price for cotton is introduced | |
| H9. If support price for cotton is introduced | |
| H10. If training and extension services are properly provided | |
| H11. If crop insurance is introduced | |

## I. Reasons for better cotton yield

I1. Was cotton yield better in this season as compared to previous seasons? Yes ☐ No ☐

I2. If yes:

| Reasons for better cotton yield | Strongly agree | Agree | Neutral | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| I3. Better quality seeds | | | | | |
| I4. Better cotton variety | | | | | |
| I5. Favourable weather | | | | | |
| I6. Less pest infestation | | | | | |
| I7. Better management | | | | | |
| I8. Better IPM | | | | | |
| I9. Better output prices | | | | | |
| I10. Better input prices | | | | | |

## J. Perspectives of Willingness-to-Pay for better cotton production (Tick option where needed)

J1. Do you want to purchase seeds of GMO cotton varieties? Yes ☐ No ☐

J2. If yes, how much maximum price of seed per kg you would pay? _________ Rs.

J3. Do you want to purchase quality poisons/spray? Yes ☐ No ☐

J4. If yes, what maximum price for poisons per litre you would pay? _________ Rs.

J5. Do you want to have access to weather information service? Yes ☐ No ☐

J6. If yes, how much you would pay for it per month? ____________________ Rs.

J7. Do you want to have access to market information services? Yes ☐ No ☐

J8. If yes, how much you would pay for it per month? ____________________ Rs.

J9. Do you want to have access to modern cotton-picking technologies? Yes ☐ No ☐

J10. If yes, how much do you want to pay for cotton picking per maund? _________ Rs.

## K. Farm Management Practices

| Management Practices | Frequently | Occasionally | Rarely | Very rarely | Never |
|---|---|---|---|---|---|
| K1. How often do you do crop rotation? | | | | | |
| K2. How often do you laser-level land? | | | | | |
| K3. How often do you do pest scouting? | | | | | |
| K4. How often do you do soil testing? | | | | | |
| K5. How often do you do water testing? | | | | | |
| K6. How often do you keep in touch with price information? | | | | | |
| K7. How often do you change seed varieties? | | | | | |
| K8. How often do you apply farm manure? | | | | | |

## L. Farm Machinery

| Sr. No. | Implement | Units | Years old |
|---|---|---|---|
| L1 | Tractor | | |
| L2 | Trolley | | |
| L3 | Tiller | | |
| L4 | Harrow | | |
| L5 | Blade | | |
| L6 | Laser leveller | | |
| L7 | Thresher | | |
| L8 | Rotavator | | |
| L9 | Boom sprayer | | |
| L10 | Peter engine | | |
| L11 | | | |
| L12 | | | |

# DYNAMICS OF FOOD PRICES IN MAJOR CITIES OF PAKISTAN

Nigar Zehra and Fouzia Sohail

## ABSTRACT

This research studies the dynamics of food prices for fifteen commodities in fourteen major cities of Pakistan. The dynamics of food prices are evaluated by estimating the components of inflation, such as the frequency of price change, the duration of price change, the average size of price change, the direction (increase or decrease) of price change, the synchronization of price change, and also by assessing the volatility of food prices. The results show that the frequency of price change is high in big metropolitan cities for most of the commodities, and there is a synchronized price change across cities, especially in tea and tomato prices. Moreover, the volatility results show that the prices of beef, chicken, egg, sugar, and all vegetables are highly volatile as compared to other food commodities. Furthermore, the study also explains the factors of food prices in Pakistan. The findings reveal that there is a negative and significant impact of the real effective exchange rate on wheat prices in the long run. Similarly, the real interest rate affects wheat and rice prices indirectly, while it has a direct impact on tea prices. There is a positive and significant impact of international crude oil prices and international food prices on most food commodities. Moreover, the study explains that in the long run, the increase in local production significantly reduces the prices of food commodities. It is also found that the government policy of adjusting (increasing) wheat support prices also has a positive and significant impact on wheat prices.

# 1. INTRODUCTION

Globalization has increased the economic integration of the world integrated economically, and the interdependency of developed and developing nations on various commodities has also increased. It is evident that during the past two decades, commodity prices exhibited increasing and volatile behaviour globally. International food prices almost doubled in the year 2007-08, which is evident from the Food and Agriculture Organization (FAO) Index – the food price increased up to 27 per cent. It is observed that there was a massive increase in the prices of some important food commodities. For instance, the prices of rice and wheat increased by 76 and 121 per cent, respectively. Further, dairy product prices and maize prices also went up by 90 per cent and 80 per cent, respectively. Headey (2014) termed this massive upsurge in food prices as an "International Food Crisis". The crisis affected about 49 developing countries.

Like other developing countries, Pakistan was also affected by the international food price crisis. In 2008-09, food inflation broke the record for the last 23 years as it increased by 23.13 per cent compared to 17.65 per cent in 2007. Between 2005 and 2008, the wheat price increased by 106 per cent, whereas, the variation in the price of other staple food commodities remained in the range of 20 to 120 per cent. Besides high global food prices, there were also some domestic reasons behind the inflated wheat price, for instance, regional smuggling and hoarding of wheat were important reasons. To combat the hoarding and smuggling of wheat, Pakistan Government increased the wheat procurement price. According to the Ministry of Finance 2008-09, due to this act, the local wheat price was increased more than the international price of wheat. These elevated wheat prices also accelerated the prices of vegetables, meat, oil and milk (Awan and Imran, 2015).

Furthermore, in 2010 and 2011, Pakistan faced the challenge of heavy floods, which reduced wheat production that further raised not only the price of wheat but also the prices of some perishable goods. In 2012, local food prices were also inflated because of the extraordinary upsurge in the global prices of wheat, soybean, and corn. However, in 2014-15 (July-April), there was a decrease in food inflation due to the decline in the prices of several food commodities, particularly the prices of potatoes, wheat, eggs, rice etc. declined. Furthermore, the decline in food inflation was also because of the reduction in oil (fuel) prices. Once again, in 2016, food price inflation showed a rising trend as the prices of, sugar, wheat, pulse (mash) and meat, increased by 3.9, 2.6, 8.5, and 1.3 per cent, respectively. In 2018-19, global food inflation did not increase too much, which further decreased the inflationary pressure and Pakistan's food inflation was recorded at only 1.8 per cent. This reduction in food inflation further reduced the overall inflation in Pakistan (Economic Survey of Pakistan, 2018-19).

In 2020, food inflation increased to 10.4 per cent due to supply disruption, seasonal changes, and an increase in transportation costs. Furthermore, reliance on imported items due to COVID-19 was also one of the reasons. In April 2021, food inflation increased to 15.7 per cent due to a massive increase in chicken, tomatoes, eggs, milk, sugar, and wheat prices. However, the prices of onion, mung, and masur decreased. This up-and-down movement in food prices is evidence of the volatile nature of food prices. It is worth mentioning that high food prices and volatility are considered two important concepts of food price dynamics. On the one hand, a high growth rate of food prices directly impacts the welfare of consumers, while volatility impacts both producers and consumers. Volatility measures the risk factors associated with the production and supply of food commodities. An increase in volatility raises uncertainty and can create production shortages.

The literature has identified different factors that can cause changes in food prices. For instance, Abbot et al. (2009), Mitchell (2008), Cooke and Robles (2009), Gilbert and Morgan (2010) and Ismail et al. (2017), explained some of the factors that affect food prices, including low investment in the agriculture sector along with low levels of commodity inventory, variations in the oil prices, global money supply, and changes in the value of the dollar. Similarly, Joiya and Salman (2013) and Awan and Imran (2015) highlighted that input prices, money supply, foreign aid, exchange rate and transportation cost played an adverse role in increasing food prices in Pakistan.

Realizing the importance of the issue, the current study research is planned to investigate the individual price dynamics using micro-data of fifteen major food commodities; beef, chicken, rice, wheat, mash, mung, masur, tomato, potato, garlic, onion, sugar, tea, milk, and eggs. The study also assesses the volatility in their monthly price series from July 2002 to July 2021. Therefore, the dynamics of food prices are gauged by estimating not only the components of inflation but also the volatility of food prices. Further, it also investigates the key factors of food prices. The foremost objectives of the study are as follows:

- To evaluate the dynamics of food prices at city and commodity levels from 2002 to 2021. For this purpose, the study analyses the indicators such as the frequency of price change, the duration of price change, the average size of price change, and the direction (increase or decrease) of price change. The study also observes the synchronisation of price change among different cities in Pakistan.

- To assess the conditional volatility in monthly prices of the above food commodities. The food price volatility is assessed by using autoregressive conditional heteroscedasticity (ARCH)/generalized ARCH (GARCH) and integrated GARCH (IGARCH) models.

- To observe the impact of various exogenous and endogenous covariates on food prices over the years.

The stylized facts of food prices computed will help us in understanding the dynamic features of food prices. Furthermore, the study will help to identify the real sources of changes in food prices that create variations in food prices and food inflation. The study clears the role of each factor (used in the study) in food price changes. The study will help the policymakers to design policies to control the variation and increase in food prices.

Following the introduction in Section 1, the paper is organized as follows. Section 2 provides a brief literature review regarding the issue, while Section 3 details the conceptual framework of the study. Section 4 explains the data sources and factors of food prices. Section 5 describes the methodology and Section 6 discusses the findings. Section 7 gives the conclusions and section 8 provides the policy recommendations.

## 2. LITERATURE REVIEW

A sufficiently large international and national literature exists regarding the drivers of inflated food prices and their volatile nature. The literature is divided into two subsections. The first subsection discusses the literature on volatility, while the second discusses the covariates of exaggerated food prices both at the international and Pakistan levels.

### Literature Based on Food Price Volatility

This section presents a concise review of the research available on food price volatility at the national and international levels. After the international crisis of food prices in 2007-08 the literature got more extensive. In this respect, Jordaan et al. (2007) determined that the daily prices of soybean and wheat were not volatile, while the daily prices of other crops, for instance, white and yellow maize and sunflower, were volatile. Similarly, Apergis and Rezitis (2011) analysed the monthly price data of food prices, for the 1985–2007 period. They concluded that the relative prices of food in Greece were volatile and had greater uncertainty about the prices in future, which further negatively impacted both consumers and producers. Sukati (2013) also worked on the identification of volatility in monthly maize monthly prices in Swaziland. Using monthly data from February 1998 to September 2013, he found elaborated that volatility in maize prices was not persistent but strongly affected by market dynamics.

Minot (2014) determined the volatility in the prices of staple food for the January 1980–March 2011 period. The author asserted that the high volatility in international food prices from 2007 to 2010 did not accelerate volatility in African prices of staple foods. The author also stated that the volatility in tradable food products was smaller than the volatility in non-tradable food products, especially in the main cities. Additionally, Kelkay and Yohannes (2014) found that in Ethiopia from December 2011 to June 2012, volatility in the prices of peas and beans had a spillover effect from one time period to another. Balanay (2015) found that in the Philippines, there was a short-term time-varying volatility in the prices of duck eggs from 1990 to 2009. Furthermore, the author recommended that as the market of duck eggs is highly uncertain, there is a need for regular monitoring to protect the market from threats in future. In another study, Kuhe (2019) utilised monthly time series data on Commodity Food Price Index from January 1991 to January 2017 and found that price volatility was quite persistent and mean reverting, indicating that past volatility was important in forecasting future volatility.

Furthermore, Zehra and Fatima (2020) assessed the volatility in sixteen food commodities for the monthly data from 2002 to 2016 for fourteen cities in Pakistan. They found that in most of the commodities (in various cities) the volatility was because of the past variance and residual effects. However, for a few commodities (in different cities), the volatility was only due to residual effects. The study also found that there existed heterogeneity among cities with differences in the intensity of volatility.

### Literature Based on Factors Affecting Food Prices

This part of the literature review is based on studies that focus on the main drivers of variation in food prices.

Schimmelpfennig and Khan (2006) underlined the relative significance of monetary and some supply-side factors of inflated prices in Pakistan. They used a stylised model of inflation that contained some monetary factors, such as money supply, credit to the private sector, and exchange rate. They also included the wheat support price for Pakistan for the January 1998–June 2005 period as a supply-side factor. they found that the role of monetary factors in current inflation was very prominent affecting inflation with one year lag. However, the variation in the support price of wheat only had a short-term impact on inflation.

Frankel (2006) analysed the US data from 1950 to 2005. The results showed an inverse relationship between the real interest rate and commodity and mineral prices. The results showed that the increase in the interest rate lowers the desire to hold commodity inventories and accelerates the supply of storable commodities which further reduces the prices. Loening et al. (2009) analysed the impact of the external, monetary, and agricultural sectors on cereal inflation in Ethiopia from January 1999 to November 2008. The main finding of the research is that there was a significant impact of lagged growth of money supply on cereal inflation in the short run but insignificant in the long run. However, there was an existence of a significant impact of the external sector (world food prices in terms of local currency) and the gap in agricultural output on cereal prices in the long run. The research highlighted that drought had an impermanent impact on cereal prices, while international fertiliser and energy price inflation had no impact on cereal prices.

Ahsan et al. (2011) found that per capita income, agriculture output, agricultural subsidies, money supply, and world food prices were the key determinants of food prices in Pakistan. An important conclusion of the paper was that the most significant variable which affected food prices in the long run as well as in the short run was money supply. On the other hand, international food prices affected food prices only in the long run which increased the domestic price in a country. They also concluded that subsidies helped in reducing food prices in the long run but the impact of the subsidies was very small. Another study by Joiya and Shahzad (2013) identified the determinants of high food prices in Pakistan. The time series data for the period 1972-73 to 2009-10 was used. The results indicated that both in the short run and the long run, GDP, food export, food import, and total credit to the agriculture sector had a significant impact on food prices. GDP and food export were contributors towards high food prices, while food imports and credit to the agriculture sector reduced the food prices.

A chapter in the book edited by Matthias Kalkuhl, Joachim von Braun, and Maximo Torero (2016) at IFPRI investigated the main drivers of food price spikes and volatility of wheat, maize, and soybean prices. The analysis indicated that exogenous shocks as well as the linkages between food, energy, and financial markets played a significant role in explaining food price volatility and price spikes.

Similarly, Nwoko et al. (2016) studied not only the long-run and short-run linkages between oil price and food price volatility but also examined the causal relationship between them. The study analysed used the yearly data of the food price volatility index and crude oil for the period 2000 to 2013. The research revealed a long-run relationship between food price volatility and oil price. Similarly, the study identified a positive and significant short-term linkage between food price volatility and oil price. However, it is found that there was a unidirectional causality from oil prices to volatility in food prices.

Moreover, Ismail et al. (2017) investigated the monthly data from April 1983 to April 2013 of rice, wheat, tea, beef, lamb poultry, sunflower oil, rape seed oil soybean oil, sugar, cotton, urea, and crude oil prices for Pakistan. The authors examined the factors that influenced the volatility of selected food and agricultural commodities. The research identified that poultry and beef prices were affected by the interest rate, while the price of wheat was affected by the exchange rate. However, rice and sugar prices were influenced by urea prices. Furthermore, the volatility of wheat prices was affected by volatility in crude oil prices. However, Sekhar et al. (2017) categorised food commodities into high- and low-volatility groups. Furthermore, the study also identified the drivers of food inflation in India by analysing the annual data of commodity prices and other variables from January 2005 to July 2015. They concluded that most of the vegetables, fruits, and mung were categorised into the high volatility group, while rice, meat, fish, eggs, milk, and masur were categorised into the low volatility group. Further, the study revealed that both the supply as well as demand side factors are key drivers of food inflation in India. However, the prices of edible oil and cereal seemed to be principally determined by supply-side factors, for instance, minimum support prices, wage rates, and production. On the other hand, the prices of milk, eggs, fish, meat, vegetables, and fruits seemed to be influenced mainly by demand-side factors, though the impact of demand- and supply-side factors seemed to be almost the same for pulses.

Norazman et al. (2018) analysing monthly data from 1991 to 2013 for Malaysia, found that the real effective exchange rate (decrease in the real effective exchange rate) and international food commodity prices were the primary factors responsible for accelerating food prices in Malaysia. Additionally, the study also reported that oil prices directly contributed to a surge in food price inflation in the long term and might have an indirect impact on Malaysian food prices via its effect on international food commodity prices. However, labour costs appeared to have a minimal effect on food price inflation in the short term as well as in the long term.

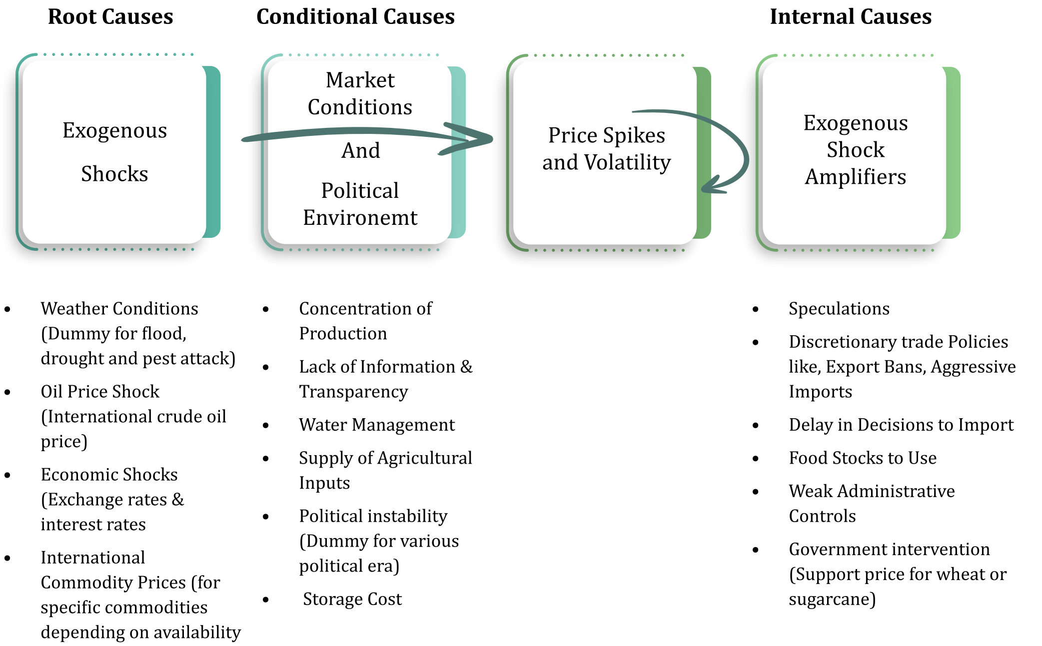
Additionally, for Iran, Radmehr et al. (2020) examined the short- and long-term influence of oil prices (petroleum prices) and exchange rate (value of Iranian currency per US dollar) on food prices. The authors analysed the monthly price data of ten food commodities for the March 1995–February 2018 period. It was revealed that in both the short-term and long-term, food prices increased due to an upsurge in energy prices. However, in the long run, an appreciation of the US dollar with respect to the Iranian rial exerted a positive and significant influence on food prices.

A brief review of the literature shows that there is a gap regarding the identification of the dynamics of food prices at the city level. The cities are different in terms of their physical structure and population which makes a difference in the demand and supply of staple food. The proposed study is an attempt to add to the literature by identifying the dynamics of food prices at the commodity-city level and by investigating the main drivers of food prices for the given period. The conceptual framework of the study is given below.

## 3. CONCEPTUAL FRAMEWORK

To determine the main drivers of food prices the study adopts the concept proposed by Tadasse et al. (2016) with a small modification.

*Figure 1: Conceptual Framework*




*Source: Tadesse et al. (2016)*

According to the framework given in Figure 1, the determinants of food prices are divided into three groups, i.e., exogenous shocks, market conditions and political environment, and endogenous shocks. It is postulated that exogenous factors are the root cause of price fluctuation. These include extreme weather shocks (heavy rains and floods), economic shocks (changes in the interest rate and exchange rate), international commodity price shocks, and oil price shocks. These exogenous shocks are expected to be responsible for generating variability in food prices, while the extent of their influences or the saturation of their effect on the native economy partly depends on the market conditions and political situation of the country. Hence, the second group of factors is associated with political and market conditions that can reduce or aggravate exogenous shocks. The majority of these factors, such as the lack of transparency in water management and commodity markets, are time-invariant and quite hard to measure. Consequently, these factors are not taken into account in the empirical analysis.

Factors included in the third group are endogenous shocks. These include unrestricted trade policies, speculative activities determined by price expectations, weak administrative controls, etc. Some of the other country-specific endogenous factors, such as the role of the middleman, hoarding, etc., are also important factors. These factors amplify the effect of other factors present in the first and second groups. However, similar to the second group of factors, most of the endogenous factors are qualitative in nature and, hence, difficult to include in the modelling of the framework.

Although the present study mainly emphasises exogenous shocks as they may cause other factors to emerge, some country-related political, economic, and other endogenous factors are also included in the empirical analysis. A detailed description of the factors affecting the prices of various commodities included in this research is given in the next section. Each factor that influences the prices of specific commodities is selected after a careful and thorough review of international and national literature.

## 4. DATA SOURCES AND FACTORS

This section provides the data sources and describes the main factors that affect food prices[1] included in the research

### Data Sources

The study employs monthly data of food prices for fifteen food commodities[2] that are a part of the CPI basket, namely, beef, chicken, pulses (mash, mung, masur), rice (IRRI), wheat, tomato, potato, onion, garlic, milk, egg, sugar, and tea for 14 large cities of Pakistan. Cities included in this analysis are Bahawalpur, Faisalabad, Hyderabad, Islamabad, Karachi, Khuzdar, Lahore, Multan, Peshawar, Quetta, Rawalpindi, Sargodha, Sialkot, and Sukkur. Cities are selected based on the definition of a big city by the Pakistan Bureau of Statistics. Monthly data is gathered from July 2002 to July 2021, from various issues of the Monthly Statistical Bulletin published by the Pakistan Bureau of Statistics. In this way, a total of about 48,090 observations are included in this study. Furthermore, the monthly data of real effective exchange rate, interest rate, international crude oil prices[3], and international prices of food commodities (tomato, beef, chicken, milk, wheat, rice, sugar and tea) in Pak Rupees is collected from the IMF and State bank of Pakistan from July 2002 to April 2021. The yearly data of the total production of food commodities (except garlic and tea) and wheat support price is collected from the Ministry of Agriculture Pakistan and PBS respectively. Moreover, the dummy variable is used for a political era.

### Main Factors of Food Price Fluctuations with Empirical Evidence

#### *International Prices of Food Commodities*

Fluctuations in international prices of food commodities have a direct as well as an indirect effect on domestic prices of food commodities via international trade and also through amendments in domestic policies. Ahsan et al. (2011) identified that international commodity prices affect domestic commodity prices even if the commodity is not tradable. ADB (2008) highlighted that increases in world food prices pressurise the domestic market in the absence of imports, which causes domestic food prices to rise. The import of food commodities at higher international prices can generate imported inflation. Therefore, the study includes international food prices in the analyses. The correlation between international and domestic food commodity prices is presented in Figure A-1 (Appendix).

#### *Real Interest Rate*

Interest rate is another important variable that affects food prices. Frankel (2006), Calvo (2008), and Roache (2010) found that agricultural commodity prices are affected by small changes in interest rates. The literature has identified that interest rate affect food prices both positively and negatively. As it is the cost of borrowing that a

[1] Description of price spells of fifteen commodities in fourteen cities is given in Box A-2 (Appendix)

[2] Selection criteria of Food Commodities and their units are given in Box A-1 and Table A-1 (Appendix)

[3] Brent Crude Oil $/(Barrel)/159L

farmer pays on a loan, a high interest rate discourages agricultural investment which increases food prices. On the other hand, the interest rate is used as a policy tool to tackle the rising general price level. Ismail et al. (2017) identified both positive and negative impacts of interest rates on some food commodities.

***Real Effective Exchange Rate***

The exchange rate also has a leading role in the transmission of international goods prices to the national market (Landerretche et al., 2007; Abbot et al., 2009; Zerom and Nakamura 2010). There are two ways in which the exchange rate affects food prices. First, as the currency depreciates, it increases the prices of inputs or raw materials, for instance, seeds, pesticides, and fertilizers. It also increases the prices of final food commodities that are imported, such as pulses. Second, a depreciation in the exchange rate also increases the import price of crude oil which further raises the transportation cost of agricultural commodities exerting inflationary pressure on food prices. Therefore, a depreciation of the exchange rate causes an increase in food prices. Furthermore, a depreciation in the exchange rate or a decline in the REER (depreciation in the value of the rupee) is an indication that the country's exports have become cheaper and imports more expensive In other words, the country gains trade competitiveness but also causes inflationary pressure (Rathburn et al., 2021).

***Crude Oil Prices (Input Prices)***

Oil price shock may influence domestic food prices in several ways through the food supply chain. For instance, it not only affects the production of the commodity by increasing the cost of production but also influences the processing and local and international distribution of the commodity. It amplifies the retail price and farm gate price, as it is used to transport the commodity from the producers to buyers. The literature suggests that an increase in agricultural input prices, namely fertilizer and crude oil, increases the expenditures of producers, which ultimately raises the prices of agricultural outputs. Herrmann (2009), Baffes (2007), and Norazman et al. (2018) have found a significant effect of crude oil or diesel on agricultural commodities.

***Government Intervention: Support Prices***

Government interventions also play a vital role to support the prices of important food commodities. The minimum support price incentivises farmers to cultivate adequate crops to fulfil the local production target. It is fixed by the government at which the crop (commodity) is procured from growers. Due to the minimum support price, farmers can get a good price for their forthcoming crop to spend on the production of agricultural commodities. Hence, it is worth mentioning here that the support price of a commodity is one of the most important determinants which is considered an endogenous shock amplifier. Khan and Qasim (1996), and Sherani, Schimmelpfennig, and Khan (2006) stated that wheat support prices increased inflation in Pakistan. In the model for wheat, the study includes wheat support prices as a proxy for government intervention.

***Political Conditions***

Tadaess et al. (2016) explained that various government policies, for instance, discretionary trade policy, export bans, aggressive imports, delays in the decision to import, etc., have a direct impact on the variability in food prices. It is considered that political condition is an endogenous variable that amplifies the spikes in food prices. The study includes the political era in the analyses as a proxy for political conditions. It is assumed that every government applies different policies to control food inflation.

## 5. RESEARCH METHODOLOGY

This section explains the different methodological approaches that are adopted for accomplishing the objectives of the study.

### The Pattern of Price Adjustment over Time

The first objective of this study is to evaluate the dynamics of food prices at the city and commodity levels for the period of analysis, i.e., from 2002 to 2021. The pattern of price change of each product is evaluated based on various indicators. For instance, the duration of price spells, the frequency of price change, the direction of price change, the average size of price change, and the degree of the synchronization of price change. The methodology of each of these indicators is described below.

#### *Price Duration and the Frequency of Price Changes*

In this study, firstly, the frequency of price change and the duration of spells for each commodity is calculated at the city level. Both these indicators are considered important in explaining the price dynamics. According to Baumgartner et al. (2005) and Woodford et al. (2009), inflation has a positive impact on the likelihood of a price change at the commodity level. Lach and Tsiddon (1992) found relatively smaller spells of commodity prices during high inflation episodes.

Prices are considered flexible (rigid) if they exhibit a high (low) frequency of price change and, thus, have a smaller (longer) duration of fixed prices. This behaviour (rigidity or flexibility) can be characterised by employing two interrelated methodological approaches. The first is the “frequency approach” and the second is the “duration approach”. The frequency approach first computes the frequency of price changes and then derives an implied duration of the spells. The duration approach measures the duration of the price spell (the number of months in which a price remains unchanged) directly and then derives an implied frequency of price changes as the inverse of duration.  Prices are considered rigid if they show a low frequency of price.

The frequency approach utilises the entire possible information available in the dataset. For instance, it incorporates all the uncensored and censored spells[4] in the computation. However, both the duration and frequency approaches exhibit similar results for all the uncensored spells of the dataset.

The average frequency of price changes (F) is calculated as the number of non-zero price change observations as a fraction of all price observations of the selected sample. For instance, in the context of the current study, the frequency of price change for a specific food product “j” sold in a particular city “k” over the period “T” would be calculated as:

$$F_{jk} = \frac{\sum_{t=2}^{T} X_{jkt}}{T_{jk}-1}$$

Where, $T_{jk}$ is the total number of monthly price observations $P_{jk}$ over the sample period and $X_{jkt}$ is the binary variable indicating the price change in t.

$$X_{jkt} = \begin{cases} 1 \text{ if } P_{jkt} \neq P_{jkt-1} \\ 0 \text{ otherwise} \end{cases}$$

[4] An incomplete series or spell witnessed in a specific price trajectory is called a censored spell. Spells could be noticed as truncated either on both sides of spells called doubled censored spells or on the right or left side of a spell called right-censored or left-censored spell respectively.

The aggregated frequency of price change at the product level would then be calculated by averaging over all the cities "k" for the same product category "j".

$$F_j = \frac{\sum_{k=1}^{14} F_{jk}}{K}$$

Given the frequency of the available data, we assume that the price changes once during a given month. The implied average and median duration of a price spell can be derived using the aggregated frequency of the price change at the product level. The implied duration of price spells could be calculated as the inverse of the frequency of price changes:

$$D_j = \frac{1}{F_j}$$

According to the duration approach, the duration of price spells is directly computed from the price trajectories. In contrast to the frequency approach, the duration approach directly deals with the issue of censoring price spells which has a considerable influence on the results. However, if the sample does not have the censored price spells, the two approaches give the same results.

The price spell of the particular product-city (j, k) is the observed episode of the fixed price $P_{j,k,t} = P_{j,k,t-1}$ so that the end of this price spell occurs when there is a price change $P_{j,k,t} \neq P_{j,k,t-1}$. The duration of this price spell is then defined by the time interval between two calendar dates, cd ($P_{j,k,t}$) – cd ($P_{j,k,t-1}$), limiting this price spell. The length of the trajectory of this product-city is the size of the time interval that the price of this product-outlet Pj,k was observed, i.e.,

$TL_{J,K}$ = cd ($P_{j,k,t}$) – cd ($P_{j,k,t-1}$)

The computation starts by calculating the average duration of the price spell of each trajectory of each product-city (j,k) by:

$$ADT_{J,K} = \frac{TL_{J,K}}{NS_{J,K}}$$

Where, TLJ,K is the length of the trajectory and $NS_{J,K}$ is the number of spells contained in the trajectory.

The second step is to compute the average duration of the product j by taking the simple average of the durations of the trajectories of the product-city $ADT_{J,K}$ across all cities for the same product j as follows:

$$ADC_j = \frac{\sum_{k=1}^{K} ADT_{J,K}}{K}$$

The direct approach entails two main advantages over the frequency approach. First, every single change in the price of product-city (j,k) is taken into account. Second, it is possible to obtain the entire distribution of the price duration.

***The Direction of Price Change***

The total frequency of price changes is simply the sum of two components, i.e., the frequency of price increases and the frequency of price decreases. Analyzing each of these components separately is useful, particularly when they may display offsetting movements in response to aggregate shocks.

The frequency of price increase for a specific food product "j" sold in a particular city "k" during the time period

"T" is calculated as:

$$F_{jk}^{\uparrow} = \frac{\sum_{t=2}^{T} X_{jkt}^{\uparrow}}{T_{jk}-1}$$

Where, $T_{jk}$ is the total number of monthly price observations $P_{jk}$ over the sample period and $X^{\uparrow}_{jkt}$ is the binary variable indicating the price increase in t.

$$X_{jkt}^{\uparrow} = \begin{cases} 1 \text{ if } P_{jkt} > P_{jkt-1} \\ 0 \text{ otherwise} \end{cases}$$

The average of the monthly frequency of price decreases would be computed analogously as:

$$F_{jk}^{\downarrow} = \frac{\sum_{t=2}^{T} X_{jkt}^{\downarrow}}{T_{jk}-1}$$

Where, $X^{\uparrow}_{jkt}$ is the binary variable indicating the price decrease in t.

$$X_{jkt}^{\downarrow} = \begin{cases} 1 \text{ if } P_{jkt} < P_{jkt-1} \\ 0 \text{ otherwise} \end{cases}$$

The aggregated frequency of price increases (decreases) at the product level is then calculated by averaging over all the cities "k" for the same product category "j".

$$F_j^{\uparrow(\downarrow)} = \frac{\sum_{k=1}^{14} F_k}{K}$$

***The Average Size of Price Change***

An alternative indicator of price-setting behaviour is the size of the price change (increase or decrease). As already explained, the frequency measure is indicative of the extensive margin (how often the price changes), whereas the size of the price change captures the intensive margin behind inflation (Klenow and Malin, 2010).

The average size of price increase or decrease at the product-city level is calculated using the following formulas respectively:

$$\bar{\partial}_{jk}^{\uparrow} = \frac{\sum_{t=2}^{T} X_{jkt}^{\uparrow}(\ln P_{jkt} - \ln P_{jkt-1})}{\sum_{t=2}^{T} X_{jkt}^{\uparrow}}$$

$$\bar{\partial}_{jk}^{\downarrow} = \frac{\sum_{t=2}^{T} X_{jkt}^{\downarrow}(\ln P_{jkt-1} - \ln P_{jkt})}{\sum_{t=2}^{T} X_{jkt}^{\downarrow}}$$

## Degree of Synchronisation across Cities

The synchronization of price changes across cities is computed using the approach proposed by Fisher and Konieczny (2000) known as the "synchronisation ratio". The synchronisation ratio is based on the monthly frequency of price changes.

A perfect synchronization of price changes occurs when either the price changes simultaneously in all the cities of the country or the price remains unchanged in all the cities. Hence, in this case, the proportion of price changes at time t is either equal to 1 or 0. If the average frequency of price changes for product category j is equal to Fj, it means, in the case of perfect synchronisation that price changes in all the cities simultaneously in Fj per cent of cases. Using the probability of price changes, it is then possible to compute the theoretical value of the standard deviation of the proportion of price changes over time in case of perfect synchronisation, which is equal to:

$$SD_j^{max} = \sqrt{F_j(1 - F_j)}$$

This theoretical value is an upper limit for the standard deviation of the proportion of price changes. Similarly, in the case of perfect staggering, if a constant proportion of Fj cities reports a price change each month then the standard deviation of the proportion of price changes over time is equal to 0. The observed standard deviation of price changes for product category j is given by:

$$SD_j = \sqrt{\frac{1}{T-1}\sum_{t=2}^{T}(F_{jt} - F_j)^2}$$

Where T is the number of months for which prices are observed.

The synchronisation ratio of product classification j is defined as the ratio of observed standard deviation to the theoretical maximum standard deviation of price change $SR_j = \frac{SD_j}{SD_j^{max}}$

The synchronisation ratio is equal to 1 in the case of perfect synchronization, while in the case of perfect staggering (complete absence of synchronisation) it is equal to zero.

## Assessment of Volatility in Food Prices

To accomplish the second objective, two methods are used. One is standard deviation and the second is ARCH/GARCH and IGARCH Models.

### *Standard Deviation*

In this method, the standard deviation of log return prices (growth rates) is measured to identify the periods of high and low volatility for each food commodity. The categorisation is based on the median value of the annual standard deviation. The years in which the standard deviation is above or equal to the median value are called high volatile periods represented by "1", while the years in which the standard deviation value is below the median value are called low volatile periods represented by "0". Furthermore, the method also helps to identify the commodities with high and low volatility. The categorisation is based on the median value of standard deviation for the commodities. Over the July 2002–July 2021 period, the commodities with a standard deviation of more than or equal to the median value are referred to as highly volatile commodities and are represented by "1". On the other hand, others are less volatile and are represented by "0". The method assumes constant variance of error terms.

### *ARCH/GARCH Model*

Based on the literature, this paper also employs ARCH/GARCH models to assess the volatility in food prices in Pakistan. To model the time series data it is supposed that the residual has constant variance (homoscedasticity), but actually, the variance of the residual is not constant and heteroscedasticity arises in various time series data. This shows that the assumption of homoskedasticity in the residual variance is not valid. Engle (1982) presented the autoregressive conditional heteroskedasticity (ARCH) models, used to analyse the time series data in the presence of heteroscedasticity.

The equation for the ARCH (p) model to determine the variance is given below:

$$\delta_t^2 = \gamma + \sum_{m=1}^{p} \alpha_m \ \varepsilon_{t-m}^2 \qquad 1$$

Where $\delta^2_t$ is the error term's conditional variance, $\varepsilon^2_{t-m}$ is the squared error term in the preceding period, and α _ms are ARCH parameters.

In this model, the error terms are considered to have a distinctive size or variance, and the variance of the present error term depends on the squares of the preceding error terms. The GARCH model, which was introduced by Bollerslev (1986), is the extension of the ARCH model, introduced by Engle in 1982. The methodology proposed a method to estimate uncertainty if the uncertainty is serially correlated. The GARCH model principally generalizes the ARCH model into an autoregressive moving average model. The equation for the GARCH model is given below.

$$\delta_t^2 = \gamma + \sum_{m=1}^{p} \alpha_m \ \varepsilon_{t-m}^2 + \sum_{n=1}^{q} \beta_n \ \delta_{t-n}^2 \qquad 2$$

In the above equation, δ2t-n are variances in the previous period, $\beta_n$s are GARCH parameters, and 0<α_m<1, 0<β n<1, and $\alpha_m + \beta_n < 1$ fulfill the GARCH conditions

The basic difference between the ARCH and GARCH models is that in the ARCH model, the conditional variance of the error term in period t is based on the squared error term of the preceding period. In the GARCH model, the conditional variance of the error term in period t is based on both the squared error term of the earlier period as in the ARCH (p) model, and also on the conditional variance in the earlier period. Hence, the model is termed the GARCH (p, q) model where p is the lagged term of the squared error term and q is the lagged term of conditional variances.

In the GARCH model, α captures the impact of random deviations in the preceding period on δt2, and β captures the impact of past variance on current variance. If the value of the ARCH error parameter (α) is significant then it is assumed that market actions significantly affect current variance. However, a significant GARCH coefficient (β) points out that shocks to conditional variance depend on the presence of previous variances and it takes a long time to die out. In other words, the volatility is persistent.

This study begins with the estimation of conditional volatility by using ARCH (1) and GARCH (1, 1) models. The ARCH (1) and GARCH (1, 1) conditions shown through equations 3 and 4, respectively, are appropriate as they display a parsimonious illustration of conditional variance that adequately fit most of the high-frequency time series data (Bollerslev, 1987) and Engle, 1993).

$$\delta_t^2 = \gamma + \alpha \ \varepsilon_{(t-1)}^2 \qquad 3$$

$$\delta_t^2 = \gamma + \alpha\varepsilon_{(t-1)}^2 + \beta\delta_{(t-1)}^2 \qquad 4$$

***Integrated GARCH (p, q) Model***

The IGARCH (p, q) model is a wider form of the GARCH (p, q) model. This model has a property of "persistent variance" where the present information remains essential to estimating conditional variances in all prospects. The study uses IGARCH (1,1) model in the cases where the sum of ARCH and GARCH parameters is equal to 1.

The necessary condition for the IGARCH (p, q) model is

α (1) + β (1) = 1

IGARCH (1, 1) is defined by the following equation:

$$\delta_t^2 = \gamma + \alpha\, \varepsilon_{(t-1)}^2 + \beta\delta_{(t-1)}^2 \qquad 5$$

Where $\alpha+\beta=1$

By employing ARCH (1)/GARCH (1,1) and IGARCH (1,1) models, the study generates volatility series for the prices of each commodity for all cities. The justification for applying ARCH/GARCH and IGARCH models for the assessment of volatility is checked by the ARCH-LM test. The test is used to identify the presence of heteroscedasticity in the price series of each food commodity for every city. The null hypothesis of the ARCH-LM test is no ARCH effect, which means that the residuals are homoscedastic, i.e., volatility remains the same over the period (Alemu, et al., 2007). A p-value smaller than 0.05 means that the null hypothesis of no ARCH effect in the residuals is rejected. This rejection of the null hypothesis means that GARCH (1,1) and IGARCH (1,1) models can be used.

## Factors Affecting Food Prices

The third objective is the identification of the factors of a food price change, which is done using the following model:

### *Autoregressive distributed lag (ARDL) model*

The empirical time series model that shows the association among the prices of food commodities and their associated factors is as follows:

$$LP_t = \beta_0 + \beta_1 LREER_t + \beta_2 LRIR_t + \beta_3 LOP_t + \beta_1 LIP_t + \beta_1 LPD_t + \beta_1 LSP_t + \varepsilon_t \qquad 6$$

Where, ⟦LP⟧_t is the log of the price series of a particular food commodity at time t, LREER, LRIR, LOP, LIP, LPD, and LSP are logs of the real effective exchange rate, the real interest rate, input prices (crude oil prices), international prices, production, and support prices, respectively. The above independent variables are almost the same for each commodity. The study uses the ARDL bound test developed by Pesaran et al. (2001). The model identifies a long-run and short-run association among the covariates and prices of each commodity. There are different cointegration approaches, for instance, Engle-Granger (1987), Johansen and Juselius (1990), and Johansen (1991). The ARDL is the most suitable model as it is applicable for the series with different integrating orders, e.g., I(0) or I(1) (Pesaran et al., 2001) unlike other models. The ARDL model is given by the following equation:

$$\Delta LP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\Delta LP_{t-i} + \sum_{i=0}^{p} \alpha_{2i}\Delta LREER_{t-i} + \sum_{i=0}^{p} \alpha_{3i}\Delta LRIR_{t-i} + \sum_{i=0}^{p} \alpha_{4i}\Delta LOP_{t-i} + \sum_{i=0}^{p} \alpha_{5i}\Delta LIP_{t-i} + \sum_{i=0}^{p} \alpha_{6i}\Delta LPD_{t-i} + \sum_{i=0}^{p} \alpha_{7i}\Delta LSP_{t-i} + \alpha_8 LP_{t-1} + \alpha_9 LREER_{t-1} + \alpha_{10} LRIR_{t-1} + \alpha_{11} LOP_{t-1} + \alpha_{12} LIP_{t-1} + \alpha_{13} LPD_{t-1} + \alpha_{14} LSP_{t-1} + \varepsilon_t \qquad 7$$

Where Δ and i are the difference operator and lag length, respectively. The long-run relationship between the covariates (variables) is identified by the F-test of the joint significance of the coefficient of lagged variables. The null hypothesis of the model is $\alpha_8=\alpha_9=\alpha_{10} = \alpha_{11}=\alpha_{12}=\alpha_{13} =\alpha_{14}= 0$, showing the absence of a long-run relationship.

In this test, the variables are cointegrated if the F-statistic (calculated) is greater than the upper critical bound (UCB), while if it is less than the lower critical bound (LCB), the series are not cointegrated. The result is inconclusive if the F-statistic (calculated) is between the UCB and the LCB. These critical bounds are given by Pesaran and Shin (1995). To estimate the short-run association, the following equation presents the error correction model separately for each commodity price.

$$\Delta LP_t = \gamma_0 + \sum_{i=0}^{p} \gamma_{1i} \Delta LREER_{t-i} + \sum_{i=0}^{p} \gamma_{2i} \Delta LRIR_{t-i} + \sum_{i=0}^{p} \gamma_{3i} \Delta LOP_{t-i} + \sum_{i=0}^{p} \gamma_{4i} \Delta LIP_{t-i} + \sum_{i=0}^{p} \gamma_{5i} \Delta LPD_{t-i} + \sum_{i=0}^{p} \gamma_{6i} \Delta LSP_{t-i} + \phi ECT_{t-1} + \varepsilon_t \qquad 8$$

The negative and significant value of the coefficient of $ECT_{t-1}$ (ϕ) means that the dependent variable monotonically converges to a long-run equilibrium as a result of a change in its determinants.

## 6. FINDINGS AND DISCUSSION

This section details the estimation results.

### The Duration and Frequency of Price Change

Table 1 below presents the average frequency of price change and the corresponding implied duration derived from the frequency approach for fifteen food products. Price rigidity computed by frequency of price change and implied duration reveals a considerable variation among food products. The green bars in the table help us to visualise and analyse the results more easily. On average, 66.8 per cent of prices changed every month during the period under study, implying the mean duration of 1.9 months of price spell.

Commodities such as tomatoes, onions, potatoes, garlic, chicken, and eggs proved to have the most flexible prices. Prices of refined sugar also showed frequent changes with the implied duration of just 1.2 months of price spell. Averaged at the city level, the prices of tomatoes changed most frequently (94.7%) implying a shorter duration of about 1 month (or even less) of price spell. Similarly, the frequency of price change of farm chicken and eggs was 94.3 and 91.5 per cent, respectively.

Wheat flour and pulses show relatively moderate price adjustments with an implied mean duration of 1.4 to 1.6 months spells, respectively. In contrast, there existed a range of other goods as well that proved relatively less flexible price behaviour. Among these, the most evident food categories were fresh milk, tea, beef, and rice. These commodities exhibited a low frequency of price change with a mean implied duration of more than three months of price spell.

*Table 1: Frequency and Implied Duration of Price Change*

| Commodities | Frequency (%) | Implied Duration (months) |
|---|---|---|
| Milk Fresh | 23.5 | 4.3 |
| Tea | 26.7 | 3.7 |
| Beef | 30.8 | 3.3 |
| Rice | 32.5 | 3.1 |
| Pulse Masoor | 61.4 | 1.6 |
| Pulse Mash washed | 64.7 | 1.5 |
| Pulse Moong Washed | 67.4 | 1.5 |
| Wheat flour | 69.5 | 1.4 |
| Garlic | 83.4 | 1.2 |
| Potatoes | 85.0 | 1.2 |
| Sugar refined | 85.1 | 1.2 |
| Onion | 91.4 | 1.1 |
| Egg Farm | 91.5 | 1.1 |
| Chicken Farm | 94.3 | 1.1 |
| Tomatoes | 94.7 | 1.1 |
| Total | 66.8 | 1.9 |

*Source: Author's Calculation*

An almost similar frequency of price change was observed for all food products at the city level Most evident fact shown in Table 2 is that in Khuzdar, the prices of almost all the food products under consideration changed less frequently than in the rest of other cities. It is also noticed that prices of most commodities changed more frequently in big metropolitan cities than in the rest of the cities. For instance, fresh milk which showed the least events of price change on average revealed a relatively higher frequency of price change in Islamabad, Rawalpindi, Karachi, Peshawar, Multan, and Lahore. Similarly, beef showed a high frequency of price change in Peshawar, Islamabad, Rawalpindi, Karachi, Multan, and Lahore.

The above analysis shows that there was a range of food commodities that are characterised by flexible prices, while several others showed moderate durations of price spells. Several other studies, such as Bils and Klenow (2004), Aucremanne and Dhyne (2004) provide similar results about the existence of highly heterogonous price-setting behaviour among various products.

As mentioned above, the duration of a price spell can also be computed directly by the duration approach. In the next section, we analyse the price behaviour of each product by the duration approach which also helps us in validating the above results.

*Table 2: Frequency of Price Change by City*

| Frequency of Price change by City (%) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cities | Beef | Chicken | Egg | Garlic | Milk | Onion | Potatoes | Pulse Mash | Pulse Masoor | Pulse Moong | Rice | Sugar | Tea | Tomatoes | Wheat flour |
| Bahawalpur | 25.8 | 95.2 | 90.4 | 79.0 | 20.5 | 87.3 | 73.4 | 60.1 | 50.7 | 59.8 | 19.2 | 77.3 | 27.1 | 93.8 | 86.9 |
| Faisalabad | 26.2 | 97.4 | 93.9 | 86.5 | 17.9 | 96.1 | 93.0 | 65.9 | 73.8 | 72.1 | 34.1 | 88.6 | 27.1 | 95.6 | 80.9 |
| Hyderabad | 27.5 | 96.1 | 93.9 | 88.8 | 21.8 | 93.4 | 83.4 | 72.9 | 72.1 | 80.1 | 35.8 | 82.5 | 25.3 | 96.9 | 79.5 |
| Islamabad | 43.7 | 98.7 | 97.4 | 82.1 | 35.8 | 96.1 | 94.8 | 55.5 | 54.1 | 63.8 | 24.0 | 87.8 | 29.7 | 98.3 | 76.0 |
| Karachi | 38.3 | 96.5 | 94.1 | 90.0 | 31.9 | 95.2 | 86.9 | 82.7 | 79.5 | 79.5 | 52.0 | 82.6 | 24.5 | 97.8 | 63.3 |
| Khuzdar | 22.7 | 78.6 | 78.6 | 76.4 | 14.4 | 86.0 | 74.2 | 55.5 | 54.1 | 49.8 | 34.9 | 75.5 | 21.8 | 86.5 | 48.5 |
| Lahore | 29.7 | 98.7 | 98.3 | 83.0 | 26.6 | 98.7 | 95.2 | 63.3 | 59.4 | 62.9 | 21.8 | 89.5 | 26.6 | 98.7 | 71.2 |
| Multan | 30.1 | 96.5 | 92.1 | 84.7 | 30.6 | 93.7 | 84.7 | 59.4 | 55.5 | 74.2 | 41.9 | 84.3 | 26.6 | 95.6 | 85.6 |
| Peshawar | 45.4 | 98.3 | 93.9 | 93.7 | 31.0 | 94.8 | 86.9 | 89.5 | 83.8 | 90.8 | 55.5 | 90.0 | 29.7 | 96.9 | 63.8 |
| Quetta | 25.3 | 94.8 | 88.6 | 82.1 | 17.0 | 85.6 | 82.3 | 86.5 | 72.9 | 86.9 | 31.4 | 88.2 | 26.2 | 94.8 | 42.8 |
| Rawalpindi | 43.7 | 98.3 | 96.5 | 79.5 | 35.8 | 96.5 | 92.3 | 63.8 | 58.1 | 66.8 | 26.6 | 93.9 | 30.6 | 98.7 | 79.0 |
| Sargodha | 28.6 | 92.1 | 90.8 | 79.9 | 19.7 | 90.4 | 83.0 | 57.2 | 49.3 | 58.5 | 35.4 | 79.9 | 25.8 | 90.0 | 72.5 |
| Sialkot | 24.5 | 96.5 | 89.0 | 82.1 | 13.1 | 83.8 | 87.8 | 47.2 | 46.3 | 46.7 | 16.2 | 77.7 | 25.3 | 91.3 | 72.5 |
| Sukkur | 20.1 | 83.0 | 86.0 | 82.1 | 12.7 | 84.1 | 72.5 | 47.6 | 50.2 | 51.5 | 25.8 | 83.0 | 27.1 | 91.3 | 58.2 |

*Source: Author's Calculation*

Table 3 shows the estimated duration of price spells from the duration approach, averaged at the city level.

*Table 3: Duration of Price Change*

| Duration of Price Change (%) | |
|---|---|
| Tomatoes | 1.06 |
| Chicken | 1.07 |
| Egg | 1.10 |
| Onion | 1.10 |
| Sugar | 1.18 |
| Potatoes | 1.19 |
| Garlic | 1.20 |
| Wheat flour | 1.51 |
| Pulse Moong | 1.54 |
| Pulse Mash | 1.60 |
| Pulse Masoor | 1.69 |
| Rice | 3.45 |
| Beef | 3.46 |
| Tea | 3.77 |
| Milk Fresh | 4.80 |
| Total | 1.98 |

*Source: Author's Calculation*

Table 3 reveals that the average duration of price spells was 1.9 months when estimated using both the frequency approach and the duration approach. A comparison of the duration approach and frequency approach shows an analogous pattern across food products. The duration of tomato prices was about 1.1 months from both approaches, which is the shortest duration found in the sample. It shows that tomatoes had the most flexible price behaviour among all the commodities in the sample. Similar to the results of the frequency approach, vegetables, farm eggs, and farm chicken showed flexible price behaviour.

On average, fresh milk had the longest duration of 4.8 months of price spells. However, analysing at the city level, substantial heterogeneity in prices of fresh milk among cities was found. Table 4 reveals that the duration of the price spell for milk was as low as 2.76 months in Islamabad and as high as 7.9 months in Sialkot, which is famous for milk production in Pakistan. Overall, it is observed that prices changed more frequently in large cities such as Islamabad, Rawalpindi, Karachi, Peshawar, Multan and Lahore, while the prices changed less frequently in cities such as Sialkot, Sukkur, and Khuzdar.

Similarly, rice, beef and tea, on average, also showed longer duration of price spells. However, similar to fresh milk, rice and beef showed greater heterogeneity in price duration in different cities. In the main cities of Punjab, such as Sialkot, Bahawalpur, Lahore, Islamabad and Rawalpindi, the duration of the price spell was large to moderate. This shows that in the cities of Punjab, which is the main region of rice cultivation in Pakistan, the prices are relatively stable.

Although the frequency of price change and duration of price spells are important indicators in assessing the dynamics of price changes across commodities and regions, to understand the economic impact of price change at the macro level, the extensive and intensive margins of inflation are even more important concepts. In this respect, the frequency of price increase and decrease defines the extensive margin of inflation, while the magnitude of the increase and decrease in prices defines the intensive margin of inflation. The estimates of the extensive and intensive margins of inflation are presented in the next sections.

*Table 4: Duration of Price Change by City*

| | Duration of Price change by City (month) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cities | Beef | Chicken Farm | Egg Farm | Garlic | Milk Fresh | Onion | Potatoes | lse Mash wash | Pulse Masoore | Moong Was | Rice | Sugar refined | Tea | Tomatoes | Wheat flour |
| Bahawalpur | 3.95 | 1.06 | 1.11 | 1.27 | 4.77 | 1.15 | 1.36 | 1.66 | 1.97 | 1.67 | 5.09 | 1.30 | 3.63 | 1.08 | 1.15 |
| Faisalabad | 3.75 | 1.03 | 1.07 | 1.16 | 5.59 | 1.04 | 1.08 | 1.52 | 1.36 | 1.39 | 2.97 | 1.13 | 3.69 | 1.05 | 1.24 |
| Hyderabad | 3.63 | 1.04 | 1.07 | 1.13 | 4.67 | 1.07 | 1.20 | 1.37 | 1.39 | 1.24 | 2.76 | 1.21 | 3.95 | 1.03 | 1.26 |
| Islamabad | 2.29 | 1.01 | 1.03 | 1.22 | 2.76 | 1.04 | 1.06 | 1.80 | 1.85 | 1.57 | 4.16 | 1.14 | 3.37 | 1.02 | 1.32 |
| Karachi | 2.57 | 1.04 | 1.06 | 1.11 | 3.18 | 1.05 | 1.15 | 1.22 | 1.26 | 1.26 | 1.92 | 1.08 | 4.09 | 1.02 | 1.58 |
| Khuzdar | 4.32 | 1.27 | 1.27 | 1.31 | 6.74 | 1.16 | 1.35 | 1.80 | 1.85 | 2.01 | 2.90 | 1.32 | 4.58 | 1.16 | 2.06 |
| Lahore | 3.37 | 1.01 | 1.02 | 1.21 | 3.75 | 1.01 | 1.05 | 1.58 | 1.68 | 1.59 | 4.49 | 1.12 | 3.75 | 1.01 | 1.40 |
| Multan | 3.32 | 1.04 | 1.09 | 1.18 | 3.32 | 1.09 | 1.18 | 1.68 | 1.79 | 1.35 | 2.41 | 1.19 | 3.75 | 1.05 | 1.17 |
| Peshawar | 2.20 | 1.02 | 1.07 | 1.09 | 3.18 | 1.06 | 1.15 | 1.12 | 1.20 | 1.10 | 1.79 | 1.11 | 3.37 | 1.03 | 1.57 |
| Quetta | 4.02 | 1.06 | 1.13 | 1.22 | 5.87 | 1.17 | 1.21 | 1.16 | 1.37 | 1.15 | 3.23 | 1.13 | 3.82 | 1.06 | 2.34 |
| Rawalpindi | 2.29 | 1.02 | 1.04 | 1.26 | 2.83 | 1.04 | 1.09 | 1.57 | 1.72 | 1.50 | 3.69 | 1.07 | 3.27 | 1.01 | 1.27 |
| Sargodha | 3.69 | 1.09 | 1.10 | 1.25 | 4.98 | 1.11 | 1.21 | 1.73 | 2.01 | 1.71 | 2.83 | 1.25 | 3.88 | 1.11 | 1.38 |
| Sialkot | 4.09 | 1.04 | 1.16 | 1.22 | 7.90 | 1.19 | 1.14 | 2.14 | 2.18 | 2.14 | 6.19 | 1.29 | 3.95 | 1.10 | 1.38 |
| Sukkur | 4.98 | 1.21 | 1.16 | 1.22 | 7.63 | 1.19 | 1.38 | 2.10 | 1.99 | 1.94 | 3.88 | 1.21 | 3.69 | 1.10 | 1.99 |

*Source: Author's calculations.*

## The Direction of Price Change

Table 5 shows the average frequency of increase and decrease in prices. Yellow bars in both columns reveal that the prices of most of the commodities increased and then decreased, showing spells of both price increase and decrease. On the other hand, other commodities exhibited a higher frequency of price increase and a lower frequency of price decrease. Overall, a price increase was found to be more frequent than a price decrease for the sampled food commodities. Table 5 shows that the average frequency of price increases was 38.2 per cent compared to 28.6 per cent of price decreases.

The highest frequency of price increases was recorded for farm eggs followed by farm chicken and potatoes, whereas the lowest frequency of price increases was found for tea and fresh milk. The highest frequency of price decreases was found for tomatoes, followed by onion and farm chicken. Rare events of price decreases were recorded for fresh milk and beef.

On average, price increases were usually more widespread, however, price decreases were also not a very uncommon phenomenon for most food products.

*Table 5: Direction of Price Change (%)*

| Commodities | Increase (%) | Decrease (%) |
|---|---|---|
| Milk Fresh | 20.62 | 2.87 |
| Beef | 27.51 | 3.24 |
| Tea | 18.34 | 8.33 |
| Rice | 21.12 | 11.35 |
| Wheat flour | 45.29 | 24.17 |
| Pulse Mash | 35.09 | 26.33 |
| Pulse Masoor | 38.02 | 26.70 |
| Pulse Moong | 37.71 | 29.69 |
| Potatoes | 47.10 | 37.90 |
| Garlic | 45.32 | 38.08 |
| Egg Farm | 53.18 | 38.30 |
| Sugar refined | 45.60 | 39.46 |
| Chicken farm | 47.63 | 46.69 |
| Onion | 44.70 | 46.72 |
| Tomatoes | 45.54 | 49.13 |
| Total | 38.18 | 28.60 |

*Source: Author's Calculations.*

Table 6 shows the direction of price changes by city. The darker shade of green in the table represents the high frequency of price change and the gradual lightening tone shows the decreasing frequency. Table 6 corroborates the city-level findings presented in Table 5.

*Table 6: Direction of Price Change by City*

| Cities | Increase/Decrease | Frequency of Price Increase & Decrease by City (%) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Beef | Chicken | Egg | Garlic | Milk | Onion | Potatoes | Pulse Mash | Pulse Masoor | Pulse Moong | Rice | Sugar | Tea | Tomatoes | Wheat flour |
| Bahawalpur | Increase | 22.7 | 46.7 | 52.4 | 46.3 | 20.1 | 44.5 | 41.0 | 36.2 | 27.9 | 30.6 | 13.5 | 43.2 | 18.3 | 45.0 | 54.6 |
| | Decrease | 3.1 | 48.5 | 38.0 | 32.8 | 0.4 | 42.8 | 32.3 | 24.0 | 22.7 | 29.3 | 5.7 | 34.1 | 8.7 | 48.0 | 32.3 |
| Faisalabad | Increase | 24.0 | 48.5 | 55.0 | 43.7 | 15.7 | 48.0 | 51.5 | 41.0 | 40.6 | 40.2 | 23.6 | 50.2 | 18.3 | 47.6 | 53.3 |
| | Decrease | 2.2 | 48.9 | 38.9 | 42.8 | 2.2 | 48.0 | 41.5 | 24.9 | 33.2 | 31.9 | 10.5 | 38.4 | 8.7 | 48.0 | 27.5 |
| Hyderabad | Increase | 25.8 | 48.0 | 53.7 | 47.2 | 18.3 | 45.4 | 47.6 | 45.0 | 42.8 | 42.8 | 22.3 | 41.5 | 17.5 | 49.8 | 48.9 |
| | Decrease | 1.7 | 48.0 | 40.2 | 41.5 | 3.5 | 48.0 | 35.8 | 27.9 | 29.3 | 37.6 | 13.5 | 41.0 | 7.9 | 47.2 | 30.6 |
| Islamabad | Increase | 39.7 | 49.8 | 57.6 | 46.3 | 32.8 | 44.1 | 52.4 | 35.8 | 33.6 | 37.6 | 17.5 | 49.3 | 20.5 | 46.3 | 49.8 |
| | Decrease | 3.9 | 48.9 | 39.7 | 35.8 | 3.1 | 52.0 | 42.4 | 19.7 | 20.5 | 26.2 | 6.6 | 38.4 | 9.2 | 52.0 | 26.2 |
| Karachi | Increase | 34.9 | 48.9 | 52.8 | 47.6 | 25.3 | 46.7 | 48.0 | 50.2 | 39.7 | 42.4 | 36.2 | 51.1 | 16.6 | 48.9 | 41.5 |
| | Decrease | 4.4 | 47.6 | 41.5 | 42.4 | 6.6 | 48.5 | 38.9 | 31.4 | 39.7 | 37.1 | 15.7 | 41.5 | 7.9 | 48.9 | 21.8 |
| Khuzdar | Increase | 17.9 | 41.5 | 41.9 | 42.4 | 11.4 | 42.4 | 38.9 | 30.1 | 30.1 | 29.7 | 22.3 | 38.4 | 14.4 | 39.3 | 31.0 |
| | Decrease | 4.8 | 37.1 | 36.7 | 34.1 | 3.1 | 43.7 | 35.4 | 25.3 | 24.0 | 20.1 | 12.7 | 37.1 | 7.4 | 47.2 | 17.5 |
| Lahore | Increase | 27.5 | 48.9 | 56.8 | 44.5 | 23.1 | 51.1 | 51.1 | 37.1 | 32.3 | 38.0 | 14.8 | 45.9 | 18.8 | 45.9 | 53.3 |
| | Decrease | 2.2 | 49.8 | 41.5 | 38.4 | 3.5 | 47.6 | 44.1 | 26.2 | 27.1 | 24.9 | 7.0 | 43.7 | 7.9 | 52.8 | 17.9 |
| Multan | Increase | 27.5 | 50.2 | 55.9 | 49.8 | 28.4 | 47.2 | 51.1 | 33.2 | 32.3 | 38.0 | 24.9 | 46.3 | 18.8 | 46.7 | 54.6 |
| | Decrease | 2.6 | 46.3 | 36.2 | 34.9 | 2.2 | 44.5 | 33.6 | 26.2 | 23.1 | 36.2 | 17.0 | 38.0 | 7.9 | 48.9 | 31.0 |
| Peshawar | Increase | 41.0 | 48.0 | 54.6 | 48.0 | 28.4 | 44.1 | 48.0 | 49.3 | 46.3 | 49.3 | 34.1 | 46.7 | 20.1 | 41.5 | 38.4 |
| | Decrease | 4.4 | 50.2 | 39.3 | 43.7 | 2.6 | 50.7 | 38.9 | 40.2 | 37.6 | 41.5 | 21.4 | 43.2 | 9.6 | 55.5 | 25.3 |
| Quetta | Increase | 22.3 | 48.5 | 50.7 | 45.9 | 14.4 | 40.2 | 45.9 | 46.7 | 44.1 | 48.0 | 18.3 | 45.4 | 18.3 | 47.6 | 25.8 |
| | Decrease | 3.1 | 46.3 | 38.0 | 36.2 | 2.6 | 45.4 | 36.2 | 39.7 | 28.8 | 38.9 | 13.1 | 42.8 | 7.9 | 47.2 | 17.0 |
| Rawalpindi | Increase | 38.4 | 48.5 | 57.2 | 45.9 | 31.9 | 45.9 | 52.0 | 40.2 | 34.9 | 41.0 | 19.2 | 51.1 | 21.4 | 45.4 | 51.5 |
| | Decrease | 5.2 | 49.8 | 39.3 | 33.6 | 3.9 | 50.7 | 40.2 | 23.6 | 23.1 | 25.8 | 7.4 | 42.8 | 9.2 | 53.3 | 27.5 |
| Sargodha | Increase | 24.5 | 47.6 | 53.3 | 38.9 | 16.6 | 43.7 | 42.8 | 31.9 | 27.5 | 32.3 | 22.7 | 41.5 | 17.9 | 43.2 | 46.3 |
| | Decrease | 21.8 | 44.5 | 37.6 | 41.0 | 3.1 | 46.7 | 40.2 | 25.3 | 21.8 | 26.2 | 12.7 | 38.4 | 7.9 | 46.7 | 26.2 |
| Sialkot | Increase | 21.4 | 48.0 | 50.7 | 45.0 | 10.0 | 42.4 | 48.0 | 27.9 | 29.7 | 28.4 | 9.2 | 42.4 | 17.5 | 43.7 | 50.2 |
| | Decrease | 3.1 | 48.5 | 35.4 | 37.1 | 3.1 | 41.5 | 39.7 | 19.2 | 16.6 | 18.3 | 7.0 | 35.4 | 7.9 | 47.6 | 22.3 |
| Sukkur | Increase | 17.5 | 43.7 | 52.0 | 43.2 | 12.2 | 40.2 | 41.0 | 27.5 | 29.3 | 29.7 | 17.0 | 45.4 | 18.3 | 46.7 | 34.9 |
| | Decrease | 2.6 | 39.3 | 34.1 | 38.9 | 0.4 | 44.1 | 31.4 | 20.1 | 21.0 | 21.8 | 8.7 | 37.6 | 8.7 | 44.5 | 15.3 |

*Source: Authors' calculations*

For beef, the overall frequency of price increases was low relative to most of the other food products. However, a city-wise comparison in Table 6 reveals the reverse case for large cities. For instance, Peshawar, Islamabad, Rawalpindi, Karachi, Lahore and Multan showed a high frequency of price increases, whereas price decreases were rare.

A similar pattern of price increase was observed for milk. The frequency of price increases was higher in large cities, such as Islamabad, Rawalpindi, Multan, Peshawar, Karachi, and Lahore compared to other cities. Rice and tea, on the other hand, showed similar frequencies of price increases across cities. A common pattern observed in these four commodities is that the difference between the frequency of price increase and decrease was larger compared to most of the other food commodities in the vegetable group, chicken, egg, and sugar.

For commodities such as chicken, egg, tomato, onion, garlic, potato, and sugar, the frequency of price increases and decreases was almost similar, which shows that a price increase is usually followed by a price decrease. These results point towards the existence of some temporary shocks, including weather conditions, speculation, pest attacks, production shock, etc.

Although the direction of price change is an important phenomenon in explaining the overall price change behaviour, the size or magnitude of price change is also important. Hence, in the next section of this study, the magnitude of price change is estimated and analysed.

## Average price change

Table 7 below shows the average size of price increases and decreases. The table shows that the average size of price increase was 11 per cent compared to an 11.36 per cent price decrease. The average size of both the price increase and decrease was sizeable for most of the perishable food products. Although for some food products, the size of the price decrease was greater than the price increase for other products the magnitude of the increase was higher.

*Table 7: Size of Price Change*

| Commodities | Increase (%) | Decrease (%) |
|---|---|---|
| Pulse Masoor | 5.25 | 4.56 |
| Pulse Mash | 5.74 | 5.06 |
| Sugar refined | 5.86 | 5.09 |
| Wheat flour | 4.73 | 5.18 |
| Pulse Moong | 6.24 | 5.28 |
| Milk Fresh | 5.51 | 7.18 |
| Rice | 8.18 | 7.97 |
| Tea | 6.72 | 8.81 |
| Beef | 5.23 | 11.68 |
| Garlic | 11.94 | 12.09 |
| Chicken Farm | 13.02 | 12.27 |
| Egg Farm | 11.60 | 14.19 |
| Potatoes | 15.95 | 18.12 |
| Onion | 21.94 | 19.80 |
| Tomatoes | 37.12 | 33.11 |
| Total | 11.00 | 11.36 |

*Source: Authors' calculations*

Table 7 shows that the price of tomatoes recorded the highest magnitude of price change, followed by onions. During the analysis period, the lowest price of tomatoes was Rs. 4.5 in Sargodha in May 2004 and the highest price recorded was Rs. 212 in Islamabad in November 2019. These variations in the prices of tomatoes are because of the production and supply shocks. Although there were very few events of price decreases in milk and beef, Table 7 shows that the magnitude of these decreases was relatively high.

Table 8 below shows the magnitude of price increases and decreases at the city and commodity levels. The red bars show the magnitude of price decreases and the blue bars show the magnitude of price increases. The table reveals that prices increased and decreased with the same magnitude in almost all the cities for most of the commodities except for milk, rice, and tomato.

The price of milk decreased by a higher magnitude only in a few cities, namely, Faisalabad, Hyderabad, Sialkot, and Peshawar. Similarly, the magnitude of the price decrease of rice was higher in Karachi and Rawalpindi. In the case of tomatoes, the highest magnitude of price increase was recorded in Sargodha, followed by Khuzdar and Bahawalpur.

In all the cities, although the smallest price increases and decreases were recorded for pulses over, the frequency of price increases was more than the frequency of price decreases. This shows small but frequent increases in the prices of pulses in all cities. It is worth mentioning that most of the demand for pulses is fulfilled through import in Pakistan as pulses are cultivated as only cash crops, hence, local production is not sufficient to meet the total demand for pulses in the country (Ullah et. al. 2020). Intensive and extensive margins of inflation for pulses show the transmission of international prices to the domestic market.

As far as wheat flour is concerned, the size of the price decreases was relatively higher than the size of the price increases in almost all cities of Pakistan. However, the events of price increases were more for wheat than the events of price decreases, which suggests the increasing trend of price over the period under study.

*Table 8: Magnitude of Price Increase and Decrease by City (%)*

| Size of Price Increase & Decrease by City (%) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cities | rease/Decrea | Beef | Chicken | Egg | Garlic | Milk | Onion | Potatoes | Pulse Mash | Pulse Masoor | Pulse Moong | Rice | Sugar | Tea | Tomatoes | Wheat flour |
| Bahawalpur | Increase | 5.53 | 13.46 | 12.32 | 12.26 | 4.28 | 22.93 | 18.88 | 6.53 | 6.06 | 8.06 | 9.49 | 5.51 | 5.62 | 41.49 | 5.21 |
| | Decrease | -9.22 | -12.10 | -15.13 | -14.40 | -3.39 | -22.52 | -21.81 | -6.56 | -4.76 | -5.96 | -8.25 | -5.05 | -6.20 | -37.54 | -6.17 |
| Faisalabad | Increase | 5.19 | 13.38 | 10.95 | 13.83 | 7.96 | 21.36 | 19.10 | 4.80 | 5.48 | 6.57 | 6.70 | 4.64 | 5.97 | 34.02 | 4.16 |
| | Decrease | -8.53 | -12.39 | -13.68 | -12.37 | -20.02 | -20.04 | -21.85 | -4.78 | -4.80 | -5.88 | -7.82 | -4.37 | -6.94 | -32.32 | -5.02 |
| Hyderabad | Increase | 4.14 | 12.29 | 11.58 | 11.53 | 6.24 | 23.52 | 15.45 | 5.10 | 4.18 | 4.83 | 7.06 | 6.71 | 8.23 | 37.76 | 4.98 |
| | Decrease | -6.65 | -11.33 | -13.58 | -11.43 | -10.92 | -21.03 | -18.93 | -5.29 | -3.80 | -3.51 | -6.10 | -5.15 | -12.06 | -38.45 | -5.14 |
| Islamabad | Increase | 3.11 | 12.62 | 9.89 | 8.61 | 3.04 | 16.95 | 10.96 | 4.36 | 5.65 | 4.53 | 5.45 | 8.20 | 6.35 | 28.35 | 3.77 |
| | Decrease | -5.91 | -11.84 | -12.57 | -9.00 | -5.93 | -13.22 | -12.30 | -3.73 | -6.12 | -3.57 | -3.22 | -8.81 | -8.87 | -23.87 | -3.82 |
| Karachi | Increase | 3.97 | 13.72 | 12.14 | 11.12 | 4.23 | 20.10 | 11.01 | 4.67 | 5.23 | 5.39 | 9.95 | 5.64 | 8.53 | 37.08 | 4.01 |
| | Decrease | -8.80 | -13.04 | -13.61 | -10.57 | -4.59 | -18.17 | -12.08 | -4.75 | -3.47 | -4.04 | -18.23 | -5.29 | -11.79 | -35.56 | -3.74 |
| Khuzdar | Increase | 6.62 | 9.77 | 14.30 | 13.84 | 7.97 | 27.27 | 16.77 | 8.52 | 7.50 | 8.36 | 8.07 | 6.35 | 7.45 | 42.10 | 6.18 |
| | Decrease | -5.19 | -9.43 | -14.35 | -15.62 | -5.25 | -25.58 | -16.71 | -7.37 | -6.84 | -8.36 | -7.99 | -4.79 | -7.87 | -33.91 | -6.36 |
| Lahore | Increase | 3.63 | 15.70 | 11.15 | 10.85 | 4.04 | 18.84 | 16.34 | 4.51 | 4.60 | 5.11 | 7.39 | 4.76 | 5.74 | 34.40 | 3.44 |
| | Decrease | -2.34 | -14.50 | -13.59 | -10.52 | -3.79 | -18.90 | -17.91 | -3.56 | -3.25 | -4.89 | -4.90 | -3.47 | -7.49 | -28.51 | -5.43 |
| Multan | Increase | 4.28 | 12.23 | 11.69 | 11.67 | 2.86 | 21.99 | 17.94 | 5.81 | 5.04 | 7.04 | 8.15 | 5.33 | 6.02 | 38.22 | 4.07 |
| | Decrease | -5.00 | -12.15 | -16.09 | -14.11 | -2.17 | -21.98 | -25.88 | -4.30 | -4.22 | -5.36 | -6.94 | -4.73 | -8.16 | -35.20 | -4.46 |
| Peshawar | Increase | 2.68 | 12.79 | 10.21 | 11.19 | 3.58 | 19.87 | 12.09 | 4.65 | 4.05 | 6.24 | 4.60 | 6.97 | 8.46 | 38.53 | 5.39 |
| | Decrease | -3.72 | -11.32 | -12.33 | -10.37 | -8.04 | -15.91 | -13.13 | -3.70 | -3.31 | -5.38 | -3.22 | -5.97 | -12.60 | -27.19 | -5.02 |
| Quetta | Increase | 5.33 | 10.82 | 9.24 | 12.34 | 6.54 | 19.83 | 13.61 | 6.63 | 4.55 | 5.38 | 7.92 | 5.31 | 5.91 | 33.50 | 6.40 |
| | Decrease | -5.21 | -10.35 | -10.17 | -12.88 | -6.09 | -16.14 | -15.35 | -5.99 | -4.49 | -4.61 | -4.63 | -4.04 | -7.55 | -32.21 | -4.79 |
| Rawalpindi | Increase | 3.38 | 14.41 | 12.05 | 9.37 | 3.21 | 21.80 | 12.94 | 4.30 | 3.91 | 5.06 | 10.64 | 4.49 | 5.45 | 32.73 | 4.21 |
| | Decrease | -4.39 | -12.99 | -15.73 | -10.39 | -4.96 | -18.46 | -15.22 | -3.72 | -3.21 | -4.84 | -17.43 | -3.82 | -7.37 | -26.40 | -4.70 |
| Sargodha | Increase | 8.78 | 14.54 | 13.23 | 15.28 | 5.77 | 26.11 | 23.06 | 5.92 | 5.83 | 6.66 | 8.62 | 5.60 | 6.03 | 43.55 | 4.44 |
| | Decrease | -5.17 | -14.60 | -16.84 | -12.62 | -6.87 | -23.19 | -22.33 | -4.23 | -4.23 | -5.23 | -9.38 | -4.28 | -7.51 | -38.47 | -4.69 |
| Sialkot | Increase | 10.83 | 13.80 | 11.55 | 11.17 | 11.05 | 23.09 | 20.00 | 6.30 | 5.48 | 6.42 | 11.96 | 5.58 | 6.10 | 38.39 | 4.32 |
| | Decrease | -4.29 | -12.68 | -14.64 | -11.42 | -11.63 | -21.85 | -22.43 | -5.47 | -6.09 | -6.00 | -6.61 | -4.78 | -7.34 | -33.80 | -5.96 |
| Sukkur | Increase | 5.68 | 12.80 | 12.12 | 14.12 | 6.33 | 23.52 | 15.14 | 8.32 | 6.01 | 7.67 | 8.50 | 6.97 | 8.20 | 39.52 | 5.58 |
| | Decrease | -3.83 | -13.11 | -16.38 | -13.62 | -6.90 | -20.15 | -17.78 | -7.41 | -5.28 | -6.31 | -6.85 | -6.67 | -11.62 | -40.15 | -7.19 |

*Source: Authors' calculations*

## The Degree of Synchronisation across Cities

Table 9 shows a broad spectrum of synchronisation across cities which ranged from partially staggered to partially synchronized pricing behaviour. On average, the synchronisation ratio of food products among cities was 0.53, whereas the computed synchronisation of each product across cities ranged between 43 and about 80 per cent. The highest degree of synchronisation in price change was for tea.

*Table 9: Synchronisation of Prices among Cities*

| | |
|---|---|
| Beef | 0.43 |
| Pulse Masoor | 0.45 |
| Milk Fresh | 0.46 |
| Rice | 0.46 |
| Pulse Moong Washed | 0.46 |
| Pulse Mash washed | 0.46 |
| Garlic | 0.48 |
| Wheat flour | 0.50 |
| Potatoes | 0.51 |
| Egg Farm | 0.57 |
| Onion | 0.57 |
| Sugar refined | 0.59 |
| Chicken Farm | 0.60 |
| Tomatoes | 0.64 |
| Tea | 0.79 |
| Total | 0.53 |

*Source: Authors' calculations*

The degree of synchronisation for tea was 80 per cent, which is the highest among all the sampled food commodities. This is probably because most of the demand for tea is fulfilled through import as Pakistan is the third largest importer of tea. Since the price of tea mainly depends on international tea prices, its price changes simultaneously in all cities.

The synchronisation ratio of tomatoes was relatively higher. This shows that the tomato shortage and delay in their import impact all the cities simultaneously. Similarly, the prices of farm chicken, refined sugar, onion, and farm egg were also found to be relatively well synchronized.

The remaining commodities, listed in Table 9, however, were found to be quasi-synchronised with the degree of synchronisation ranging between 51 and 43 per cent. It is important to note that although the prices of food items are released by the government to maintain the harmonised system, these results show that there are problems with implementation and proper checks and balances of prices across cities.

## Volatility Assessment

### *Standard Deviation*

The periods of high and low volatility for each commodity are presented in Table A-3 (Appendix). The table shows that during the period of accelerated global food prices, i.e., 2002-2008, in Pakistan the food prices of beef, chicken, egg, tomato, and sugar were highly volatile as compared to other commodities. Furthermore, 2008-09 was highly volatile for egg, milk, onion, tomato, potato, mash, masoor, rice, wheat, and tea. Unsurprisingly, in

2008-09 the food inflation record of the previous 23 years was broken as inflation reached 23.13 per cent. In the next year, almost all food commodities remained volatile except tomatoes and tea. It is evident from the results that during the years 2014-2015 and 2015-16, the volatility in most of the food commodity prices was low as there was a decline in the fuel prices in 2014-15. Additionally, in 2020, due to COVID-19, all the food commodities, except onion, were highly volatile. Table A-4 (Appendix) shows that the prices of beef, chicken, egg, sugar, and all vegetables were highly volatile over the given period, while milk, tea and rice, wheat, and all three pulses were comparatively less volatile.

***ARCH/ GARCH Model***

Before estimating ARCH/ GARCH and IGARCH models, unit root and ARCH-LM tests were applied. For the unit root, the Augmented Dickey-Fuller (ADF) test was applied to the log return[5] price series of each food commodity for each city. Unit root results[6] reveal that the log return price series of all food commodities were stationary at the level for each city.

***The ARCH Lagrange Multiplier (LM) Test***

ARCH-LM test was performed to identify the existence of short-run time-varying volatility in the log return prices of food commodities for each city. Table A-5 (Appendix) shows that for most of the cities, the ARCH effect was present in the log return price series of all food commodities except Khuzdar, Quetta, and Sukkur (beef), Islamabad (chicken), Khuzdar (milk), Bahawalpur (garlic), Lahore and Sialkot (onion), Karachi and Multan (potato), Bahawalpur and Sukkur (tomato) Khuzdar and Lahore (mash), Bahawalpur, Karachi, Lahore, and Multan (masoor), Bahawalpur, Hyderabad, and Sialkot (mung), Sargodha (wheat), Khuzdar and Sialkot (IRRI rice) and Peshawar (tea and sugar). However, it is found that the ARCH effect was present in the log return prices of eggs in all cities of Pakistan. Finally, the ARCH-LM test shows that the log return price series had an ARCH effect. The test endorses the application of ARCH (1)/GARCH (1,1) and IGARCH (1,1) methodology for assessing the volatility in the price series of selected food commodities.

***ARCH (1) Model***

Table A-6 (Appendix) explains the results of the ARCH(1) model applied to the log return price series of food commodities. The ARCH coefficient is significant for all the commodities, showing that the short-term time-varying volatility in the return prices of all the above commodities was influenced by some external factors, which may have caused extra supply in some periods and a deficient supply in the next period.

***GARCH (1,1) Model***

GARCH(1,1) model helps to answer whether the volatility was only due to some external factors or also due to the existence of previous volatility in the food commodities. The food commodities were divided into five groups[7].

Table A-7 (Appendix) shows the results for the meat group. Significant ARCH and GARCH coefficients for beef, in each city, show that the volatility in the log return price series was not only enormously affected by residual effects but also due to the presence of past variance in log return prices. It shows that the volatility in beef prices was persistent and takes a long time to come to an end. On the other hand, for chicken prices only the ARCH parameter is significant for each city though, the GARCH parameter is significant only for Khuzdar, Quetta and

[5] Log Return = ln $p_t$ / $p_{t-1}$ where, $p_t$ is the monthly price for period t and $p_{t-1}$ is the monthly price for period t-1

[6] Results are shown in Table A-2 (Appendix)

[7] 1. Meat Group (Beef and Chicken), 2. Dairy Group (milk and egg), 3. Vegetable Group (Garlic, Onion, Potato and Tomato), 4. Cereal and Pulses Group ( Rice, Wheat, Pulse Mash, Pulse Masoor and Pulse Moong) 5. Other Group (Sugar and Tea)

Sargodha. Significant ARCH coefficient and insignificant GARCH coefficient explain that in chicken prices the presence of volatility was only due to the factors that cause changes in the supply and demand of chicken, while past variance did not affect current volatility. For the cities for which the conditions of the GARCH model were not fulfilled, such as a negative GARCH coefficient, the ARCH(1)[8] model was considered for volatility assessment.

The results for the dairy group are given in Table A-8. The significant ARCH coefficient for both commodities in each city indicates that volatility was highly influenced by residual effects. That might have been due to the change in input prices (oil prices) and seasonal (winter and summer) changes, which create volatility in the log return price of eggs and milk. For example, in the winter season, the demand for eggs generally rises. However, the GARCH coefficient of egg prices is insignificant in the majority of the cities except for Quetta, showing that the volatility in most of the cities was not due to previous volatility. However, the conditional volatility in milk prices was also due to the presence of previous volatility in the majority of the cities except for Islamabad and Sargodha. For all those cities where the GARCH coefficient is negative, the ARCH model is used since it is an appropriate model to assess conditional volatility. IGARCH model is used in the return price series of milk for Peshawar as the sum of both ARCH and GARCH coefficients is equal to 1. IGARCH[9] model fulfils its necessary condition, i.e., $\alpha + \beta = 1$, displaying that shocks have permanent impact on volatility.

The results for the vegetable group are reported in Table A-9. The results show that in this group the ARCH parameter is significant for all commodities, which shows that short-term time-varying volatility in prices of vegetables had responsive behaviour towards shocks or residual effects. These shocks might have been the change in transportation costs, change in international prices of vegetables, or change in weather conditions (rains and floods in 2010 and 2011, particularly in Sindh, harmed the production of these vegetables). On the other hand, past volatility in vegetable prices had no effect on current volatility in the majority of the cities. However, the volatility in the log return prices of garlic (Faisalabad, Hyderabad, Multan, Peshawar, Quetta, and Sukkur), onion (Rawalpindi and Sukkur), tomato (Khuzdar), and potato (Bahawalpur) was due to both the existence of residual effects and previous volatility, showing persistent behaviour of volatility in these cities. The ARCH(1) model is considered in cases where the GARCH coefficient was negative. IGARCH (1,1) model is applied to garlic (Sukkur) and Onion (Rawalpindi), where the summation of both coefficients is equal to or more than 1.

The results for the cereal and pulses groups are presented in Table A-10 and A-11 (Appendix). The ARCH parameter is significant for all commodities in all the cities. The results show that short-term time-varying volatility in prices of cereal and pulses was affected by residual effects that might have affected the crop yield. The crop yield is based on different factors including weather conditions, input prices etc. Ismail, et al. (2017) showed that urea price had a significant impact on rice prices, while rupee depreciation influenced wheat prices. The results show that volatility was persistent in the return prices of IRRI rice and wheat in all cities as the past variance significantly affected the present variance. Similarly, in most of the cities, the volatility was also persistent in mash, masoor, and mung prices except for mash prices in Quetta, Sialkot, and Sukkur, masoor prices in Islamabad, and mung prices in Quetta and Sargodha. For the cases in which the condition of the GARCH model is violated, i.e., a negative GARCH coefficient[10] , the ARCH model is used. Furthermore, in return prices where the sum of ARCH and GARCH coefficients is equal to or greater than 1, the IGARCH model is used[11].

Table A-12 (Appendix) presents the GARCH results for sugar and tea. The results depict that for both commodities, in each city, the ARCH coefficient is significant, implying that volatility was strong because of residual effects. For sugar, there might have been some political factors, including government policies, and high input prices, specifically fluctuation in crude oil prices, which is used in processing. However, the factors that

[8] For Bahawalpur, Karachi, Rawalpindi and Sialkot chicken prices ARCH(1) model is considered

[9] IGARCH Model results for all commodities are presented in Table A-13 (Appendix).

[10] For mash (Quetta, Sialkot and Sukkur) and for masoor (Islamabad)

[11] For mash (Faisalabad, Hyderabad, Islamabad, and Rawalpindi), for masoor (Sargodha), for IRRI rice (Peshawar and Sukkur), and for wheat (Rawalpindi)

might have caused fluctuations in tea prices could have been the international price of tea, exchange rate, and oil prices as Pakistan is a large importer of tea. The results point out that the volatility in sugar prices in all cities was not dependent on the existence of previous volatility except for Karachi. On the other hand, the significant GARCH coefficient of tea prices for every city illustrates that volatility was not only due to residual effects but also influenced by the previous variance. As discussed previously, the ARCH model is suitable for volatility assessment in series where the GARCH coefficient is negative[12] .

### Factors Affecting Food Prices

In this section, the ARDL results are discussed. In the ARDL model, most of the policy macroeconomic variables, such as real effective exchange rate, real interest rate, and crude oil prices, are included for all food commodities to capture the intensity of exogenous shocks in determining the prices of food commodities. However, some other regressors, for instance, international prices of the same commodities and local production of commodities are included in the model depending on the availability of time series data. Another important group of factors identified by the literature are the political and market conditions. However, such factors, for example, transparency and political stability are difficult to quantify. Therefore, to gauge the impact of political instability, three dummies for different political eras are included in the model. Support prices are announced only for wheat by the Government of Pakistan each year. Therefore, only the wheat support price is included in the model. This variable signifies the role of the government in determining the prices of wheat.

Table A-14 in the Appendix shows the group unit root test results. A group unit root test is performed for the first difference to ensure that all the series are integrated at I(1) or I(0). It has been argued that higher-order integrated variables can exhibit spurious regression results in Autoregressive Distributed Lag Models (ARDLs). Therefore, for examining the cointegration of variables using ARDL bound testing, the stationarity of the series was checked, as a precondition, suggested by Dickey and Fuller (1979).

The group unit root test for the first difference confirmed that the order of integration for each variable of each model was either I(0) or I(1). Therefore, ARDL bound testing was performed to determine the long-run as well as short-run impacts of various factors on the prices of food commodities.

The order of lags for each model was selected based on the AIC. According to Pesaran and Shin (1995), precise adjustment of orders of the ARDL model is necessary to remove serial correlation in the residual and resolve the endogenous variable issue. Hence, the lags' maximum values are decided for each of the fifteen models based on the AIC criterion. The results are given in Figure A-3 (Appendix).

Table 10, shows the F-statistics for the ARDL long run form and bounds test along with the corresponding lower bounds, i.e., I(0) and upper bounds, i.e., I(1) at a 5 per cent level of significance. Results confirm the presence of a long-run cointegrating association between the variables for most of the models. With log prices of various food commodities, for instance, onion, tomato, potato, beef, chicken egg, milk, wheat, pulse mash, sugar, and tea, as dependent variables, the null hypothesis of no level relationship was rejected as the F-statistics exceeded upper bound critical values.

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[12] Multan, Rawalpindi, Sargodha, and Sukkur for Sugar

Note: Conditional standard deviation graphs for all commodities are presented in Figure A-2 (Appendix).

*Table 10: ARDL Bound Test Results*

| Dependent Variables | F-Statistics | Lower bound at 5% | Upper bound at 5% | k | Remarks |
|---|---|---|---|---|---|
| Vegetable Group | | | | | |
| log (Onion price) | 8.29 | 2.56 | 3.49 | 4 | Present |
| log (tomato price) | 8.10 | 2.39 | 3.38 | 5 | Present |
| log (garlic price) | 0.90 | 2.79 | 3.67 | 3 | Absent |
| log (potato price) | 8.29 | 2.56 | 3.49 | 4 | Present |
| Meat Group | | | | | |
| log (beef price) | 4.54 | 2.39 | 3.38 | 5 | Present |
| log (chicken price) | 5.93 | 2.39 | 3.38 | 5 | Present |
| Dairy Group | | | | | |
| log (egg price) | 9.99 | 2.56 | 3.49 | 4 | Present |
| log (milk price) | 9.79 | 2.39 | 3.38 | 5 | Present |
| Cereal & Pulses Group | | | | | |
| log (wheat price) | 9.66 | 2.27 | 3.28 | 6 | Present |
| log (rice price) | 2.13 | 2.39 | 3.38 | 5 | Absent |
| log (Pulse moong price) | 3.03 | 2.56 | 3.49 | 4 | Absent |
| log (pulse mash price) | 3.4 | 2.56 | 3.49 | 4 | Present |
| log (pulse masoor price) | 2.32 | 2.56 | 3.49 | 4 | Absent |
| Other Group | | | | | |
| log (sugar price) | 3.38 | 2.39 | 3.38 | 5 | Present |
| log (tea price) | 14.94 | 2.56 | 3.49 | 4 | Present |

*Source: Authors' calculations*

Table 10 provides evidence of a long-run relationship between log prices of onion, tomato, potato, beef, chicken egg, milk, wheat, pulse mash, sugar, and tea and their determinants. Table 11 describes the partial long-term impact of various factors on the log prices of these food commodities. Table 11 shows that the log of the real effective exchange rate (REER) significantly influenced the log prices of wheat. A 1 per cent point decrease in the REER increased the wheat prices by 0.64 per cent. The model with log wheat price confirms the negative association of prices with the REER, which is supported by literature as well. For instance, it is well documented that the exchange rate transmits international goods prices to local markets (Zerom and Nakamura 2010; Abbot et al., 2009; Landerretche et al., 2007). Ismail et al. (2017) also found the same results for Pakistan.

The results show that there is a negative relationship between the prices of wheat and rice and interest and a positive relationship between the price of tea and interest rate. These results mean that a 1 per cent decline in interest rate caused the prices of wheat and rice to increase by 0.11 and 0.57 per cent, respectively. On the other hand, a 1 per cent increase in interest rate increased the price of tea by about 0.72 per cent respectively. Ismail et al. (2017) also found mixed results regarding the impact of the interest rate on the prices of various food commodities.

*Table 11: Long-Run Coefficients*

| Dependent (prices) \ Independent Variables | Exchange Rate | Interest Rate | Oil Price | International Price | Production | Support Price | c |
|---|---|---|---|---|---|---|---|
| Vegetable Group | | | | | | | |
| log (Onion price) | 0.24 | 0.02 | 0.27** | | 0.67 | - | -3.50 |
| log (tomato price) | 0.57 | -0.53 | 0.40** | -0.56 | -1.02** | - | -1.88 |
| log (garlic price) | 1.01 | 3.43 | -0.99 | - | - | - | -2.83 |
| log (potato price) | 0.48 | -0.05 | 0.53*** | - | -0.27 | - | 1.84 |
| Meat Group | | | | | | | |
| log (beef price) | 0.40 | -0.19 | 0.05 | 0.58*** | 0.25 | - | -1.07 |
| log (chicken price) | -0.16 | -0.03 | 0.15*** | 0.45*** | 0.18 | - | 1.37 |
| Dairy Group | | | | | | | |
| log (egg price) | -0.54 | -0.18 | 0.25*** | - | -1.53*** | - | -8.55*** |
| log (milk price) | -1.18 | 0.48 | 0.90 | 0.12 | 1.26 | - | -8.19 |
| Cereal & Pulses Group | | | | | | | |
| log (wheat price) | -0.64*** | -0.11*** | 0.05* | 0.10*** | -0.17 | 0.74*** | 5.52*** |
| log (rice price) | 0.12 | -0.57*** | 0.48*** | 0.92*** | -0.61 | - | 3.93 |
| log (Pulse moong price) | -8.09 | 1.32 | 0.16 | - | -2.02 | - | 49.95 |
| log (pulse mash price) | -0.25 | 0.40 | -0.14 | - | -1.55*** | - | 20.17* |
| log (pulse masoor price) | -4.76 | -0.27 | 0.06 | - | -1.60*** | - | 30.05 |
| Other Group | | | | | | | |
| log (sugar price) | 0.07 | -0.25 | 0.21*** | 0.56*** | -1.20*** | - | 14.65 |
| log (tea price) | 0.08 | 0.72*** | 0.04 | 0.22** | - | - | -0.01 |

*Source: Authors' calculations. ***, **, and * show 1%, 5%, and 10% level of significance, respectively.*

The other most important exogenous factor is the crude oil price. Table 11 shows a significant and positive impact of oil prices on almost all commodities. The largest impact of oil prices was found on vegetable prices. Results reveal that a 1 per cent increase in crude oil price led to 0.53 per cent, 0.40 per cent, and 0.27 per cent increase in the prices of potatoes, tomatoes, and onions, respectively. Similarly, chicken and egg prices were also affected by increases in oil prices. A 1 per cent increase in oil price raised the prices of chicken and eggs by 0.15 per cent and 0.25 per cent, respectively. Wheat prices were also affected by oil prices but the impact was minimal. The sugar price model, however, exhibited a significant and positive impact of a rise in oil prices on sugar prices. These findings are consistent with the earlier findings. For instance, Herrmann (2009), Ismail et al. (2017), and several other researchers showed that, among other variables, the crude oil price was the foremost factor in the case of Pakistan that caused fluctuation in the commodity prices.

Table 11 confirms the proposition that international prices of commodities affect the local prices even in the absence of trading activities (Ahsan et al., 2011 and ADB, 2008). The present study also found a positive impact of international food prices on the prices of staple food commodities, such as beef, chicken, wheat, rice, sugar, and tea. A 1 per cent increase in international food prices increased the local prices of beef, chicken, wheat, rice, sugar, and tea by 0.58, 0.45, 0.1, 0.92, 0.56, and 0.22 per cent, respectively.

Another factor that plays a major role in reducing domestic prices is total local production (TLP), which has an inverse relationship with local prices (Tadesse et al., 2016). TLP is included in the model only for those commodities that are produced locally. Table 11 shows the impact of TLP on the production of various commodities on their prices. According to the results, a 1 per cent increase in the local production of mash, masoor, sugarcane, tomato, and egg led to a decrease in decline their prices by 1.55, 1.6, 1.2, 1.0, and 1.5 per cent, respectively. The literature also supports these findings. For example, Ahsan et al. (2011) found that a decline in the production of wheat and rice increases food prices in Pakistan.

The wheat support price is the foremost policy tool to regulate the price of wheat. There are a few studies that look at the relationship between the wheat support price and inflation. For example, Khan and Qasim (1996) and Sherani, Schimmelpfennig, and Khan (2006) found a positive and significant link between the wheat support price and food inflation in Pakistan. However, no study looks at the relationship between the wheat support price and the market price of wheat. Therefore, to fill this gap, the present study includes the wheat support price in the empirical analysis. The results, given in Table 11, show a positive and highly significant impact of the wheat support price on wheat prices. These findings suggest that a higher support price encourages farmers to increase wheat production, not only by increasing yield per acre but also by bringing more area under wheat cultivation.

Table 12 shows the coefficients of $ECT_{t-1}$ for each model which is given by Equation 8. The $ECT_{t-1}$ coefficients show the short-run[13] adjustment. It is worth mentioning here that an ECT coefficient between -1 to 0 implies that the correction in commodity prices in period t is a proportion of the error in the previous period, i.e., t-1. This means that the food commodity prices would converge monotonically to a long-run equilibrium as a result of changes in their determinants. On the other hand, a positive or lower than -2 ECT coefficient implies that the food commodity prices would diverge. Moreover, a value between -2 and -1 implies a dampening oscillation in the food commodity prices around their equilibrium trail.

Table 12, however, shows that the coefficients of $ECT_{t-1}$ are between -1 and 0 for each model. It must be noted that the long-run bound test, discussed above, indicated the presence of long-run cointegration among the food commodity prices and their determinants. The coefficients of all the models are statistically highly significant at the 1 per cent level. This indicates that the error correction method monotonically converges to the equilibrium. The coefficient of $ECT_{t-1}$ of the prices of onions, tomatoes, potatoes, chicken, eggs, wheat, and tea reveals a higher pace of correction each month and implies that the divergence from the equilibrium level of prices in the current period was corrected by 35, 41, 24, 49, 37, 33, and 24 per cent, respectively, in the following month. However, the pace of adjustment was relatively slower for other commodities such as beef, milk, mash, and sugar.

Residual diagnostic tests separately for each model were also run to check their robustness. Table A-15 (Appendix) shows the results of tests for F-statistics, serial correlation, homoscedasticity, and lag selection criteria. Figure A-4 (Appendix) shows the graphs of the CUSUM stability test for each model. The test for serial correlation confirmed the Gauss-Markov assumption of no serial correlation. Although the problem of heteroscedasticity was detected in some of the models, these models were reestimated by employing the robust standard error process. The literature suggests that for large sample sizes, robust standard errors overcome the problem of heteroscedasticity and provide unbiased standard errors of slope coefficients. F2 shows the overall significance of the models, which confirms the model's accuracy.

[13] Detailed Short run Coefficient results are reported in Table A-16 (Appendix)

*Table 12: Short-run Coefficients*

| Dependent (Prices) \ Independent Variables | $ECT_{t-1}$ |
|---|---|
| Vegetable Group | |
| Δlog (Onion price) | -0.35*** |
| Δlog (tomato price) | -0.41*** |
| Δlog (garlic price) | - |
| Δlog (potato price) | -0.24*** |
| Meat Group | |
| Δlog (beef price) | -0.12*** |
| Δlog (chicken price) | -0.49*** |
| Dairy Group | |
| Δlog (egg price) | -0.37*** |
| Δlog (milk price) | -0.009*** |
| Cereal & Pulses Group | |
| Δlog (wheat price) | -0.33*** |
| Δlog (rice price) | - |
| Δlog (Pulse moong price) | - |
| Δlog (pulse mash price) | -0.04*** |
| Δlog (pulse masoor price) | - |
| Other Group | |
| Δlog (sugar price) | -0.13*** |
| Δlog (tea price) | -0.24*** |

*Source: Authors' calculations. ***, **, and * show 1%, 5%, and 10% level of significance, respectively.*

Figure A-4 (Appendix) shows that CUSUM lines are within the 5 per cent level of significance critical bounds. This shows the precision of the long-run and short-run parameters of the models. This also proves that models are correctly specified.

## 7. CONCLUSION

The study is an attempt to analyse the dynamics of food prices by testing various stylised facts and volatility further to identify the main factors related to food prices. For this purpose, monthly data from July 2002 to July 2021 was collected from the monthly statistical bulletin for 14 large cities of Pakistan for 15 important food commodities, which gave a total of 48,090.

Firstly, the frequency of price change and duration of spells for each commodity were calculated at the city level. The results showed that vegetables, farm chicken, and eggs had the most flexible prices. Analysis at the city level showed that the prices of almost all the food products changed less frequently in Khuzdar than in the rest of the other cities. The results also showed that the prices of most commodities, particularly milk and beef, changed more frequently in big metropolitan cities.

The frequency of price change was further disaggregated to determine the frequency of price increases and decreases separately along with the magnitude of these increases and decreases. It was found that most of the commodities, for instance, eggs, chicken, tomatoes, onions, and potatoes, displayed an increase in prices followed by a decrease. On the other hand, other commodities, such as tea, milk, beef, and rice, exhibited a higher frequency of price increases and a lower frequency of price decreases.

The size of the price change clearly shows that the price of tomatoes changed by the highest magnitude followed by onion. Significant changes in the prices of tomatoes were observed because of supply shocks. Although the prices of milk and beef prices seldom decreased the magnitude of these decreases in prices was relatively high. At the city level, small but frequent increases in the prices of pulses were recorded. The intensive and extensive margins of inflation for pulses show the transmission of international prices into the domestic market.

As far as the synchronisation of price changes across cities is concerned, tea exhibited a higher degree of synchronisation than all other products. Since the price of tea mainly depends on international tea prices, its price changed simultaneously in all cities. The synchronisation ratio for tomatoes was relatively higher. Similarly, the prices of chicken, refined sugar, onions, and eggs were also found relatively well synchronised. The remaining commodities were found to be quasi-synchronised.

For an in-depth assessment of food price dynamics, and to understand the risk factors associated with the production and supply of food commodities, volatility in food prices at the commodity and city levels is assessed. The volatility is assessed by both the standard deviation and ARCH/GARCH/IGARCH methods. Stationarity tests show that the log return price series of all food commodities in each city is stationary at level. The standard deviation shows that beef, chicken, eggs, sugar, and all vegetables were highly volatile over the given period as compared to other commodities. Further, the ARCH-LM test confirmed that most of the food price series had short-term time-varying volatility in their residuals which allowed the application of the ARCH/GARCH model. The results of the model show that for the milk, tea, and the cereals and pulses group, both the residual effects and past variance were responsible for the current volatility in most of the cities. For sugar, eggs, and vegetable group, the main reason for volatility in most of the cities was external factors.

Furthermore, the ARDL bound test shows that there was a negative and significant impact of the REER on wheat prices in the long run. The real interest rate had a mixed effect on food prices in the long run. It inversely affected wheat and rice prices but directly affected tea prices. An increase in international crude oil prices significantly increased the prices of vegetables except for garlic. It also increased the prices of chicken, eggs, wheat, rice, and sugar in the long run. The study finds support for international food price transmission to domestic prices in the long run. The results revealed that an increase in international prices of beef, chicken, wheat, rice, sugar, and tea significantly increased their domestic prices. On the other hand, in the long run, an increase in local production of tomatoes, eggs, mash, masoor, and sugar significantly reduced their prices. Regarding the government's wheat support price policy, it was observed that an increase in the wheat support price had a positive and significant impact on wheat prices.

The results also indicate that the log prices of onions, tomatoes, potatoes, chicken, eggs, wheat, and tea monotonically converged to equilibrium. It implies that the divergence from the equilibrium level of prices in the current period would be corrected by 35, 41, 24, 49, 37, 33, and 24 per cent, respectively in the next month. However, the pace of adjustment was relatively slower for other commodities, such as beef, milk, mash, and sugar.

# 8. KEY POLICY RECOMMENDATIONS

The findings of the study suggest the following policy options:

- Since the results show that prices of most commodities changed more frequently in big metropolitan cities than in the rest of the cities, there is a need to control speculative and hoarding activities in big cities.

- The results show small but frequent increases in the prices of pulses in all cities. It is worth mentioning here that most of the demand for pulses is fulfilled through imports as pulses are cultivated as only cash crops domestically. Therefore, changes in international prices are transmitted to the domestic market. According to Tadasse et. al. (2016), these sorts of exogenous shocks can be controlled through market conditions and the political environment. This suggests that there is a need to increase the local production of these low-water-consuming crops to dampen the effect of the volatility in international prices. A stable political environment would also help.

- The government releases a price list to maintain a harmonised system across cities. However, the results show that most of the commodities were quasi-synchronised across cities. This finding shows a lack of proper implementation and checks and balances on prevailing prices across cities.

- The government should formulate a system to monitor the market prices of highly volatile food commodities (beef, chicken, egg, sugar and vegetables) in each city. It would help to stabilize food prices.

- The results of this study show that the wheat support price increases the price of wheat. This increase in wheat prices will decrease the production of other agricultural commodities and, ultimately, hurt the consumers. Thus, there is a need to increase the per-acre yield of wheat instead.

- To encourage investment in crop production by local farmers, it is important to provide loans at a low interest rate.

- The results reveal that the high crude oil prices increase the prices of most of the food commodities. Even though international crude oil prices are out of the government's control, the government may consider the provision of crude oil at subsidised rates to the producers to reduce the input cost.

- Furthermore, there is a need to construct a proper transportation system from farms (villages) to the city markets to reduce transportation costs.

## REFERENCES

Abbott, P. C., Hurt, C., & Tyner, W. E. (2009). *What's driving food prices?* (No. 741-2016-51224).

Prices, A. F. (2008). *Inflation in developing Asia: Is poverty reduction coming to an end*. Asian Development Bank (ADB).

Ahsan, H., Iftikhar, Z., & Kemal, M. A. (2011). *The determinants of food prices: A case study of Pakistan.*

Apergis, N., & Rezitis, A. (2011). Food price volatility and macroeconomic factors: Evidence from GARCH and GARCH-X estimates. *Journal of Agricultural and Applied Economics,* 43(1), 95-110.

Aucremanne, L., & Dhyne, E. (2004). *How frequently do prices change? Evidence based on the micro data underlying the Belgian CPI.*

Awan, A. G., & Imran, M. (2015). Food price inflation and its impact on Pakistan's economy. *Food Science and Quality Management*, 41, 61-72.

Baffes, J. (2007). Oil spills on other commodities. *Resources Policy,* 32(3), 126-134.

Balanay, R. M. (2015). Analyzing price volatility and supply response of duck eggs in the Philippines for industry development implications relative to climate change adaptation*. Annals of Studies in Science and Humanities,* 1(1), 35-45.

Baumgartner, J., Glatzer, E., Rumler, F., & Stiglbauer, A. (2005). *How frequently do consumer prices change in Austria? Evidence from micro CPI data* (European Central Bank Working Paper Series, No.523)

Bils, M., & Klenow, P. J. (2004). Some evidence on the importance of sticky prices. *Journal of Political Economy,* 112(5), 947-985.

Bollerslev, T. (1987). A conditionally heteroskedastic time series model for speculative prices and rates of return. *The Review of Economics and Statistics*, 542-547.

Bollerslev, T. 1986. Generalized autoregressive conditional heteroscedasticity. *Journal of Econometrics,* 31, 307–327.

Calvo, G. (2008). *Exploding commodity prices, lax monetary policy, and sovereign wealth funds.*

Cooke, B., and Robles, M. (2009). *Recent food price movements: A time series analysis* (IFPRI Discussion Paper, 00942). IFPRI.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association,* 74(366a), 427-431.

Engle, R. F. (1993). Statistical models for financial volatility. *Financial Analysts Journal,* 49(1), 72-78.

Engle, R. and Granger, C. (1987) Cointegration and error correction representation: Estimation and testing. *Econometrica,* 55, 251-276.

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica: Journal of the Econometric Society,* 987-1007.

Fisher, T. C., & Konieczny, J. D. (2000). Synchronization of price changes by multiproduct firms: Evidence from Canadian newspaper prices. *Economics Letters,* 68(3), 271-277.

Frankel, J. A. (2006). *The effect of monetary policy on real commodity prices* (NBER working paper, No. 12713).

Gilbert, C .L. and C. W. Morgan. 2010 b. Food price volatility. *Philos. Trans. R. Soc. B Biol. Sci.,* 365(1554): 3023-3034.

Headey, D. D. (2014). *Food prices and poverty reduction in the long run* (Discussion Paper 01331). International Food Policy Research Institute.

Ismail, A., Ihsan, H., Khan, S. A., & Jabeen, M. (2017). Price volatility of food and agricultural commodities: A case study of Pakistan. *Journal of Economic Cooperation & Development, 38*(3), 77-120.

Herrmann, M. (2009). *Food security and agricultural development in times of high commodity prices* (No. 196). United Nations Conference on Trade and Development.

Joiya, S. A., & Shahzad, A. A. (2013). Determinants of high food prices: The case of Pakistan. *Pakistan Economic and Social Review,* 93-107.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with appucations to the demand for money. *Oxford Bulletin of Economics and Statistics,* 52(2), 169-210.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica*, 1551-1580.

Jordaan, H., Grove, B., Jooste, A., & Alemu, Z. G. (2007). Measuring the price volatility of certain field crops in South Africa using the ARCH/GARCH approach. *Agrekon,* 46(3), 306-322.

Kelkay, B. D., & Yohannes, E. G. (2015). The Application of Garch Family Models for Agricultural Crop Products in Amhara Region, Ethiopia. *Science, Technology and Arts Research Journal,* 3(4), 49-58.

Khan, A. H., Qasim, M. A., & Ahmad, E. (1996). Inflation in Pakistan revisited. *The Pakistan Development Review,* 35(4), 747-759.

Klenow, P. J., & Malin, B. A. (2010). Microeconomic evidence on price-setting. In *Handbook of monetary economics* (Vol. 3, pp. 231-284). Elsevier.

Kuhe, D. A. (2019). Modeling volatility of agricultural commodity food price index in Nigeria using ARMA-GARCH models. *Mediterranean Journal of Basic and Applied Sciences*, 3(1), 55-75.

Lach, S., & Tsiddon, D. (1992). The behavior of prices and inflation: An empirical analysis of disaggregat price data. *Journal of Political Economy,* 100(2), 349-389.

De Gregorio, J., Landerretche, O., Neilson, C., Broda, C., & Rigobon, R. (2007). Another pass-through bites the dust? Oil prices and inflation. *Economia,* 7(2), 155-208.

Loening, J. L., Durevall, D., & Birru, Y. A. (2009). *Inflation dynamics and food prices in an agricultural economy: The case of Ethiopia* (World Bank Policy Research Working Paper 4969). The World Bank.

Minot, N. (2014). Food price volatility in sub-Saharan Africa: Has it really increased?. *Food Policy,* 45, 45-56.

Mitchell, D. (2008). *A note on rising food prices* (World Bank Policy Research Working Paper, 4682)

Nakamura, E., & Zerom, D. (2010). Accounting for incomplete pass-through. *The Review of Economic Studies,* 77(3), 1192-1230.

Norazman, U. Z., Khalid, H., & Ghani, G. M. (2018). Food inflation: a study on key determinants and price transmission processes for Malaysia. *International Journal of Business & Society,* 19(1).

Nwoko, I. C., Aye, G. C., & Asogwa, B. C. (2016). Effect of oil price on Nigeria's food price volatility. *Cogent Food & Agriculture,* 2(1), 1146057.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics,* 16(3), 289-326.

Pesaran, M. H., & Shin, Y. (1995). *An autoregressive distributed lag modelling approach to cointegration analysis* (Vol. 9514). University of Cambridge.

Perron, P. (1997). Further evidence on breaking trend functions in macroeconomic variables. *Journal of Econometrics,* 80(2), 355-385.

Radmehr, R., & Rastegari Henneberry, S. (2020). Energy price policies and food prices: Empirical evidence from Iran. *Energies,* 13(15), 4031.

Roache, M. S. K. (2010). *What explains the rise in food price volatility?*. International Monetary Fund.

Joiya, S. A., & Shahzad, A. A. (2013). Determinants of high food prices: The case of Pakistan. *Pakistan Economic and Social Review,* 93-107

Schimmelpfennig, A. and Khan, M. S. (2006). *Inflation in Pakistan: Money or wheat?* (International Monetary Fund, Working Paper /06/60).

Sekhar, C. S. C., Roy, D., & Bhatt, Y. (2017). *Food inflation and food price volatility in India: Trends and determinants* (IFPRI Discussion Paper 1640)

Sukati, M. (2013). *Measuring maize price volatility in Swaziland using ARCH/GARCH approach* (Munich Personal RePEc Archive, Paper No.51840).

Tadasse, G., Algieri, B., Kalkuhl, M., & Von Braun, J. (2016). Drivers and triggers of international food price spikes and volatility. In *Food price volatility and its implications for food security and policy,* 59-82. Springer International Publishing

Torero, M., Braun, J. V. and Kalkuhl, M. (2016). *Food price volatility and its implications for food security and policy* (p. 626). Springer Nature.

Ullah, A., Arshad, M., Kächele, H., Zeb, A., Mahmood, N., & Müller, K. (2020). Socio-economic analysis of farmers facing asymmetric information in inputs markets: Evidence from the rainfed zone of Pakistan. *Technology in Society,* 63, 101405.

Vasco, C., & Woodford, M. (2009). *Credit Fricitons and Optimal Monetary Policy.* BIS.

Zehra, N., & Fatima, A. (2019). Food price volatility: A comparative analysis among major cities of Pakistan. *Pakistan Journal of Applied Economics,* 29(1), 71-91.

# APPENDIX

*Box A-1: Selection Criteria for Food Commodities*

CPI basket contains 487 items of goods and services prevailing in 40 major cities of Pakistan. Out of this basket, food and non-alcoholic beverages constitutes 34.84 percent share. The food commodities are selected, keeping in view their relative importance and share in average household food expenditure. According to HIES 2018-19, the percentage share of food and beverages group in total expenditure of households is about 36 percent. Whereas, the selected commodities of this study constitute more than 60 percent share in total food expenditure. Within these commodities milk alone constitute about 22.5 percent share, which is followed by wheat (11.2 percent) and vegetables (8.7 percent). Whereas, expenditure on rice, sugar, tea, beef and chicken are hovering around 3 percent share. Hence, these commodities are the basic food commodities, which have direct welfare impact on households. All of these commodities are also included in CPI basket of food commodities for computing food inflation.

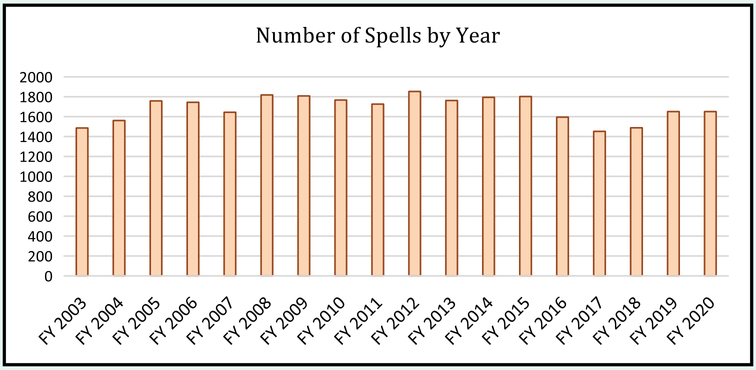
*Table A-1: Units of Commodities*

| Commodity | Units |
|---|---|
| Beef | 1 kg |
| Chicken | 1 kg |
| Pulse Mash | 1 kg |
| Pulse Masoor | 1 kg |
| Pulse Moong | 1 kg |
| Rice IRI | 1 kg |
| Wheat | 1 kg |
| Garlic | 1 kg |
| Ginger | 1 kg |
| Potatoes | 1 kg |
| Onions | 1 kg |
| Tomatoes | 1 kg |
| Milk | 1 litre |
| Eggs | 1dozen |
| Sugar | 1 kg |
| Tea (Lipton Yellow Label) | 200 gm. |

*Source: Pakistan Bureau of Statistics*

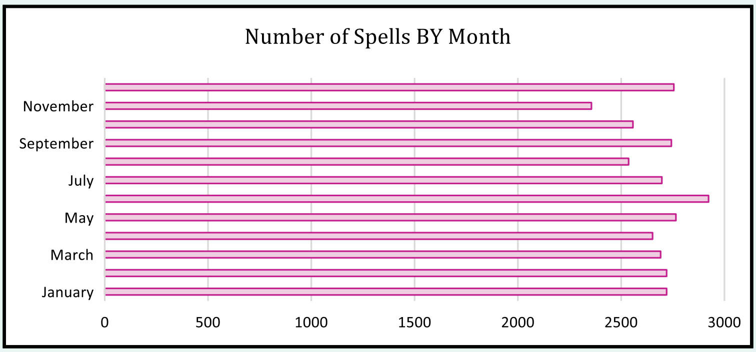
*BOX A-2: Price Spell of Food Commodities*

Price spells of fifteen commodities and fourteen cities are presented graphically below. The figure shows the number of price spells per year. A higher number of price spells shows that the occurrence of price change is more frequent in that particular year. A glimpse of the graph shows that the number of food price spells was relatively fewer in 2017 and 2018 and highest from 2012 to 2015. However, a higher number of spells does not necessarily mean higher inflation; rather it shows more instability.



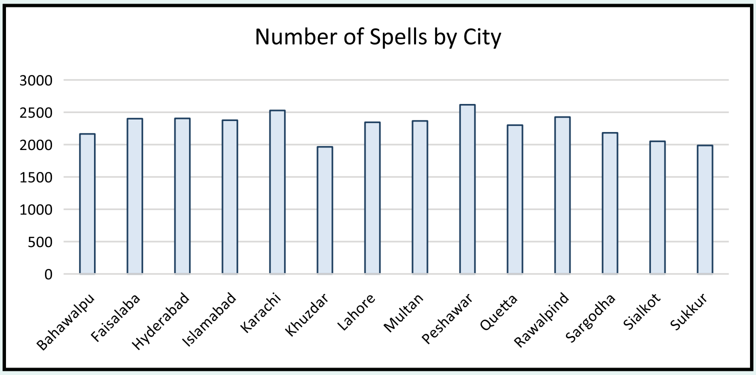

*Source: Authors' illustration*

The total number of food price spells is graphed in the following figure. It is an attempt to identify the months in which prices were recorded to revise. The figure shows that the revision in prices was higher in June and December. This shows that the prices of most of the products changed at the end of fiscal and financial years.



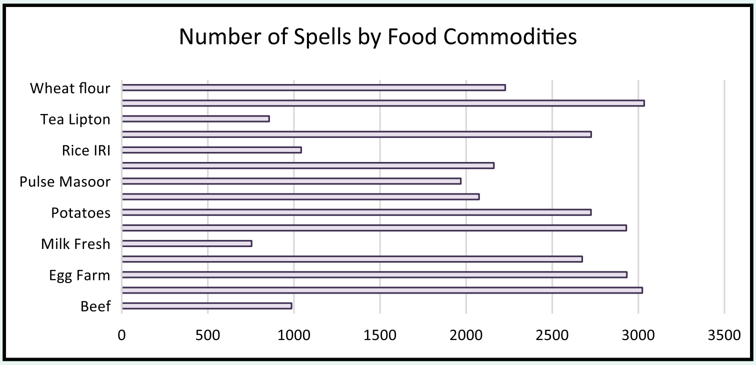

*Source: Authors' illustration*

Differences in the number of regular price spells were even more pronounced when analyzed at the city level as shown in the figure given below. The highest number of spells were observed in most of the big cities, such as Peshawar, Karachi, Rawalpindi, and Islamabad. It shows that prices of the food commodities were relatively short-lived in these cities compared to Khuzdar, Sukkur, and Sialkot. Other cities, including Quetta, Sargodha, Multan, Lahore, and Bahawalpur, showed a moderate number of spells.




*Source: Authors' illustration*

The following graph shows considerable heterogeneity in the number of regular price spells at the level of commodities. Variations disaggregated by product are most apparent. The highest number of regular price spells, i.e., short-lived durations were recorded for milk, tea, beef, and rice. In contrast, tomatoes, farm chicken, farm eggs, onions, potatoes, and sugar recorded the highest occurrence of price changes.




*Source: Authors' illustration*

*Table A-2: Commodity- and City-Wise Unit Root Test Results of Food Prices*

| City | Order of Integration | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Beef | Chicken | Egg | Milk | Garlic | Onion | Potato | Tomato | Mash | Masoor | Mung | IRRI Rice | Wheat | Sugar | Tea |
| Bahawalpur | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Faisalabad | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Hyderabad | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Islamabad | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Karachi | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Khuzdar | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Lahore | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Multan | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Peshawar | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Quetta | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Rawalpindi | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Sargodha | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Sialkot | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |
| Sukkur | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |

*Source: Authors' estimation. I(0) represents that series is stationary at level.*

*Table A-3: Commodity-Wise High and Low Volatility Periods*

| Year | Beef | Chicken | Egg | Milk | Garlic | Onion | Potato | Tomato | Pulse Mash | Pulse Masoor | Pulse Moong | Rice IRI | Wheat | Sugar | Tea |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002-03 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2003-04 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| 2004-05 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 2005-06 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| 2006-07 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 2007-08 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| 2008-09 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 2009-10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 2010-11 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 2011-12 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 2012-13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 2013-14 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 2014-15 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 2015-16 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2016-17 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 2017-18 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 2018-19 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 2019-20 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2020-21 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| Median (%) | 2.6 | 14.4 | 14.4 | 2.8 | 13.5 | 24.8 | 21.9 | 42 | 4.8 | 4.2 | 5.2 | 3.4 | 4.4 | 5.6 | 4.3 |

*Source: Authors' calculations*

*Table A-4: High and Low Volatile Commodities*

| | |
|---|---|
| Beef | 1 |
| Chicken | 1 |
| Egg | 1 |
| Milk | 0 |
| Garlic | 1 |
| Onion | 1 |
| Potato | 1 |
| Tomato | 1 |
| Pulse Mash | 0 |
| Pulse Masoor | 0 |
| Pulse Moong | 0 |
| Rice IRI | 0 |
| Wheat | 0 |
| Sugar | 1 |
| Tea | 0 |
| Median (in %) | 8.5 |

*Source: Authors' calculations*

*Table A-5: ARCH-LM TEST*

| City | P-Value | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Beef | Chicken | Egg | Milk | Garlic | Onion | Potato | Tomato |
| Bahawalpur | 0.0062 | 0 | 0.0003 | 0 | 0.333* | 0 | 0 | 0.31* |
| Faisalabad | 0.0031 | 0.0001 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hyderabad | 0 | 0 | 0 | 0 | 0 | 0.006 | 0 | 0 |
| Islamabad | 0 | 0.12* | 0 | 0 | 0 | 0 | 0.0018 | 0 |
| Karachi | 0 | 0 | 0 | 0 | 0 | 0 | 0.056* | 0 |
| Khuzdar | 0.0864* | 0.0017 | 0 | 0.39* | 0 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lahore | 0.017 | 0 | 0.047 | 0 | 0 | 0.7* | 0.001 | 0 |
| Multan | 0 | 0.0008 | 0 | 0 | 0.028 | 0 | 0.8* | 0.0071 |
| Peshawar | 0 | 0.0043 | 0 | 0 | 0 | 0.0001 | 0 | 0 |
| Quetta | 0.86* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rawalpindi | 0 | 0 | 0 | 0 | 0 | 0 | 0.0001 | 0 |
| Sargodha | 0 | 0 | 0 | 0 | 0.001 | 0 | 0.0003 | 0 |
| Sialkot | 0 | 0 | 0.045 | 0 | 0.0003 | 0.48* | 0.0001 | 0 |
| Sukkur | 0.186* | 0.0003 | 0 | 0 | 0 | 0 | 0.0002 | 0.45* |

| City | P-Value | | | | | | |
|---|---|---|---|---|---|---|---|
| | Pulse Mash | Pulse Masoor | Pulse Moong | Wheat | Rice IRI | Tea | Sugar |
| Bahawalpur | 0 | 0.88* | 0.38* | 0 | 0 | 0 | 0.022 |
| Faisalabad | 0 | 0 | 0.008 | 0.007 | 0 | 0 | 0.0005 |
| Hyderabad | 0 | 0 | 0.29* | 0.013 | 0 | 0 | 0 |
| Islamabad | 0 | 0 | 0.007 | 0 | 0 | 0 | 0.33* |
| Karachi | 0 | 0.27* | 0.0006 | 0 | 0 | 0 | 0 |
| Khuzdar | 0.9* | 0 | 0.0027 | 0 | 0.61* | 0 | 0 |
| Lahore | 0.32* | 0.88* | 0 | 0 | 0.033 | 0 | 0 |
| Multan | 0 | 0.22* | 0 | 0.019 | 0 | 0 | 0 |
| Peshawar | 0 | 0.002 | 0 | 0 | 0 | 0.22* | 0.021 |
| Quetta | 0 | 0.015 | 0 | 0 | 0 | 0 | 0.116* |
| Rawalpindi | 0 | 0.035 | 0 | 0 | 0 | 0 | 0 |
| Sargodha | 0 | 0 | 0 | 0.12* | 0 | 0 | 0.012 |
| Sialkot | 0 | 0.0001 | 0.77* | 0 | 0.2* | 0 | 0.0035 |
| Sukkur | 0 | 0.004 | 0 | 0 | 0.0035 | 0 | 0 |

*Source: Authors' calculations. *a p-value greater than 0.05 shows the acceptance of null hypotheses implying that the volatility is not time varying and so on.*

*Table A-6: ARCH (1) Results*

| City | P-Value | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Beef | Chicken | Egg | Milk | Garlic | Onion | Potato | Tomato |
| Bahawalpur | 0.12** | 0.31* | 0.55* | 0.40* | | 0.41* | 0.80* | |
| Faisalabad | 0.24* | 0.30** | 0.47* | 0.21* | 0.19* | 0.36* | 0.27* | 0.35* |
| Hyderabad | 0.20** | 0.27** | 0.48* | 0.42* | 0.79* | 0.19** | 0.16** | 0.34** |
| Islamabad | 0.35* | | 0.46* | 0.21* | 0.88* | 0.50* | 0.28** | 0.51* |
| Karachi | 0.32* | 0.31* | 0.55* | 0.22* | 0.66* | 0.27* | | 0.35* |
| Khuzdar | | 0.14** | 0.42* | | 0.60* | 0.11* | 0.30** | 0.30** |
| Lahore | 0.44* | 0.16* | 0.53* | 0.98* | 0.24* | | 0.20** | 0.42* |
| Multan | 0.18** | 0.31** | 0.56* | 0.48* | 0.24** | 0.31* | | 0.51* |
| Peshawar | 0.61* | 0.25** | 0.45* | 0.36* | 0.39* | 0.22** | 0.13* | 0.44* |
| Quetta | | 0.90* | 0.35* | 0.55* | 0.03* | 0.37* | 0.11* | 0.50* |
| Rawalpindi | 0.70* | 0.19** | 0.13** | 0.13* | 0.26* | 0.38** | 0.29* | 0.30* |
| Sargodha | 0.22* | 0.33* | 0.50* | 0.24** | 0.22* | 0.30** | 0.24* | 0.55* |
| Sialkot | 0.24* | 0.30** | 0.18* | 0.20* | 0.23* | | 0.29** | 0.50* |
| Sukkur | | 0.26** | 0.51* | 0.42* | 0.24** | 0.47* | 0.25* | |
| City | P-Value | | | | | | | |
| | Pulse Mash | Pulse Moong | Pulse Masoor | Rice IRI | Wheat | Sugar | Tea | |
| Bahawalpur | 0.14* | | | 0.41* | 0.13* | 0.21* | 0.45* | |
| Faisalabad | 0.18* | 0.28** | 0.16* | 0.46* | 0.28* | 0.29** | 0.48* | |
| Hyderabad | 0.59* | | 0.32* | 0.58* | 0.32* | 0.28* | 0.56* | |
| Islamabad | 0.42* | 0.29* | 0.22* | 0.32* | 0.50* | | 0.27* | |
| Karachi | 0.15* | 0.19* | | 0.91* | 0.33* | 0.38* | 0.55* | |
| Khuzdar | | 0.11** | 0.22* | | 0.53* | 0.14** | 0.52* | |
| Lahore | | 0.34* | | 0.60* | 0.17* | 0.27* | 0.42* | |
| Multan | 0.10* | 0.70* | | 0.32* | 0.30* | 0.55* | 0.48* | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peshawar | 0.12* | 0.48* | 0.17** | 0.82* | 0.28* | 0.46* | |
| Quetta | 0.22** | 0.52** | 0.26* | 0.22* | 0.69* | | 0.44* |
| Rawalpindi | 0.35* | 0.53* | 0.22* | 0.27* | 0.70* | 0.32* | 0.17* |
| Sargodha | 0.16** | 0.39** | 1.10* | 0.40* | | 0.29** | 0.48* |
| Sialkot | 0.30* | | 0.30* | | 0.86* | 0.36* | 0.54* |
| Sukkur | 0.23* | 0.40* | 0.18* | 0.59* | 0.21** | 0.27** | 0.43* |

*Source: Authors' calculations. *and ** represent significance at 1% and 5%, respectively.*

*Table A-7: GARCH (1,1) Results for the Meat Group*

| | BEEF | | | CHICKEN | | |
|---|---|---|---|---|---|---|
| City | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β |
| Bahawalpur | 0.104** | 0.720* | 0.824 | 0.317* | -0.056 | 0.261 |
| Faisalabad | 0.703* | 0.047** | 0.75 | 0.296** | 0.011 | 0.307 |
| Hyderabad | 0.156* | 0.753* | 0.909 | 0.265** | 0.037 | 0.302 |
| Islamabad | 0.562* | 0.303* | 0.866 | | | |
| Karachi | 0.241* | 0.477* | 0.718 | 0.304* | -0.041 | 0.262 |
| Khuzdar | | | | 0.115** | 0.550* | 0.665 |
| Lahore | 0.504* | 0.169** | 0.673 | 0.157* | 0.077 | 0.234 |
| Multan | 0.114* | 0.629* | 0.743 | 0.310** | 0.002 | 0.312 |
| Peshawar | 0.514* | 0.358* | 0.872 | 0.242** | 0.11 | 0.352 |
| Quetta | | | 0.358 | 0.093** | 0.904* | 0.997 |
| Rawalpindi | 0.195* | 0.534* | 0.728 | 0.192** | -0.114 | 0.078 |
| Sargodha | 0.165* | 0.161* | 0.325 | 0.150* | 0.600** | 0.75 |
| Sialkot | 0.348* | 0.298* | 0.646 | 0.285** | -0.313 | -0.03 |
| Sukkur | | | | 0.276** | 0.239 | 0.515 |

*Source: Authors' calculations. *and ** represent significance at 1% and 5%, respectively.*

*Table A-8: GARCH (1,1) Results for the Dairy Group*

| City | EGG | | | MILK | | |
|---|---|---|---|---|---|---|
| | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β |
| Bahawalpur | 0.561* | 0.043 | 0.603 | 0.220** | 0.339* | 0.559 |
| Faisalabad | 0.445* | -0.163 | 0.281 | 0.155* | 0.470* | 0.625 |
| Hyderabad | 0.481* | 0.031 | 0.513 | 0.324* | 0.405* | 0.729 |
| Islamabad | 0.418* | -0.19 | 0.227 | 0.215* | 0.018 | 0.233 |
| Karachi | 0.553* | -0.02 | 0.533 | 0.158* | 0.784* | 0.942 |
| Khuzdar | 0.430* | -0.124 | 0.307 | | | |
| Lahore | 0.469* | 0.04 | 0.509 | 0.081* | 0.746* | 0.827 |
| Multan | 0.556* | 0.083 | 0.638 | 0.351* | 0.005* | 0.356 |
| Peshawar | 0.447* | -0.017 | 0.431 | 0.143* | 0.847* | 0.99 |
| Quetta | 0.183* | 0.743* | 0.926 | 0.769* | 0.074* | 0.842 |
| Rawalpindi | 0.135* | -0.055 | 0.08 | 0.124* | -0.194 | -0.07 |
| Sargodha | 0.513* | 0.153 | 0.666 | 0.727* | 0.002 | 0.73 |
| Sialkot | 0.269* | 0.237 | 0.507 | 0.209** | -0.02 | 0.189 |
| Sukkur | 0.526* | 0.075 | 0.601 | 0.150** | 0.600* | 0.75 |

*Source: Authors' calculations. *and ** represent significance at 1% and 5%, respectively.*

*Table A-9: GARCH (1,1) Results for the Vegetable Group*

| City | GARLIC | | | ONION | | |
|---|---|---|---|---|---|---|
| | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β |
| Bahawalpur | | | | 0.410* | 0.117 | 0.526 |
| Faisalabad | 0.093* | 0.649* | 0.742 | 0.361* | 0.19 | 0.551 |
| Hyderabad | 0.283* | 0.628* | 0.911 | 0.186** | 0.251 | 0.437 |
| Islamabad | 0.545* | 0.05 | 0.595 | 0.498* | 0.011 | 0.509 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Karachi | 0.682* | -0.009 | 0.673 | 0.282* | 0.116 | 0.398 |
| Khuzdar | 0.482* | 0.289 | 0.771 | 0.105* | 0.069 | 0.174 |
| Lahore | 0.319* | 0.241 | 0.56 | | | |
| Multan | 0.354* | 0.355* | 0.709 | 0.317* | 0.16 | 0.478 |
| Peshawar | 0.150* | 0.600* | 0.75 | 0.218** | 0.009 | 0.228 |
| Quetta | 0.338* | 0.416* | 0.754 | 0.370* | 0.002 | 0.372 |
| Rawalpindi | 0.248* | 0.106 | 0.354 | 0.447* | 0.636* | 1.083 |
| Sargodha | 0.284* | -0.192 | 0.092 | 0.300** | 0.013 | 0.314 |
| Sialkot | 0.256* | -0.19 | 0.066 | | | |
| Sukkur | 0.843* | 0.221** | 1.064 | 0.434* | 0.405* | 0.839 |
| | POTATO | | | TOMATO | | |
| City | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β |
| Bahawalpur | 0.694* | 0.239* | 0.932 | | | |
| Faisalabad | 0.279* | 0.173 | 0.452 | 0.350* | -0.086 | 0.264 |
| Hyderabad | 0.161** | -0.069 | 0.091 | 0.348** | -0.117 | 0.232 |
| Islamabad | 0.274** | -0.136 | 0.137 | 0.511* | 0.053 | 0.564 |
| Karachi | | | 0 | 0.440* | -0.391 | 0.049 |
| Khuzdar | 0.298** | 0.136 | 0.434 | 0.201** | 0.708* | 0.909 |
| Lahore | 0.236* | -0.315 | -0.079 | 0.425* | 0.036 | 0.461 |
| Multan | | | 0 | 0.576* | 0.125 | 0.701 |
| Peshawar | 0.131* | 0.037 | 0.169 | 0.437* | 0.009 | 0.446 |
| Quetta | 0.109* | -0.069 | 0.04 | 0.477* | -0.146 | 0.331 |
| Rawalpindi | 0.287* | 0.043 | 0.33 | 0.303* | 0.004 | 0.307 |
| Sargodha | 0.233* | -0.038 | 0.195 | 0.510* | 0.097 | 0.607 |
| Sialkot | 0.286** | 0.244 | 0.53 | 0.496* | 0.096 | 0.592 |
| Sukkur | 0.312* | -0.218 | 0.094 | | | |

*Source: Authors' calculations. *and ** represent significance at 1% and 5%, respectively.*

*Table A-10: GARCH (1,1) Results for the Cereal and Pulses Group*

| | PULSE MASH | | | PULSE MASOOR | | |
|---|---|---|---|---|---|---|
| City | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β |
| Bahawalpur | 0.081* | 0.821* | 0.902 | | | |
| Faisalabad | 0.138* | 0.868* | 1.006 | 0.273* | 0.519* | 0.792 |
| Hyderabad | 0.660* | 0.373* | 1.033 | 0.291* | 0.255* | 0.546 |
| Islamabad | 0.340* | 0.667* | 1.007 | 0.212* | -0.019 | 0.193 |
| Karachi | 0.145* | 0.401* | 0.546 | | | |
| Khuzdar | | | | 0.184* | 0.726* | 0.91 |
| Lahore | | | | | | |
| Multan | 0.076* | 0.794* | 0.87 | | | |
| Peshawar | 0.109* | 0.814* | 0.924 | 0.069** | 0.890* | 0.959 |
| Quetta | 0.232* | -0.004 | 0.228 | 0.067** | 0.917* | 0.984 |
| Rawalpindi | 0.251* | 0.767* | 1.019 | 0.231* | 0.616* | 0.847 |
| Sargodha | 0.177** | 0.426** | 0.603 | 0.599* | 0.506* | 1.106 |
| Sialkot | 0.339* | -0.117 | 0.222 | 0.184* | 0.788* | 0.972 |
| Sukkur | 0.199* | -0.203 | -0.004 | 0.376* | 0.577* | 0.953 |

| | PULSE MOONG | | | RICE IRI | | |
|---|---|---|---|---|---|---|
| City | ARCH COEFFICIENT (α) | GARCH COEFFICIENT (β) | α + β | ARCH COEFFICIENT (α) | GARCH COEFFICIENT (β) | α + β |
| Bahawalpur | | | | 0.143* | 0.780* | 0.923 |
| Faisalabad | 0.291* | 0.681* | 0.97 | 0.145* | 0.693* | 0.839 |
| Hyderabad | | | | 0.562* | 0.378* | 0.94 |
| Islamabad | 0.231* | 0.748* | 0.98 | 0.174* | 0.727* | 0.901 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Karachi | 0.244* | 0.584* | 0.83 | 0.150** | 0.600** | 0.75 |
| Khuzdar | 0.079* | 0.822* | 0.90 | | | |
| Lahore | 0.341* | 0.373* | 0.71 | 0.702* | 0.233* | 0.935 |
| Multan | 0.584* | 0.388* | 0.97 | 0.239* | 0.447* | 0.686 |
| Peshawar | 0.478* | 0.402* | 0.88 | 0.226* | 0.813* | 1.038 |
| Quetta | 0.523** | 0.056 | 0.58 | 0.165* | 0.417* | 0.581 |
| Rawalpindi | 0.575* | 0.208* | 0.78 | 0.327** | 0.501* | 0.828 |
| Sargodha | 0.391** | 0.284 | 0.68 | 0.343* | 0.449* | 0.792 |
| Sialkot | | | | | | |
| Sukkur | 0.373* | 0.553* | 0.93 | 0.139* | 0.868* | 1.007 |

*Source: Authors' calculations. *and ** represent significance at 1% and 5%, respectively.*

*Table A-11: GARCH (1,1) Results for the Cereal and Pulses Group*

| | WHEAT | | |
|---|---|---|---|
| City | ARCH COEFFICIENT (α) | GARCH COEFFICIENT (β) | α + β |
| Bahawalpur | 0.109* | 0.640* | 0.749 |
| Faisalabad | 0.201* | 0.683* | 0.884 |
| Hyderabad | 0.318* | 0.627* | 0.945 |
| Islamabad | 0.453* | 0.510* | 0.963 |
| Karachi | 0.437* | 0.540* | 0.976 |
| Khuzdar | 0.322* | 0.425* | 0.748 |
| Lahore | 0.319* | 0.532* | 0.851 |
| Multan | 0.160* | 0.692* | 0.852 |
| Peshawar | 0.144* | 0.726* | 0.87 |
| Quetta | 0.279* | 0.696* | 0.975 |
| Rawalpindi | 0.580* | 0.425* | 1.005 |

| | | | |
|---|---|---|---|
| Sargodha | | | |
| Sialkot | 0.779** | 0.161* | 0.94 |
| Sukkur | 0.286** | 0.577* | 0.863 |

*Source; Authors' calculations. *and ** represent significance at 1% and 5%, respectively.*

*Table A-12: GARCH (1,1) Results for Sugar and Tea*

| | SUGAR | | | TEA | | |
|---|---|---|---|---|---|---|
| City | ARCH COEFFICIENT (α) | GARCH COEFFICIENT (β) | α + β | ARCH COEFFICIENT (α) | GARCH COEFFICIENT (β) | α + β |
| Bahawalpur | 0.139** | 0.456 | 0.595 | 0.343* | 0.615* | 0.958 |
| Faisalabad | 0.288** | 0.008 | 0.296 | 0.298* | 0.589* | 0.887 |
| Hyderabad | 0.278* | 0.002 | 0.280 | 0.363* | 0.573* | 0.936 |
| Islamabad | | | | 0.139* | 0.698* | 0.836 |
| Karachi | 0.192* | 0.647* | 0.838 | 0.379* | 0.587* | 0.966 |
| Khuzdar | 0.128** | 0.249 | 0.377 | 0.276* | 0.625* | 0.902 |
| Lahore | 0.196** | 0.363 | 0.559 | 0.371* | 0.615* | 0.987 |
| Multan | 0.542* | -0.013 | 0.529 | 0.346* | 0.605* | 0.951 |
| Peshawar | 0.492* | 0.092 | 0.585 | | | |
| Quetta | | | | 0.208* | 0.702* | 0.91 |
| Rawalpindi | 0.361* | -0.129 | 0.232 | 0.178* | 0.803* | 0.98 |
| Sargodha | 0.295** | -0.115 | 0.180 | 0.222* | 0.702* | 0.924 |
| Sialkot | 0.293** | 0.152 | 0.446 | 0.359* | 0.608* | 0.967 |
| Sukkur | 0.254** | -0.111 | 0.143 | 0.341* | 0.592* | 0.933 |

*Source: Authors' calculations. *and ** represent significance at 1% and 5%, respectively.*

*Table A-13: IGARCH Results for All Commodities*

| Commodity | City | ARCH COEFFICIENT (α) | GARCH COEFFICENT (β) | α + β |
|---|---|---|---|---|
| Chicken | Quetta | 0.08 | 0.92 | 1 |
| Milk | Peshawar | 0.07 | 0.93 | 1 |
| Garlic | Sukkur | 0.06 | 0.94 | 1 |
| Onion | Rawalpindi | 0.16 | 0.84 | 1 |
| Mash | Islamabad | 0.12 | 0.88 | 1 |
| Mash | Faisalabad | 0.07 | 0.93 | 1 |
| Mash | Hyderabad | 0.12 | 0.88 | 1 |
| Mash | Rawalpindi | 0.17 | 0.83 | 1 |
| Masoor | Sargodha | 0.08 | 0.92 | 1 |
| IRRI Rice | Peshawar | 0.11 | 0.89 | 1 |
| IRRI Rice | Sukkur | 0.07 | 0.93 | 1 |
| Wheat | Rawalpindi | 0.19 | 0.80 | 1 |

*Source: Authors' calculations. *and ** represent significance at 1% and 5%, respectively.*

*Table A-14: Group Unit Root Test (First Difference)*

| Variables | Lags | P-Values |
|---|---|---|
| **Vegetable Group** | | |
| (a) Onion | | |
| Method | Statistic | Probabilities |
| ADF - Fisher Chi-square | 592.357 | 0.0000 |
| ADF - Choi Z-stat | -23.5522 | 0.0000 |
| Domestic Price | 0 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |

| | | |
|---|---|---|
| Production | 0 | 0.0000 |
| (b) Tomato | | |
| Method | Statistic | Probabilities |
| ADF - Fisher Chi-square | 543.860 | 0.0000 |
| ADF - Choi Z-stat | -22.3832 | 0.0000 |
| Domestic Price | 6 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 0 | 0.0000 |
| International Price | 9 | 0.0000 |
| (c) Garlic | | |
| Method | Statistic | Probabilities |
| ADF - Fisher Chi-square | 443.085 | 0.0000 |
| ADF - Choi Z-stat | -20.3277 | 0.0000 |
| Domestic Price | 0 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| (d) Potato | | |
| Method | Statistic | Probabilities |
| ADF - Fisher Chi-square | 549.063 | 0.0000 |
| ADF - Choi Z-stat | -22.5697 | 0.0000 |
| Domestic Price | 6 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 0 | 0.0000 |

| Meat Group | | |
|---|---|---|
| (a) Beef | | |
| Method | Statistic | Probabilities |
| ADF - Fisher Chi-square | 727.967 | 0.0000 |
| ADF - Choi Z-stat | -26.0537 | 0.0000 |
| Domestic Price | 0 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 0 | 0.0000 |
| International Price | 0 | 0.0000 |
| (b) Chicken | | |
| Method | Statistic | Probabilities |
| ADF - Fisher Chi-square | 592.152 | 0.0000 |
| ADF - Choi Z-stat | -21.9616 | 0.0000 |
| Domestic Price | 2 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 11 | 0.0857 |
| International Price | 0 | 0.0000 |
| **Dairy** | | |
| (a) Egg | | |
| Method | Statistic | Probabilities |
| ADF - Fisher Chi-square | 428.660 | 0.0000 |
| ADF - Choi Z-stat | -18.0830 | 0.0000 |
| Domestic Price | 9 | 0.0000 |

| | | |
|---|---|---|
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 11 | 0.0000 |
| (b) Milk | | |
| Method | Statistic | Probabilities |
| ADF - Fisher Chi-square | 612.330 | 0.0000 |
| ADF - Choi Z-stat | -23.3152 | 0.0000 |
| Domestic Price | 2 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 0 | 0.0000 |
| International Price | 1 | 0.0000 |
| **Cereal & Pulses Group** | | |
| (a) Wheat | | |
| Method | Statistics | Probabilities |
| ADF - Fisher Chi-square | 615.707 | 0.0000 |
| ADF - Choi Z-stat | -22.5829 | 0.0000 |
| Domestic Price | 0 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 11 | 0.0000 |
| International Price | 0 | 0.0000 |
| Wheat Support Prices | 11 | |
| (b) Rice | | |

| Method | Statistics | Probabilities |
|---|---|---|
| ADF - Fisher Chi-square | 628.433 | 0.0000 |
| ADF - Choi Z-stat | -24.0702 | 0.0000 |
| Domestic Price | 0 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 0 | 0.0857 |
| International Price | 0 | 0.0000 |
| (c) Pulse Moong | | |
| Method | Statistics | Probabilities |
| ADF - Fisher Chi-square | 517.882 | 0.0000 |
| ADF - Choi Z-stat | -21.6735 | 0.0000 |
| Domestic Price | 1 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 0 | 0.0000 |
| (d) Pulse Mash | | |
| Method | Statistics | Probabilities |
| ADF - Fisher Chi-square | 617.970 | 0.0000 |
| ADF - Choi Z-stat | -24.0504 | 0.0000 |
| Domestic Price | 0 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 0 | 0.0000 |

| (e) Pulse Masoor | | |
|---|---|---|
| Method | Statistics | Probabilities |
| ADF - Fisher Chi-square | 427.919 | 0.0000 |
| ADF - Choi Z-stat | -19.2625 | 0.0000 |
| Domestic Price | 2 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 0 | 0.0000 |
| **Others Group** | | |
| (a) Sugar | | |
| Method | Statistics | Probabilities |
| ADF - Fisher Chi-square | 639.151 | 0.0000 |
| ADF - Choi Z-stat | -24.3413 | 0.0000 |
| Domestic Price | 1 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 1 | 0.0000 |
| Oil Price | 0 | 0.0000 |
| Production | 0 | 0.0000 |
| International Price | 0 | 0.0000 |
| (b) Tea | | |
| Method | Statistics | Probabilities |
| ADF - Fisher Chi-square | 488.457 | 0.0000 |
| ADF - Choi Z-stat | -21.2557 | 0.0000 |
| Domestic Price | 1 | 0.0000 |
| Exchange Rate | 0 | 0.0000 |
| Interest Rate | 0 | 0.0000 |

| | | |
|---|---|---|
| Oil Price | 0 | 0.0000 |
| International Price | 1 | 0.0000 |

*Source: Authors' calculations*

*Table A-15: Residual Diagnostic Test/ Model Robustness*

| Dependent Variables | $F^2$ Stat | $R^2$ | $X^2_{Serialcorrelation}$ | $X^2_{hetero}$ | AIC lag selection |
|---|---|---|---|---|---|
| Vegetable Group | | | | | |
| log (Onion price) | 101.7606*** | 0.90 | 0.89 | Robust SE (HAC) | (4, 0, 3, 1, 3) |
| log (tomato price) | 49.08887*** | 0.71 | 0.80 | Robust SE (HAC) | (1, 0, 1, 0, 0, 0) |
| log (garlic price) | 1832.16*** | 0.98 | 0.86 | Robust SE (HAC) | (2, 2, 0, 0) |
| log (potato price) | 131.8729*** | 0.94 | 0.93 | Robust SE (HAC) | (4, 4, 5, 4, 0) |
| Meat Group | | | | | |
| log (beef price) | 3840.197*** | 0.99 | 0.11 | 0.93 | (4, 0, 0, 1, 0, 0) |
| log (chicken price) | 229.9765*** | 0.95 | 0.20 | Robust SE (HAC) | (4, 1, 3, 0, 1, 0) |
| Dairy Group | | | | | |
| log (egg price) | 260.0035*** | 0.94 | 0.30 | 0.24 | (1, 0, 2, 1, 4) |
| log (milk price) | 31401.96*** | 0.99 | 0.81 | Robust SE (HAC) | (2, 1, 0, 0, 1, 1) |
| Cereal & Pulses Group | | | | | |
| log (wheat price) | 2575.58*** | 0.99 | 0.435 | Robust SE (HAC) | (2, 2, 0, 0, 0, 4, 3) |
| log (rice price) | 7057.850*** | 0.99 | 0.65 | Robust SE (HAC) | (2, 0, 2, 0, 3, 0) |
| log (Pulse moong price) | 4970.500 | 0.99 | 0.17 | 0.13 | (3, 0, 0, 0, 2) |
| log (pulse mash price) | 2181.496*** | 0.99 | 0.59 | Robust SE (HAC) | (3, 0, 5, 0, 1) |
| log (pulse masoor price) | 3847.106*** | 0.99 | 0.72 | Robust SE (HAC) | (4, 1, 0, 2, 0) |
| Other Group | | | | | |
| log (sugar price) | 552.98*** | 0.98 | 0.31 | Robust SE (HAC) | (3, 0, 3, 1, 2, 3) |
| log (tea price) | 2804.805*** | 0.99 | 0.41 | Robust SE (HAC) | (1, 4, 4, 1, 0) |

*Source: Authors' calculations*

*Table A-16: Short-Run Coefficients*

## 1- Onion

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_ONION_PRICE)

Selected Model: ARDL(4, 0, 3, 1, 3)

Case 2: Restricted Constant and No Trend

Date: 03/01/22 Time: 22:52

Sample: 2002M07 2021M04

Included observations: 222

| ECM Regression<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LOG_DOMESTIC_ONION_PRICE(-1)) | 0.263204 | 0.065474 | 4.019992 | 0.0001 |
| D(LOG_DOMESTIC_ONION_PRICE(-2)) | 0.164573 | 0.067392 | 2.442025 | 0.0155 |
| D(LOG_DOMESTIC_ONION_PRICE(-3)) | 0.126888 | 0.068311 | 1.857493 | 0.0647 |
| D(LOG_INTERESTRATE) | -0.402843 | 0.121423 | -3.317689 | 0.0011 |
| D(LOG_INTERESTRATE(-1)) | -0.251147 | 0.131542 | -1.909251 | 0.0576 |
| D(LOG_INTERESTRATE(-2)) | -0.227947 | 0.123138 | -1.851154 | 0.0656 |
| D(LOG_OILPRICE) | -0.164396 | 0.138085 | -1.190544 | 0.2352 |
| D(LOG_PRODUCTION) | 0.731073 | 0.472104 | 1.548541 | 0.1230 |
| D(LOG_PRODUCTION(-1)) | 0.318318 | 0.471672 | 0.674872 | 0.5005 |
| D(LOG_PRODUCTION(-2)) | 1.565533 | 0.468465 | 3.341839 | 0.0010 |
| P1 | -0.401215 | 0.060654 | -6.614869 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| P2 | -0.154287 | 0.035738 | -4.317228 | 0.0000 |
| P3 | -0.063871 | 0.026093 | -2.447833 | 0.0152 |
| CointEq(-1)* | -0.349545 | 0.048949 | -7.141035 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.261443 | Mean dependent var | 0.003852 |
| Adjusted R-squared | 0.215283 | S.D. dependent var | 0.221489 |
| S.E. of regression | 0.196204 | Akaike info criterion | -0.358334 |
| Sum squared resid | 8.007191 | Schwarz criterion | -0.143751 |
| Log-likelihood | 53.77510 | Hannan-Quinn criterion | -0.271699 |
| Durbin-Watson stat | 1.995908 | | |

* p-value incompatible with t-Bounds distribution.

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| F-statistic | 8.294759 | 10% | 2.2 | 3.09 |
| k | 4 | 5% | 2.56 | 3.49 |
| | | 2.5% | 2.88 | 3.87 |
| | | 1% | 3.29 | 4.37 |

**2-Tomato**

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_TOMATO_PRICES)

Selected Model: ARDL(1, 0, 1, 0, 0, 0)

Case 2: Restricted Constant and No Trend

Date: 03/01/22 Time: 22:37

Sample: 2002M07 2021M04

Included observations: 203

| ECM Regression<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LOG_INTERESTRATE) | -0.754049 | 0.170927 | -4.411527 | 0.0000 |
| P1 | -0.589483 | 0.086824 | -6.789408 | 0.0000 |
| P2 | -0.361164 | 0.060952 | -5.925348 | 0.0000 |
| P3 | -0.313846 | 0.055783 | -5.626240 | 0.0000 |
| CointEq(-1)* | -0.412506 | 0.053936 | -7.648106 | 0.0000 |
| R-squared | 0.297166 | Mean dependent var | | 0.005351 |
| Adjusted R-squared | 0.282967 | S.D. dependent var | | 0.351528 |
| S.E. of regression | 0.297667 | Akaike info criterion | | 0.438636 |
| Sum squared resid | 17.54386 | Schwarz criterion | | 0.520242 |
| Log likelihood | -39.52157 | Hannan-Quinn criterion | | 0.471651 |
| Durbin-Watson stat | 1.939690 | | | |

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| F-statistic | 8.102999 | 10% | 2.08 | 3 |

| | | | | |
|---|---|---|---|---|
| k | 5 | 5% | 2.39 | 3.38 |
| | | 2.5% | 2.7 | 3.73 |
| | | 1% | 3.06 | 4.15 |

**3- Potato**

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_POTATO_PRICES)

Selected Model: ARDL(4, 4, 5, 4, 0)

Case 2: Restricted Constant and No Trend

Date: 02/28/22 Time: 22:18

Sample: 2002M07 2021M04

Included observations: 221

| ECM Regression<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LOG_DOMESTIC_POTATO_PRICES(-1)) | 0.361678 | 0.060532 | 5.974960 | 0.0000 |
| D(LOG_DOMESTIC_POTATO_PRICES(-2)) | 0.051254 | 0.064994 | 0.788594 | 0.4313 |
| D(LOG_DOMESTIC_POTATO_PRICES(-3)) | 0.116443 | 0.063731 | 1.827085 | 0.0692 |
| D(LOG_EXCHANGERATE) | 1.515590 | 0.641585 | 2.362258 | 0.0191 |
| D(LOG_EXCHANGERATE(-1)) | -0.596664 | 0.664823 | -0.897478 | 0.3706 |
| D(LOG_EXCHANGERATE(-2)) | -0.385382 | 0.659401 | -0.584442 | 0.5596 |
| D(LOG_EXCHANGERATE(-3)) | 1.499199 | 0.640834 | 2.339449 | 0.0203 |

| | | | | |
|---|---|---|---|---|
| D(LOG_EXCHANGERATE) | 1.515590 | 0.641585 | 2.362258 | 0.0191 |
| D(LOG_EXCHANGERATE(-1)) | -0.596664 | 0.664823 | -0.897478 | 0.3706 |
| D(LOG_EXCHANGERATE(-2)) | -0.385382 | 0.659401 | -0.584442 | 0.5596 |
| D(LOG_EXCHANGERATE(-3)) | 1.499199 | 0.640834 | 2.339449 | 0.0203 |
| D(LOG_INTERESTRATE) | -0.254831 | 0.087492 | -2.912617 | 0.0040 |
| D(LOG_INTERESTRATE(-1)) | -0.227075 | 0.095248 | -2.384042 | 0.0181 |
| D(LOG_INTERESTRATE(-2)) | -0.247158 | 0.095167 | -2.597095 | 0.0101 |
| D(LOG_INTERESTRATE(-3)) | -0.026306 | 0.093669 | -0.280842 | 0.7791 |
| D(LOG_INTERESTRATE(-4)) | -0.344141 | 0.085118 | -4.043126 | 0.0001 |
| D(LOG_OILPRICE) | -0.065174 | 0.102338 | -0.636853 | 0.5250 |
| D(LOG_OILPRICE(-1)) | 0.155346 | 0.108326 | 1.434063 | 0.1531 |
| D(LOG_OILPRICE(-2)) | -0.081600 | 0.108763 | -0.750253 | 0.4540 |
| D(LOG_OILPRICE(-3)) | 0.226070 | 0.105645 | 2.139913 | 0.0336 |
| P1 | -0.333672 | 0.048528 | -6.875872 | 0.0000 |
| P2 | -0.226715 | 0.036918 | -6.140956 | 0.0000 |
| P3 | -0.109945 | 0.023693 | -4.640361 | 0.0000 |
| CointEq(-1)* | -0.244828 | 0.034278 | -7.142469 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.410877 | Mean dependent var | 0.005736 |
| Adjusted R-squared | 0.355189 | S.D. dependent var | 0.169045 |
| S.E. of regression | 0.135744 | Akaike info criterion | -1.069958 |
| Sum squared resid | 3.703699 | Schwarz criterion | -0.762432 |
| Log likelihood | 138.2304 | Hannan-Quinn criterion | -0.945785 |

Durbin-Watson stat 2.000867

* p-value incompatible with t-Bounds distribution.

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| F-statistic | 8.290972 | 10% | 2.2 | 3.09 |
| k | 4 | 5% | 2.56 | 3.49 |
| | | 2.5% | 2.88 | 3.87 |
| | | 1% | 3.29 | 4.37 |

**4- Beef**

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_BEEF_PRICE)

Selected Model: ARDL(4, 0, 0, 1, 0, 0)

Case 2: Restricted Constant and No Trend

Date: 03/02/22 Time: 19:36

Sample: 2002M07 2021M04

Included observations: 222

| ECM Regression<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LOG_DOMESTIC_BEEF_PRICE(-1)) | -0.640265 | 0.063103 | -10.14628 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| D(LOG_DOMESTIC_BEEF_PRICE(-2)) | -0.381343 | 0.073033 | -5.221512 | 0.0000 |
| D(LOG_DOMESTIC_BEEF_PRICE(-3)) | -0.213329 | 0.063359 | -3.366981 | 0.0009 |
| D(LOG_OILPRICE) | 0.047200 | 0.026470 | 1.783124 | 0.0760 |
| P1 | -0.065784 | 0.016597 | -3.963697 | 0.0001 |
| P2 | -0.026467 | 0.010828 | -2.444313 | 0.0153 |
| P3 | -0.037509 | 0.009667 | -3.880252 | 0.0001 |
| CointEq(-1)* | -0.123140 | 0.021525 | -5.720803 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.405542 | Mean dependent var | 0.009877 |
| Adjusted R-squared | 0.386097 | S.D. dependent var | 0.049177 |
| S.E. of regression | 0.038531 | Akaike info criterion | -3.639319 |
| Sum squared resid | 0.317718 | Schwarz criterion | -3.516700 |
| Log likelihood | 411.9644 | Hannan-Quinn criterion | -3.589813 |
| Durbin-Watson stat | 2.045895 | | |

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| F-statistic | 4.544285 | 10% | 2.08 | 3 |
| k | 5 | 5% | 2.39 | 3.38 |
| | | 2.5% | 2.7 | 3.73 |
| | | 1% | 3.06 | 4.15 |

**5- Chicken**

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_CHICKEN_PRICE)

Selected Model: ARDL(4, 1, 3, 0, 1, 0)

Case 2: Restricted Constant and No Trend

Date: 03/02/22 Time: 18:27

Sample: 2002M07 2021M04

Included observations: 222

| ECM Regression<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LOG_DOMESTIC_CHICKEN_PRICE(-1)) | 0.220526 | 0.068875 | 3.201840 | 0.0016 |
| D(LOG_DOMESTIC_CHICKEN_PRICE(-2)) | 0.046846 | 0.063341 | 0.739591 | 0.4604 |
| D(LOG_DOMESTIC_CHICKEN_PRICE(-3)) | -0.207603 | 0.060512 | -3.430779 | 0.0007 |
| D(LNEXCHANGE_RATE) | 1.504946 | 0.437883 | 3.436871 | 0.0007 |
| D(LOG_INTERESTRATE) | -0.281170 | 0.057883 | -4.857585 | 0.0000 |
| D(LOG_INTERESTRATE(-1)) | -0.137129 | 0.064316 | -2.132125 | 0.0342 |
| D(LOG_INTERESTRATE(-2)) | -0.102434 | 0.060674 | -1.688281 | 0.0929 |
| D(LOG_INTERNATIONAL_CHICKEN_PRICE) | 0.517944 | 0.138355 | 3.743594 | 0.0002 |
| P1 | -0.074722 | 0.017690 | -4.223987 | 0.0000 |
| P2 | 0.043713 | 0.013669 | 3.197887 | 0.0016 |
| P3 | 0.015706 | 0.012464 | 1.260065 | 0.2091 |

| | | | | |
|---|---|---|---|---|
| CointEq(-1)* | -0.493269 | 0.075443 | -6.538344 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.448821 | Mean dependent var | 0.008558 |
| Adjusted R-squared | 0.419949 | S.D. dependent var | 0.127140 |
| S.E. of regression | 0.096831 | Akaike info criterion | -1.779159 |
| Sum squared resid | 1.969015 | Schwarz criterion | -1.595230 |
| Log likelihood | 209.4866 | Hannan-Quinn criterion | -1.704900 |
| Durbin-Watson stat | 2.058745 | | |

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| F-statistic | 5.932645 | 10% | 2.08 | 3 |
| k | 5 | 5% | 2.39 | 3.38 |
| | | 2.5% | 2.7 | 3.73 |
| | | 1% | 3.06 | 4.15 |

**6- Egg**

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_EGG_PRICES)

Selected Model: ARDL(1, 0, 2, 1, 4)

Case 2: Restricted Constant and No Trend

Date: 03/02/22 Time: 00:19

Sample: 2002M07 2021M04

Included observations: 222

| ECM Regression<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LOG_EXCHANGERATE) | 0.032970 | 0.555398 | 0.059363 | 0.9527 |
| D(LOG_EXCHANGERATE(-1)) | 1.106785 | 0.566700 | 1.953035 | 0.0522 |
| D(LOG_OILPRICE) | -0.073238 | 0.084911 | -0.862521 | 0.3894 |
| D(LOG_PRODUCTION_EGG) | 2.492709 | 0.492852 | 5.057721 | 0.0000 |
| D(LOG_PRODUCTION_EGG(-1)) | 0.563083 | 0.495211 | 1.137057 | 0.2568 |
| D(LOG_PRODUCTION_EGG(-2)) | 1.060626 | 0.494832 | 2.143407 | 0.0332 |
| D(LOG_PRODUCTION_EGG(-3)) | 1.563136 | 0.497421 | 3.142479 | 0.0019 |
| SEASONALDUMMY | 0.121015 | 0.020802 | 5.817534 | 0.0000 |
| CointEq(-1)* | -0.370886 | 0.047334 | -7.835516 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.300675 | Mean dependent var | 0.006862 |
| Adjusted R-squared | 0.274409 | S.D. dependent var | 0.144986 |
| S.E. of regression | 0.123501 | Akaike info criterion | -1.305432 |
| Sum squared resid | 3.248806 | Schwarz criterion | -1.167485 |
| Log likelihood | 153.9029 | Hannan-Quinn criterion | -1.249737 |
| Durbin-Watson stat | 1.909566 | | |

* p-value incompatible with t-Bounds distribution.

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| F-statistic | 9.992351 | 10% | 2.2 | 3.09 |
| k | 4 | 5% | 2.56 | 3.49 |
| | | 2.5% | 2.88 | 3.87 |
| | | 1% | 3.29 | 4.37 |

**7- Milk**

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_MILK_PRICES)

Selected Model: ARDL(2, 1, 0, 0, 1, 1)

Case 2: Restricted Constant and No Trend

Date: 03/01/22 Time: 23:44

Sample: 2002M07 2021M04

Included observations: 224

| ECM Regression<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LOG_DOMESTIC_MILK_PRICES(-1)) | -0.141593 | 0.064974 | -2.179224 | 0.0304 |
| D(LOG_EXCHANGERATE) | 0.122210 | 0.065316 | 1.871052 | 0.0627 |
| D(LOG_OILPRICE) | 0.035044 | 0.010201 | 3.435410 | 0.0007 |
| D(LOG_INTERNATIONAL_MILK_PRICE) | 0.021271 | 0.011218 | 1.896199 | 0.0593 |
| CointEq(-1)* | -0.008780 | 0.001046 | -8.394350 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.125374 | Mean dependent var | 0.007926 |
| Adjusted R-squared | 0.109399 | S.D. dependent var | 0.015756 |
| S.E. of regression | 0.014869 | Akaike info criterion | -5.557016 |
| Sum squared resid | 0.048418 | Schwarz criterion | -5.480864 |
| Log likelihood | 627.3858 | Hannan-Quinn criterion | -5.526277 |
| Durbin-Watson stat | 1.978323 | | |

* p-value incompatible with t-Bounds distribution.

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| F-statistic | 9.790651 | 10% | 2.08 | 3 |
| k | 5 | 5% | 2.39 | 3.38 |
| | | 2.5% | 2.7 | 3.73 |
| | | 1% | 3.06 | 4.15 |

**8- Wheat**

ARDL Error Correction Regression

Dependent Variable: D(LNDOMESTIC_WHEAT_PRICE)

Selected Model: ARDL(2, 2, 0, 0, 0, 4, 3)

Case 2: Restricted Constant and No Trend

Date: 02/25/22 Time: 01:22

Sample: 2002M07 2021M04

Included observations: 222

| ECM Regression | | | | |
|---|---|---|---|---|
| Case 2: Restricted Constant and No Trend | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LNDOMESTIC_WHEAT_PRICE(-1)) | 0.267274 | 0.058151 | 4.596204 | 0.0000 |
| D(LNEXCHANGE_RATE) | 0.058445 | 0.148191 | 0.394388 | 0.6937 |
| D(LNEXCHANGE_RATE(-1)) | 0.276881 | 0.154337 | 1.793998 | 0.0743 |
| D(LNPRODUCTION) | -0.017795 | 0.119306 | -0.149153 | 0.8816 |
| D(LNPRODUCTION(-1)) | 0.348951 | 0.120356 | 2.899334 | 0.0042 |
| D(LNPRODUCTION(-2)) | -0.097523 | 0.122535 | -0.795879 | 0.4270 |
| D(LNPRODUCTION(-3)) | 0.280544 | 0.114529 | 2.449538 | 0.0152 |
| D(LNSUPPORT_PRICE) | 0.095371 | 0.051094 | 1.866569 | 0.0634 |
| D(LNSUPPORT_PRICE(-1)) | -0.188388 | 0.056504 | -3.334067 | 0.0010 |
| D(LNSUPPORT_PRICE(-2)) | -0.080585 | 0.055935 | -1.440675 | 0.1512 |
| P1 | -0.084458 | 0.010834 | -7.795808 | 0.0000 |
| P2 | -0.050082 | 0.007433 | -6.737664 | 0.0000 |
| P3 | -0.009904 | 0.004272 | -2.318214 | 0.0214 |
| CointEq(-1)* | -0.326844 | 0.036543 | -8.944094 | 0.0000 |
| R-squared | 0.359922 | Mean dependent var | | 0.008475 |
| Adjusted R-squared | 0.319917 | S.D. dependent var | | 0.039506 |
| S.E. of regression | 0.032579 | Akaike info criterion | | -3.949293 |
| Sum squared resid | 0.220773 | Schwarz criterion | | -3.734709 |
| Log likelihood | 452.3715 | Hannan-Quinn criterion | | -3.862657 |

| | |
|---|---|
| Durbin-Watson stat | 1.928906 |

* p-value incompatible with t-Bounds distribution.

| F-Bounds Test | | | Null Hypothesis: No levels relationship | |
|---|---|---|---|---|
| | | | | |
| F-statistic | 9.663078 | 10% | 1.99 | 2.94 |
| k | 6 | 5% | 2.27 | 3.28 |
| | | 2.5% | 2.55 | 3.61 |
| | | 1% | 2.88 | 3.99 |

**9- Pulse Mash**

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_MASH_PRICES)

Selected Model: ARDL(3, 0, 5, 0, 1)

Case 2: Restricted Constant and No Trend

Date: 03/20/22 Time: 14:20

Sample: 2002M07 2021M04

Included observations: 221

| ECM Regression<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LOG_DOMESTIC_MASH_PRICES(-1)) | -0.152043 | 0.067676 | -2.246640 | 0.0257 |

| | | | | |
|---|---|---|---|---|
| D(LOG_DOMESTIC_MASH_PRICES(-2)) | 0.105092 | 0.065246 | 1.610706 | 0.1088 |
| D(LOG_EXCHANGERATE) | 0.079833 | 0.246732 | 0.323560 | 0.7466 |
| D(LOG_EXCHANGERATE(-1)) | -0.431372 | 0.254261 | -1.696575 | 0.0913 |
| D(LOG_EXCHANGERATE(-2)) | 0.195522 | 0.259260 | 0.754155 | 0.4516 |
| D(LOG_EXCHANGERATE(-3)) | 0.657868 | 0.256929 | 2.560503 | 0.0112 |
| D(LOG_EXCHANGERATE(-4)) | 0.561812 | 0.255590 | 2.198097 | 0.0291 |
| D(LOG_PRODUCTION) | 0.190138 | 0.103129 | 1.843686 | 0.0667 |
| CointEq(-1)* | -0.039504 | 0.008631 | -4.577131 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.167746 | Mean dependent var | 0.008577 |
| Adjusted R-squared | 0.136340 | S.D. dependent var | 0.058484 |
| S.E. of regression | 0.054351 | Akaike info criterion | -2.946828 |
| Sum squared resid | 0.626259 | Schwarz criterion | -2.808442 |
| Log likelihood | 334.6245 | Hannan-Quinn criterion | -2.890950 |
| Durbin-Watson stat | 2.021585 | | |

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| F-statistic | 3.409337 | 10% | 2.2 | 3.09 |
| k | 4 | 5% | 2.56 | 3.49 |
| | | 2.5% | 2.88 | 3.87 |

| | | | |
|---|---|---|---|
| | 1% | 3.29 | 4.37 |

**10 - Sugar**

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_SUGAR_PRICES)

Selected Model: ARDL(3, 0, 3, 2, 1, 3)

Case 2: Restricted Constant and No Trend

Date: 03/20/22 Time: 00:04

Sample: 2002M07 2021M04

Included observations: 223

| ECM Regression<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LOG_DOMESTIC_SUGAR_PRICES(-1)) | -0.219462 | 0.064197 | -3.418574 | 0.0008 |
| D(LOG_DOMESTIC_SUGAR_PRICES(-2)) | 0.144759 | 0.063635 | 2.274813 | 0.0240 |
| D(LOG_INTERESTRATE) | -0.020412 | 0.039177 | -0.521014 | 0.6029 |
| D(LOG_INTERESTRATE(-1)) | -0.057522 | 0.041494 | -1.386256 | 0.1672 |
| D(LOG_INTERESTRATE(-2)) | 0.055681 | 0.039431 | 1.412110 | 0.1595 |
| D(LOG_INTERNATIONAL_SUGAR_PRICE) | 0.220227 | 0.125620 | 1.753120 | 0.0811 |
| D(LOG_INTERNATIONAL_SUGAR_PRICE(-1)) | 0.238624 | 0.128952 | 1.850489 | 0.0657 |
| D(LOG_OILPRICE) | -0.043531 | 0.045554 | -0.955581 | 0.3404 |
| D(LOG_PRODUCTION) | 0.098631 | 0.124500 | 0.792216 | 0.4292 |

| | | | | |
|---|---|---|---|---|
| D(LOG_PRODUCTION(-1)) | 0.318871 | 0.126608 | 2.518563 | 0.0126 |
| D(LOG_PRODUCTION(-2)) | 0.292025 | 0.129209 | 2.260097 | 0.0249 |
| P1 | -0.119453 | 0.026158 | -4.566581 | 0.0000 |
| P2 | -0.054317 | 0.015203 | -3.572868 | 0.0004 |
| P3 | -0.032092 | 0.010067 | -3.187885 | 0.0017 |
| CointEq(-1)* | -0.133280 | 0.027021 | -4.932450 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.280158 | Mean dependent var | 0.006631 |
| Adjusted R-squared | 0.231707 | S.D. dependent var | 0.072740 |
| S.E. of regression | 0.063758 | Akaike info criterion | -2.602551 |
| Sum squared resid | 0.845536 | Schwarz criterion | -2.373369 |
| Log likelihood | 305.1844 | Hannan-Quinn criterion | -2.510031 |
| Durbin-Watson stat | 2.045697 | | |

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| F-statistic | 3.375323 | 10% | 2.08 | 3 |
| k | 5 | 5% | 2.39 | 3.38 |
| | | 2.5% | 2.7 | 3.73 |
| | | 1% | 3.06 | 4.15 |

**11 - Tea**

ARDL Error Correction Regression

Dependent Variable: D(LOG_DOMESTIC_TEA_PRICES)

Selected Model: ARDL(1, 4, 4, 1, 0)

Case 2: Restricted Constant and No Trend

Date: 03/01/22 Time: 23:22

Sample: 2002M07 2021M04

Included observations: 216

| ECM Regression<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(LOG_EXCHANGERATE) | 0.507702 | 0.147503 | 3.441990 | 0.0007 |
| D(LOG_EXCHANGERATE(-1)) | -0.135443 | 0.152923 | -0.885699 | 0.3769 |
| D(LOG_EXCHANGERATE(-2)) | 0.053160 | 0.150842 | 0.352422 | 0.7249 |
| D(LOG_EXCHANGERATE(-3)) | -0.467792 | 0.148750 | -3.144810 | 0.0019 |
| D(LOG_INTERESTRATE) | -0.069187 | 0.059201 | -1.168675 | 0.2439 |
| D(LOG_INTERESTRATE(-1)) | -0.257865 | 0.062668 | -4.114749 | 0.0001 |
| D(LOG_INTERESTRATE(-2)) | -0.256228 | 0.064101 | -3.997233 | 0.0001 |
| D(LOG_INTERESTRATE(-3)) | -0.165645 | 0.064744 | -2.558482 | 0.0113 |
| D(LOG_INTERNATIONAL_TEA_PRICE) | -0.047595 | 0.032762 | -1.452735 | 0.1479 |
| P1 | -0.024181 | 0.004645 | -5.206078 | 0.0000 |
| P2 | -0.029880 | 0.006146 | -4.862005 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| P3 | -0.006542 | 0.004145 | -1.578306 | 0.1161 |
| CointEq(-1)* | -0.241562 | 0.025199 | -9.586254 | 0.0000 |

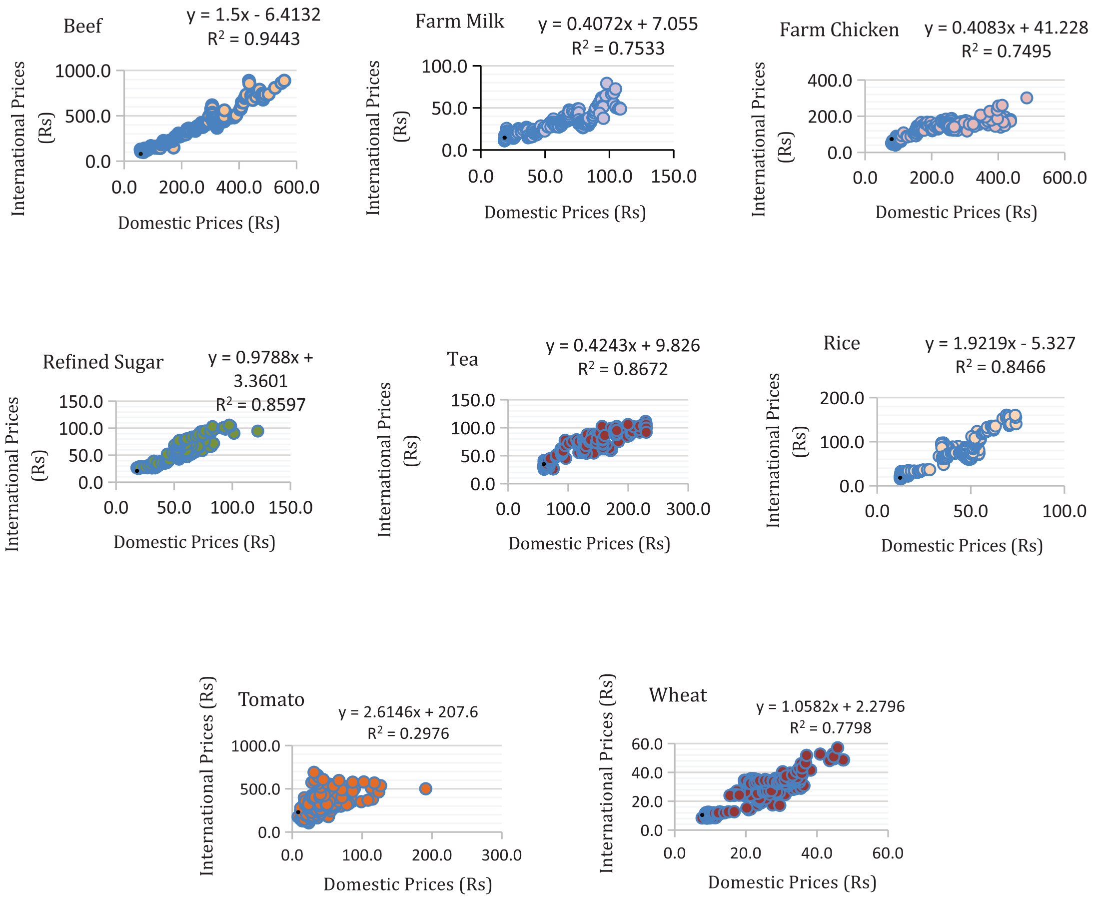
| | | | |
|---|---|---|---|
| R-squared | 0.387728 | Mean dependent var | 0.005174 |
| Adjusted R-squared | 0.351535 | S.D. dependent var | 0.038822 |
| S.E. of regression | 0.031262 | Akaike info criterion | -4.034530 |
| Sum squared resid | 0.198394 | Schwarz criterion | -3.831388 |
| Log likelihood | 448.7292 | Hannan-Quinn criterion | -3.952460 |
| Durbin-Watson stat | 2.212518 | | |

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| F-statistic | 14.93880 | 10% | 2.2 | 3.09 |
| k | 4 | 5% | 2.56 | 3.49 |
| | | 2.5% | 2.88 | 3.87 |
| | | 1% | 3.29 | 4.37 |

*Figure A-1: Correlation Between International and Domestic Food Prices*

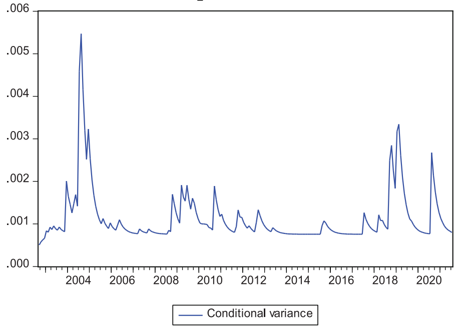



*Source: Authors' illustration based on the PBS data July 2002–April 2021*

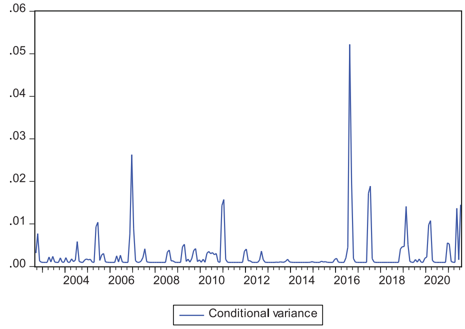
*Figure A-2: Conditional Standard Deviation*

**Beef**

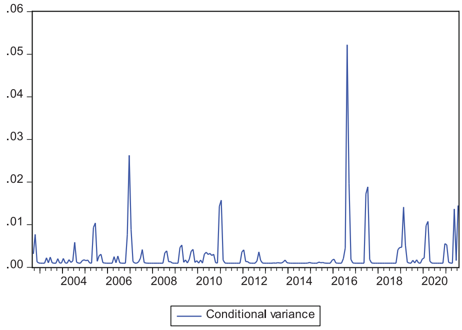
Bahawalpur



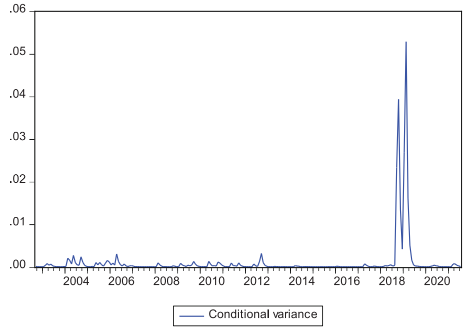

Faisalabad



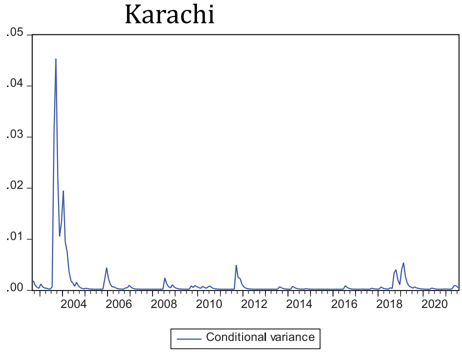

Hyderabad



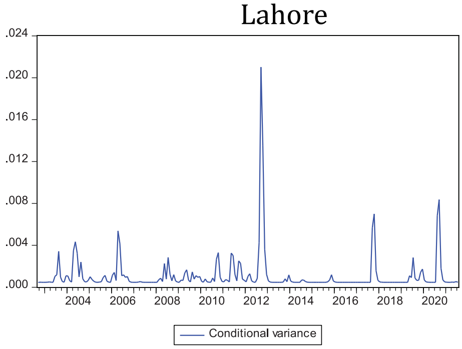

Islamabad



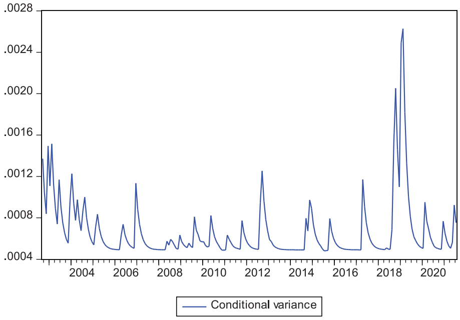

Karachi



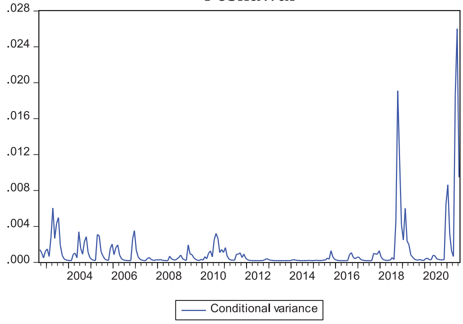

Lahore



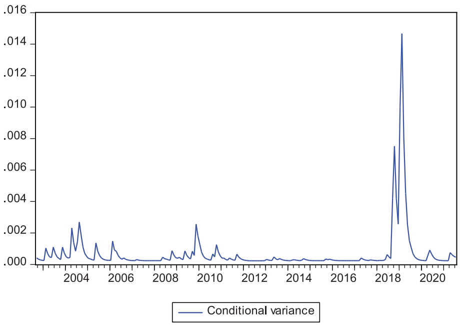
Multan



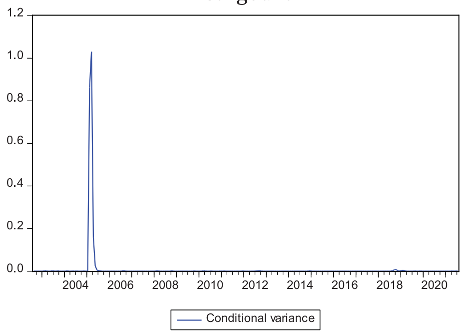

Peshawar



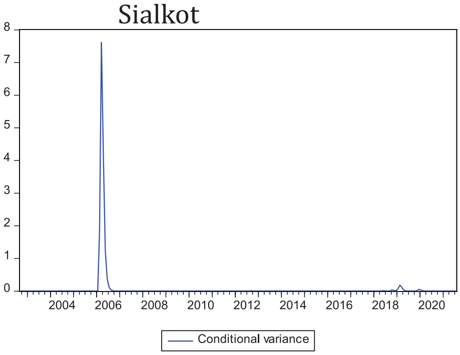

Rawalpindi




Sargodha

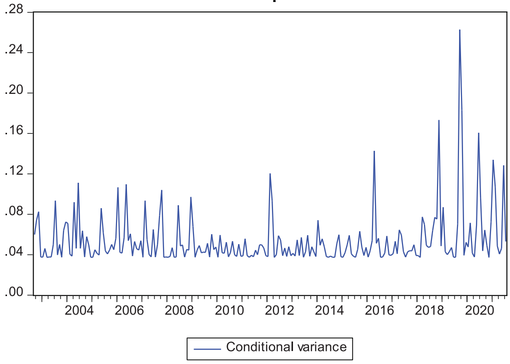



Sialkot

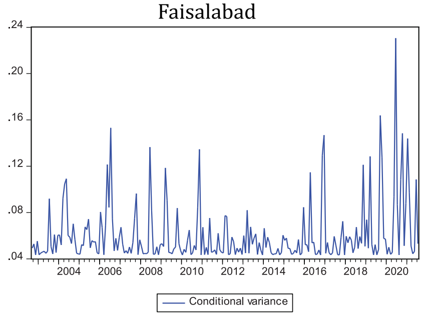


## Chicken

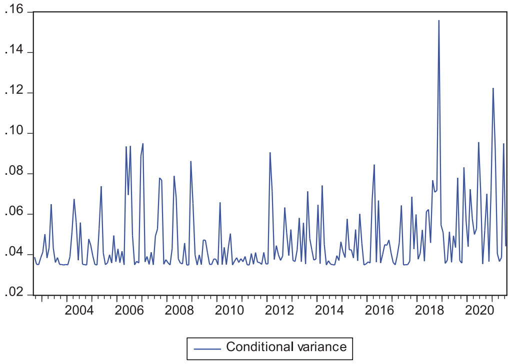
### Bahawalpur



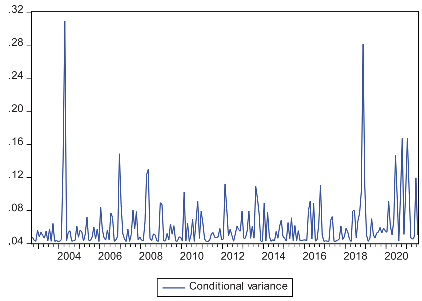

### Faisalabad



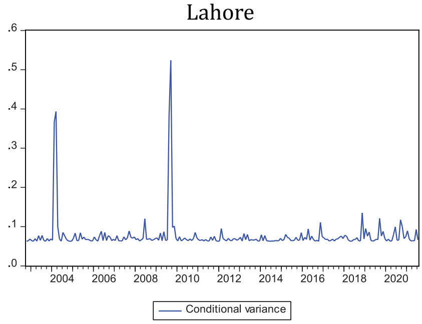

### Hyderabad



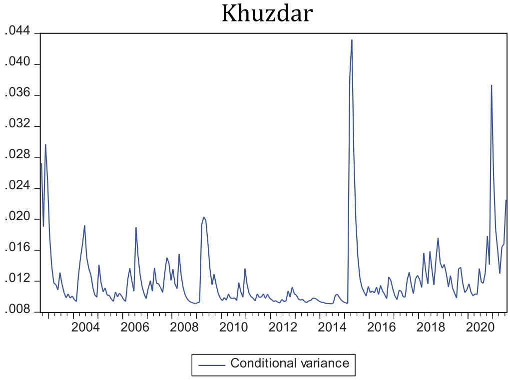

### Karachi



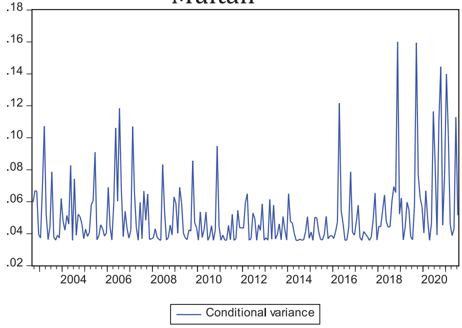

### Lahore



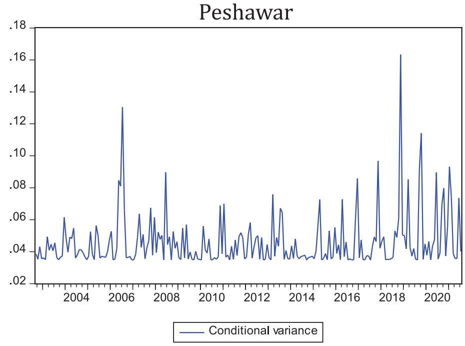

### Khuzdar



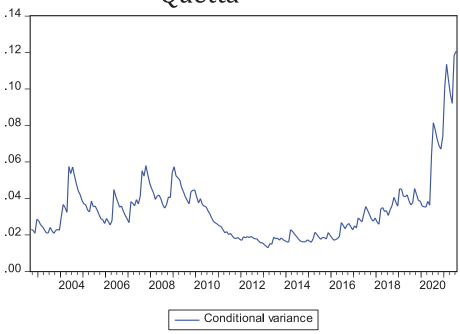
Multan



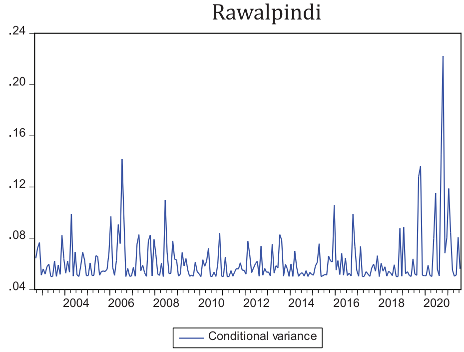

Peshawar



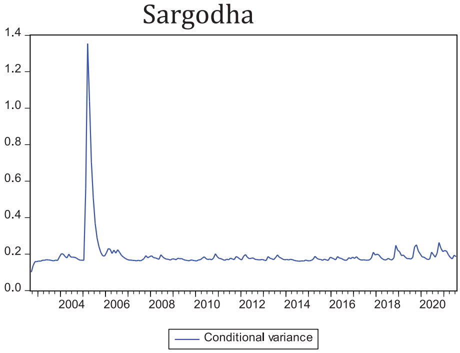

Quetta



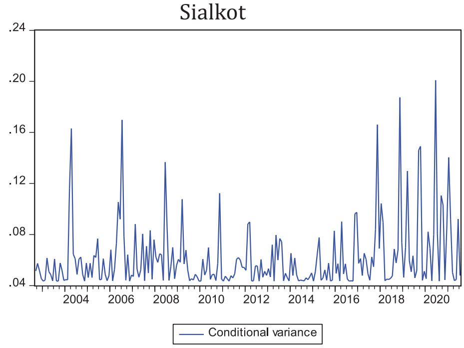

Rawalpindi



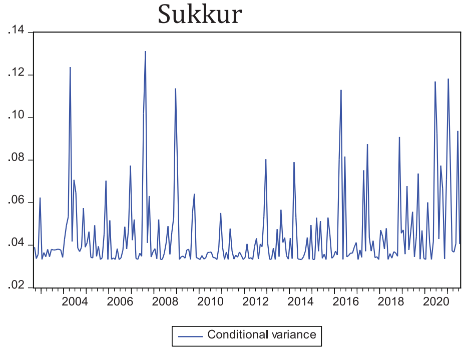

Sargodha




Sialkot

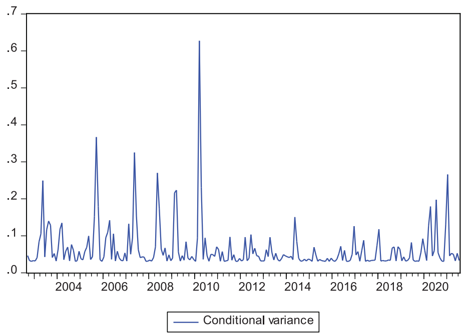


Sukkur

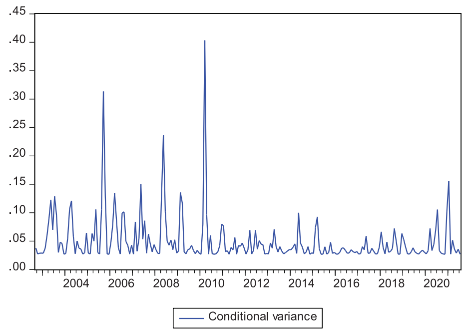



## EGG

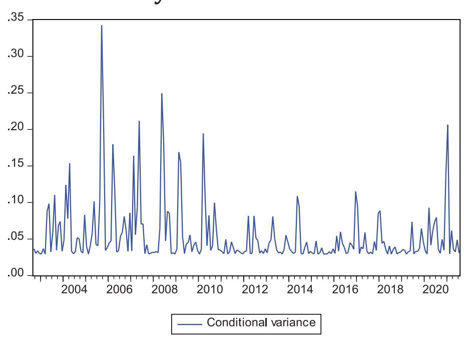
Bahawalpur



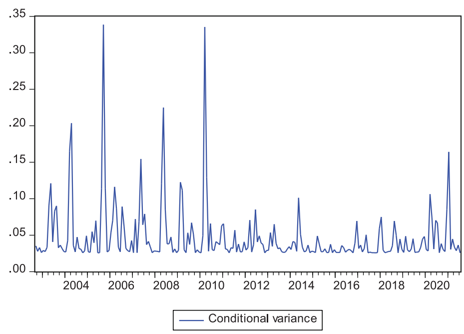

Faisalabad



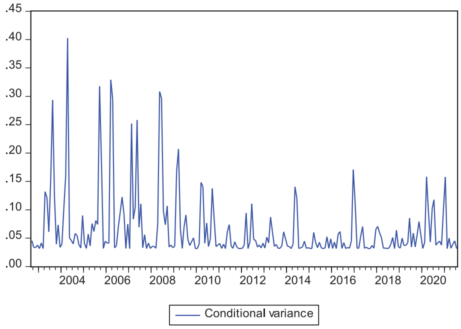

Hyderabad



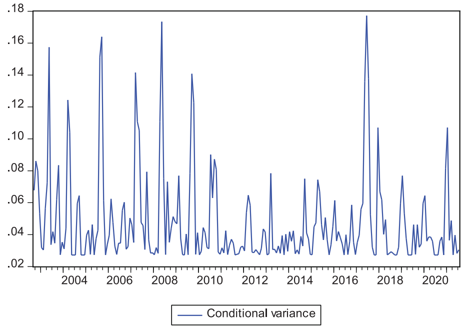

Islamabad



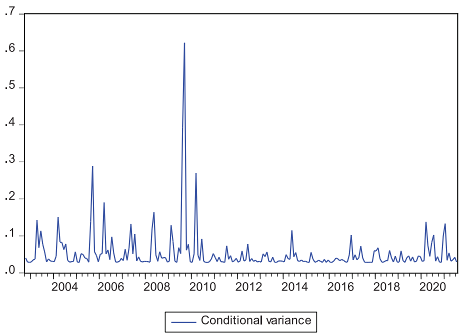
Karachi



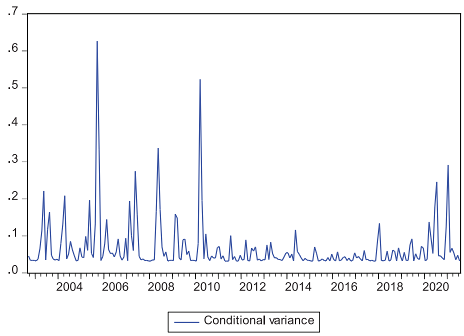

Khuzdar



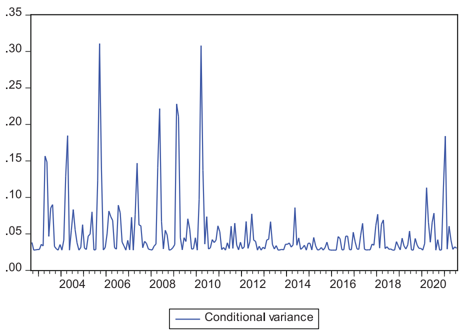

Lahore



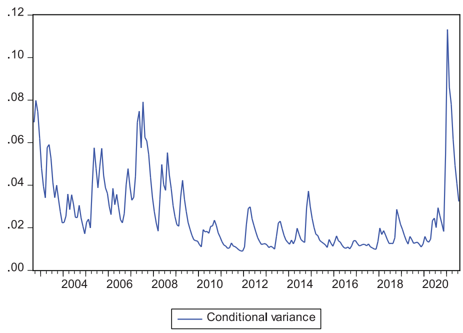

Multan



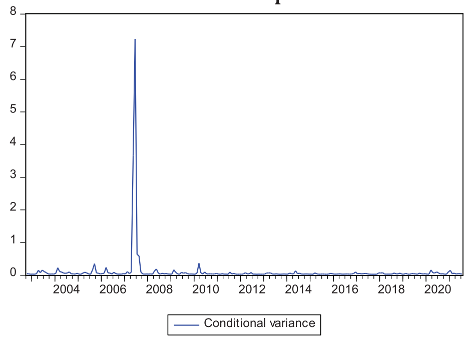

Peshawar



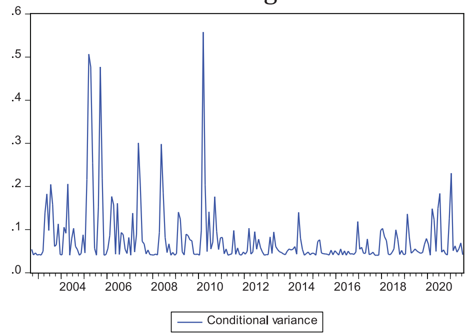

Quetta



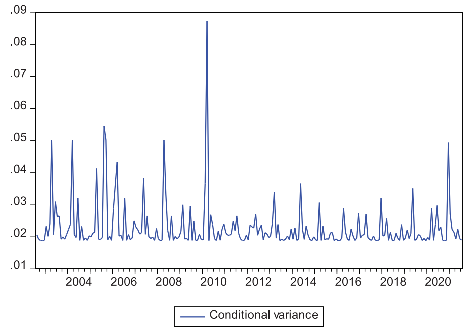
Rawalpindi



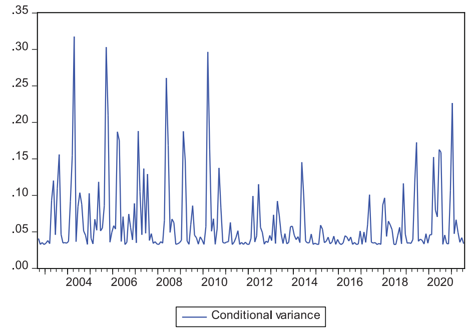

Sargodha




Sialkot

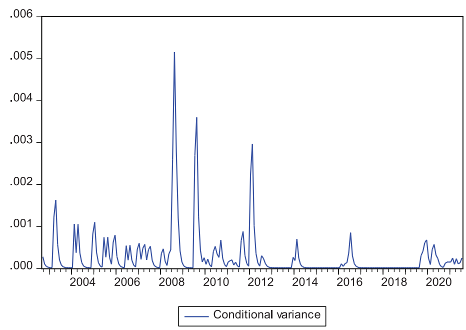



Sukkur

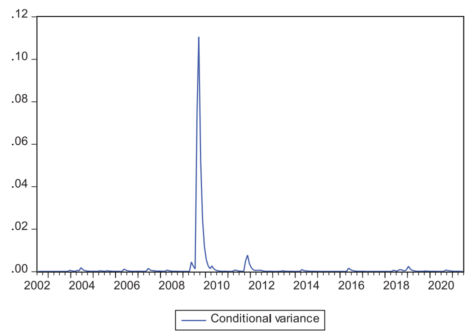



**Milk**

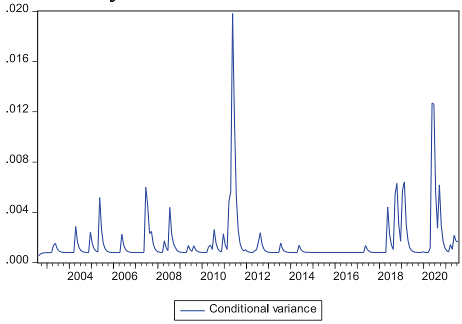
Bahawalpur



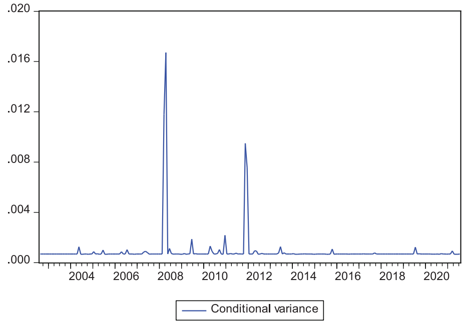

Faisalabad



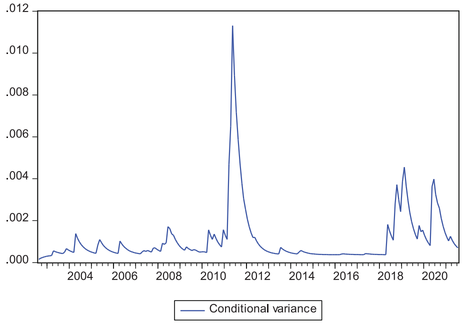
Hyderabad



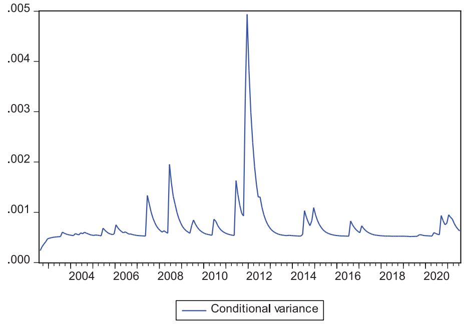

Islamabad



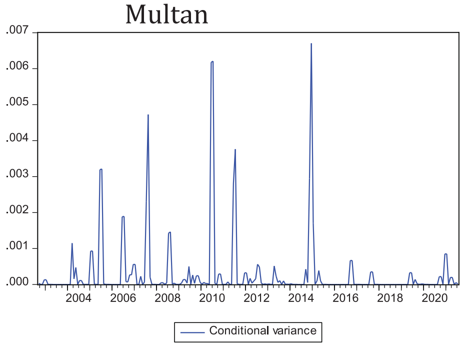

Karachi



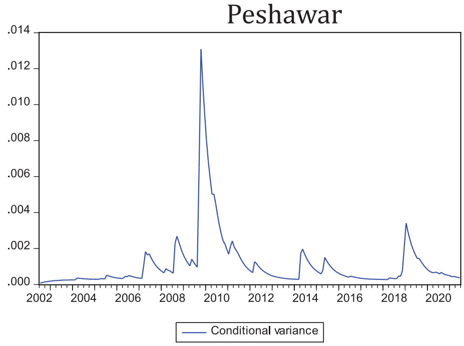

Lahore



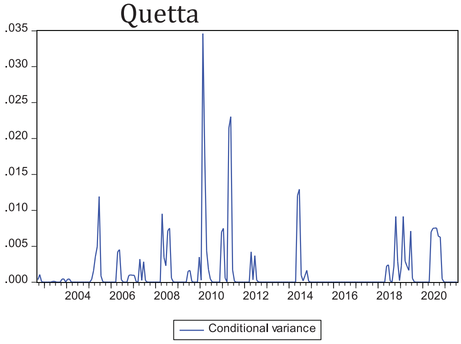

Multan



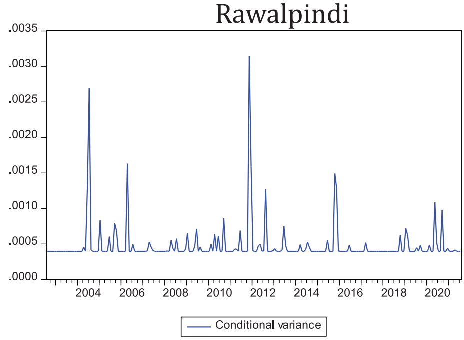

Peshawar



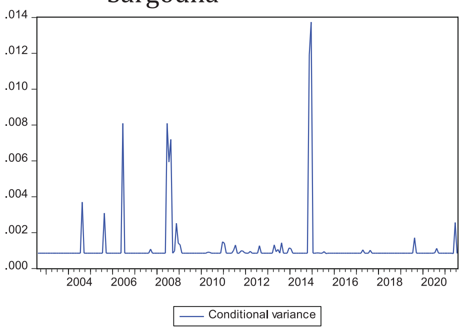
## Quetta



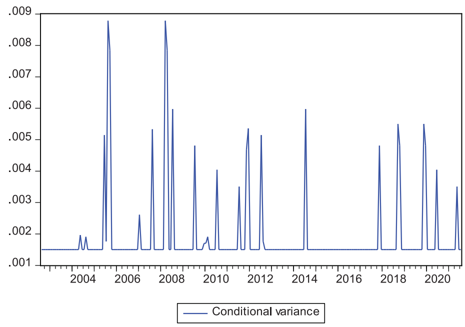

## Rawalpindi



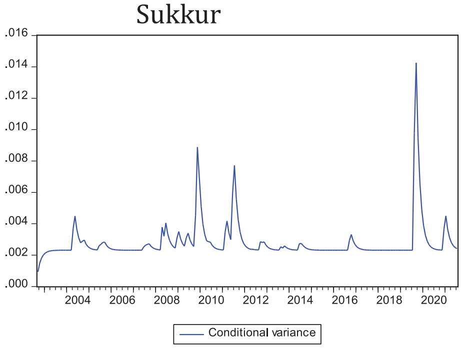

## Sargodha




## Sialkot

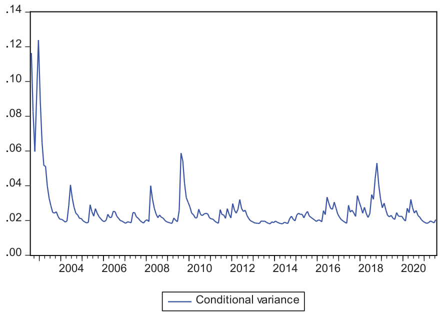



## Sukkur

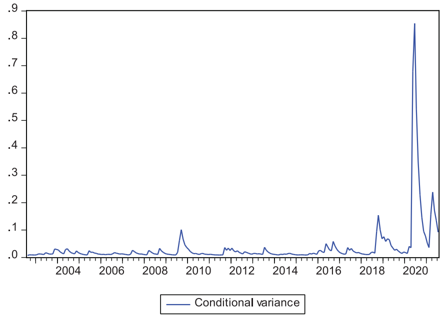


## Garlic

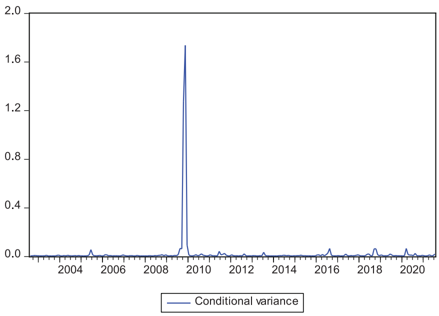
Faisalabad



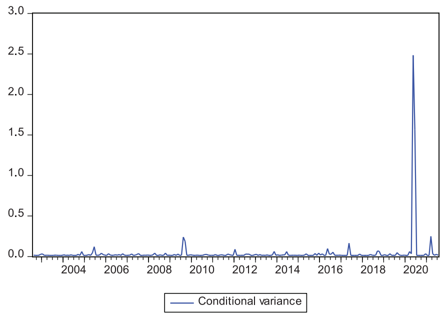

Hyderabad



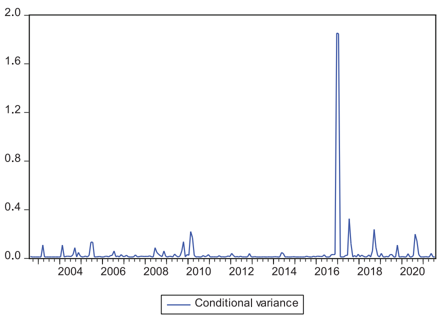

Islamabad



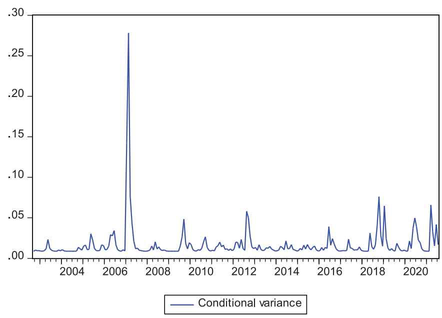

Karachi

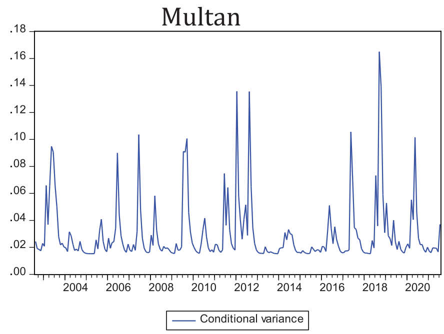


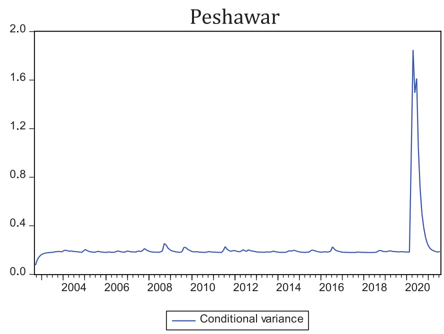

Khuzdar

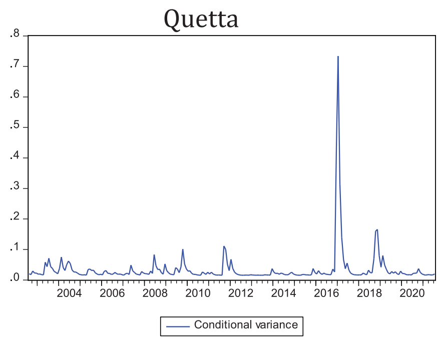


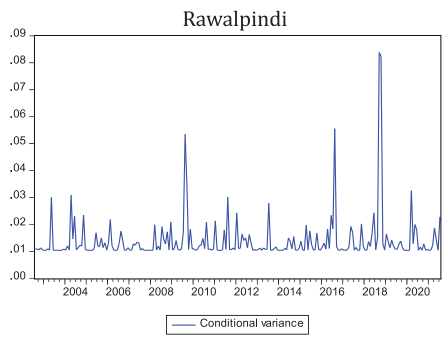

Lahore

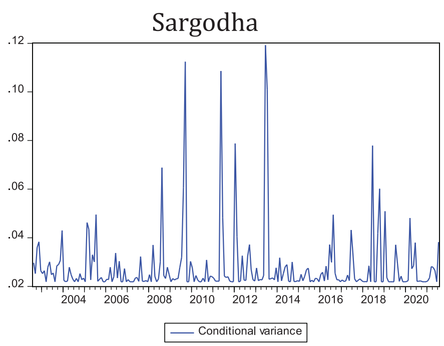


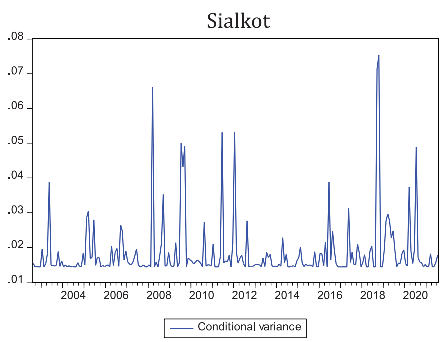

Multan
.18
.16
.14
.12
.10
.08
.06
.04
.02
.00
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance


Peshawar
2.0
1.6
1.2
0.8
0.4
0.0
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance

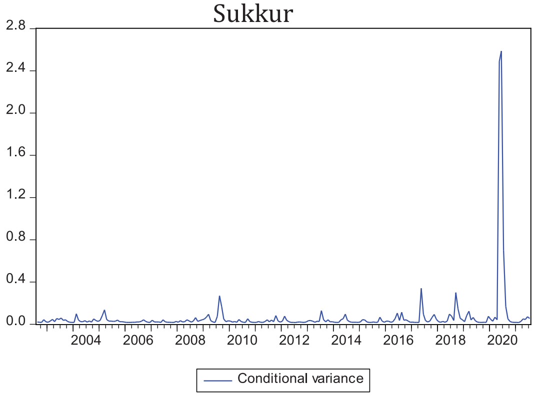

Quetta
.8
.7
.6
.5
.4
.3
.2
.1
.0
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance


Rawalpindi
.09
.08
.07
.06
.05
.04
.03
.02
.01
.00
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance


Sargodha
.12
.10
.08
.06
.04
.02
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance

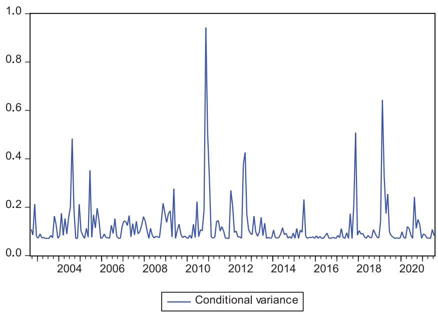

Sialkot
.08
.07
.06
.05
.04
.03
.02
.01
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance

### Sukkur

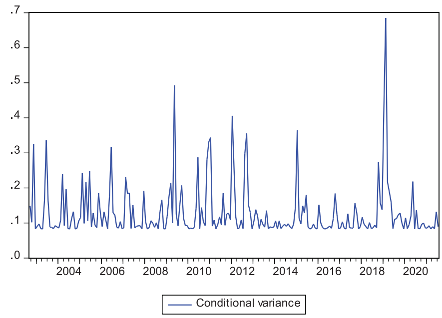



## Onion

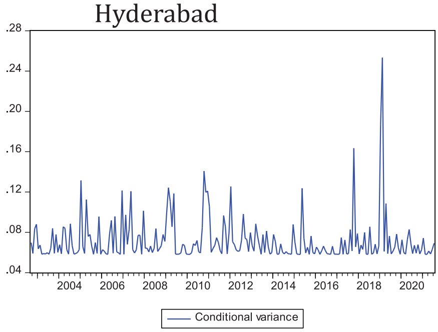
### Bahawalpur



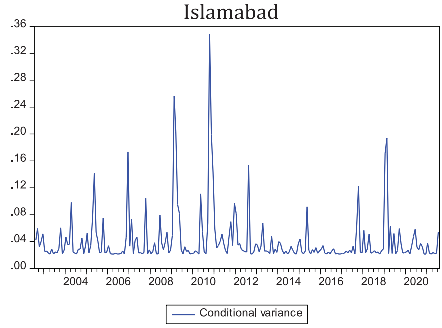

### Faisalabad



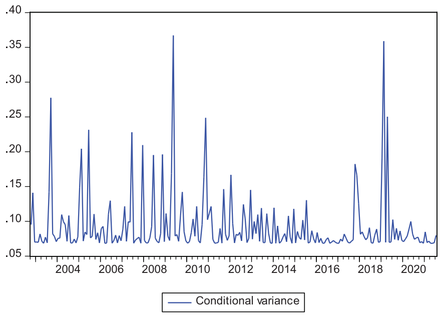

### Hyderabad



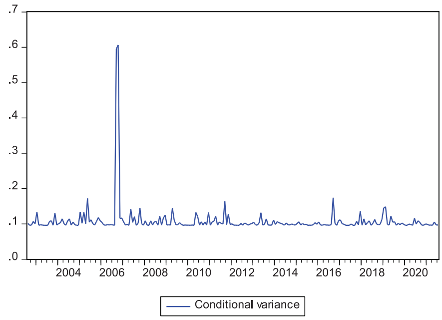

### Islamabad



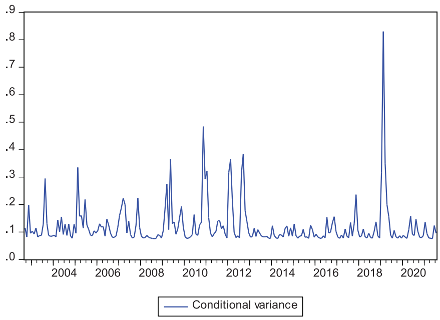
Karachi



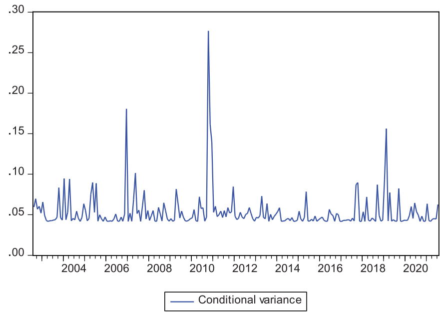

Khuzdar



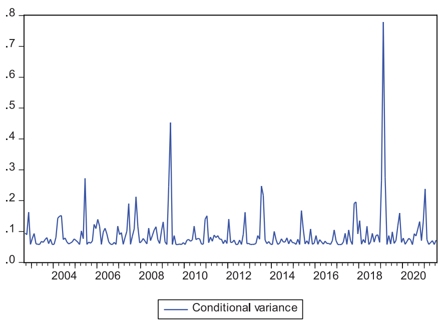

Multan



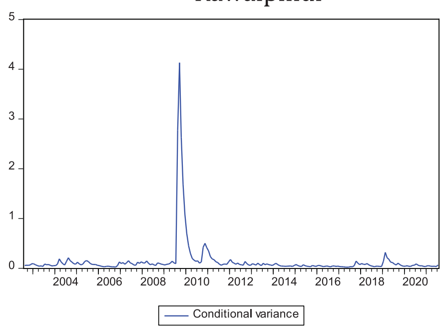

Peshawar



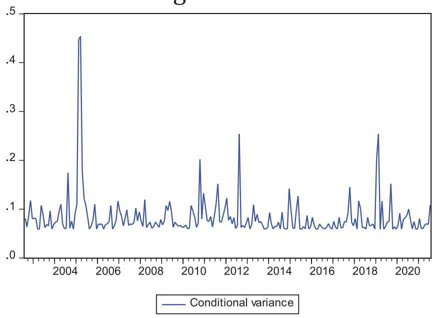

Quetta



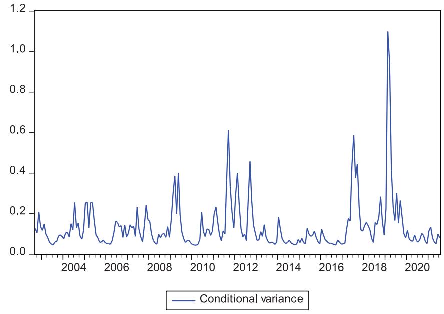

Rawalpindi



Sargodha

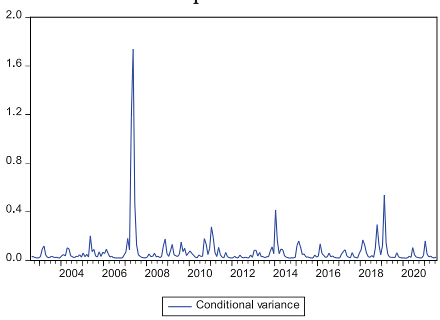



Sukkur

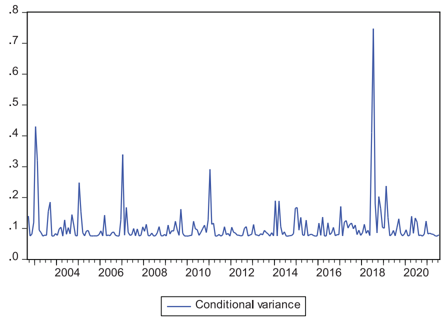



## Potato

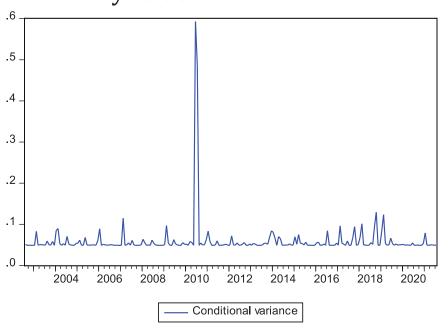
Bahawalpur



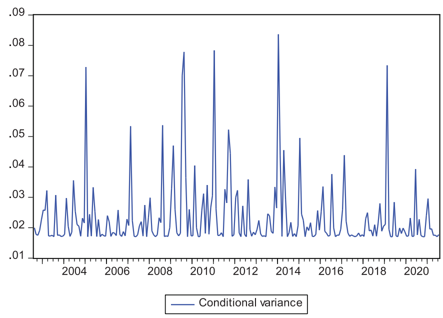

Faisalabad



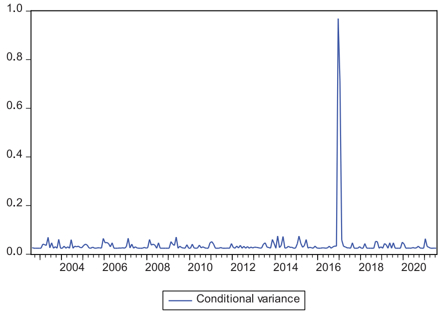

Hyderabad



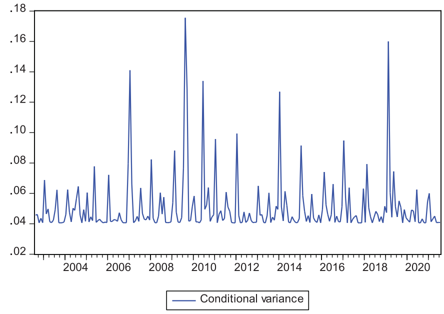

Islamabad



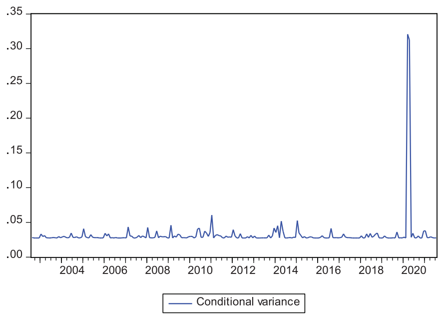
Khuzdar



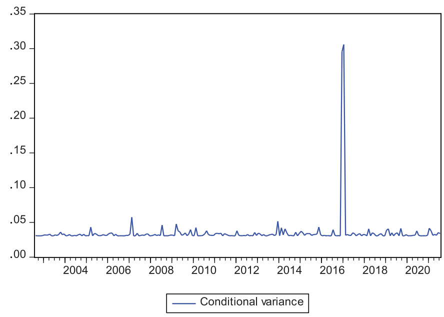

Lahore



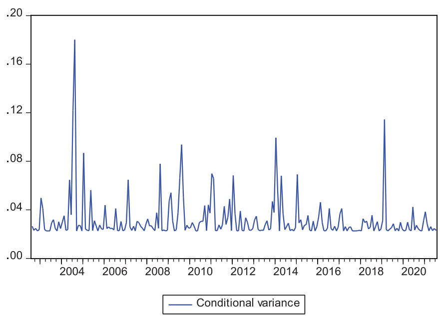

Peshawar



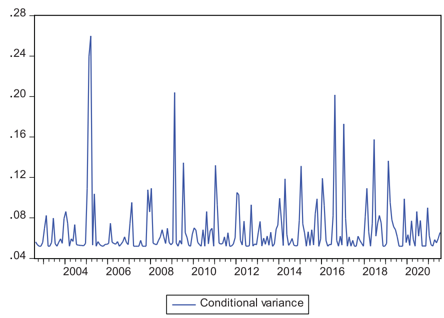

Quetta



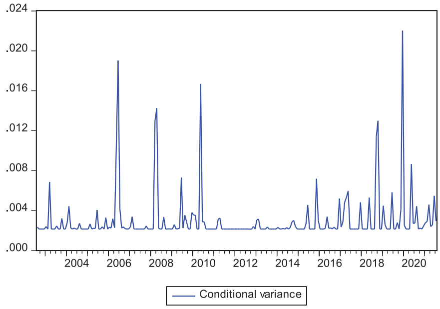

Rawalpindi



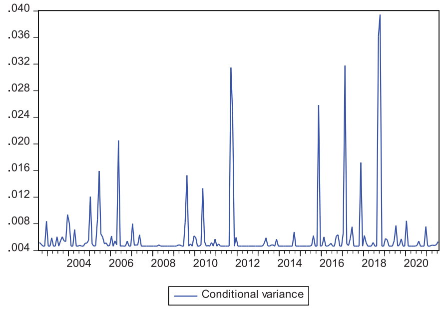

Sargodha



Sialkot

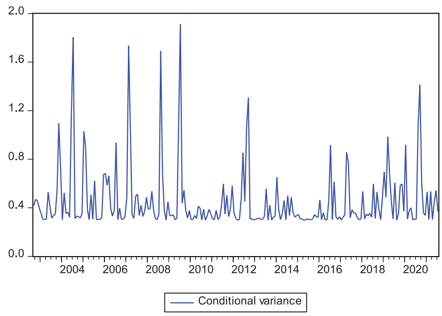



Sukkur

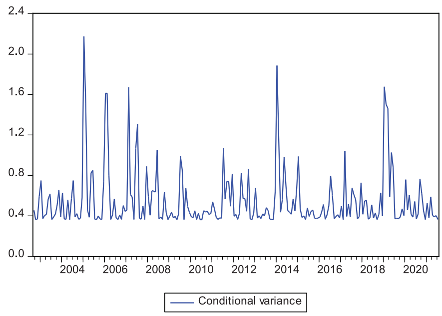



## Tomato

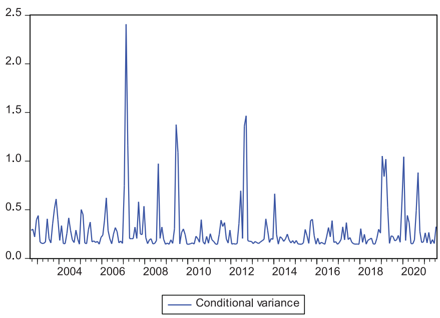
Faisalabad



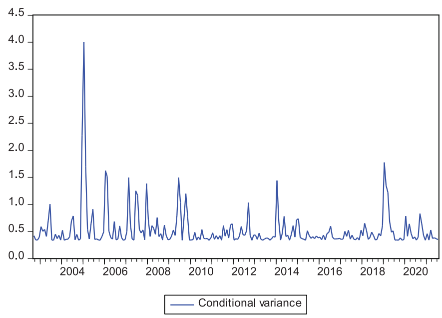

Hyderabad



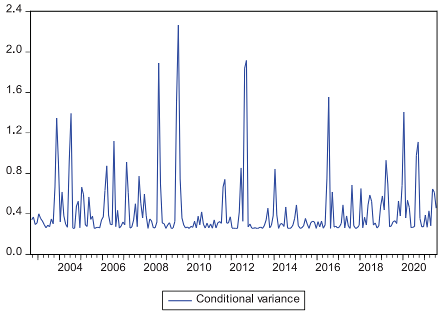

Islamabad



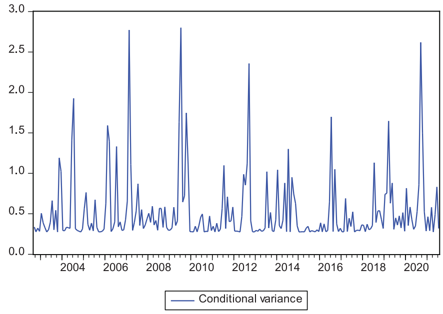

Karachi



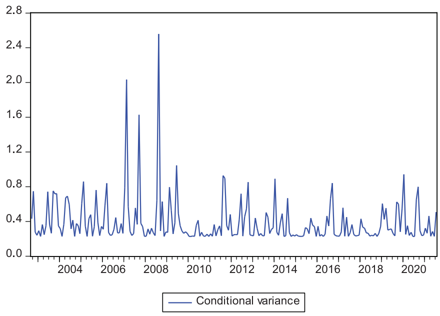
Lahore



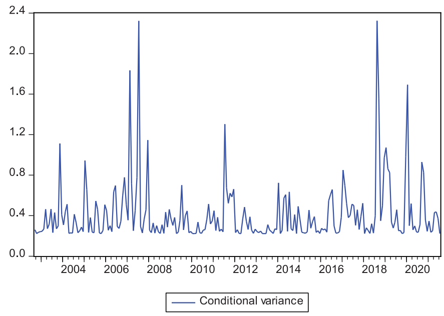

Multan



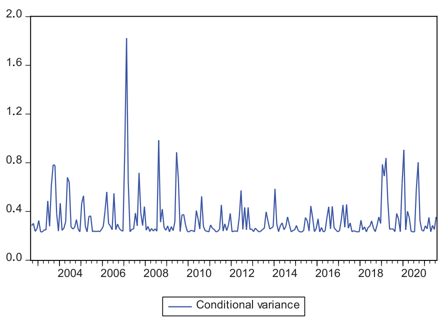

Peshawar



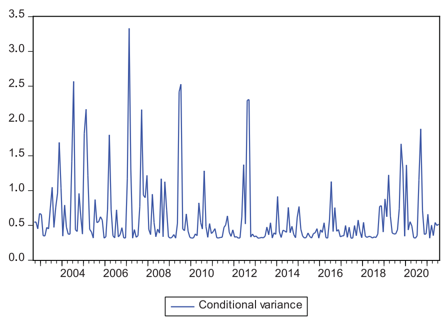

Quetta



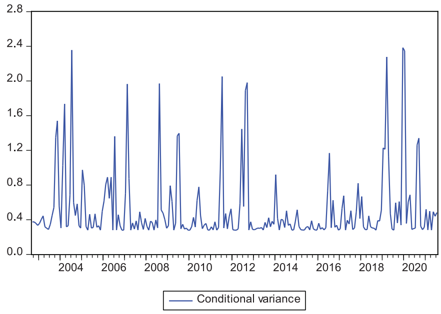

Rawalpindi




Sargodha

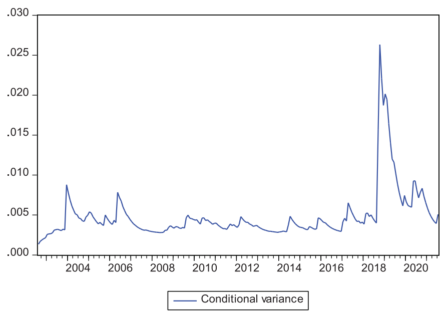


Sialkot

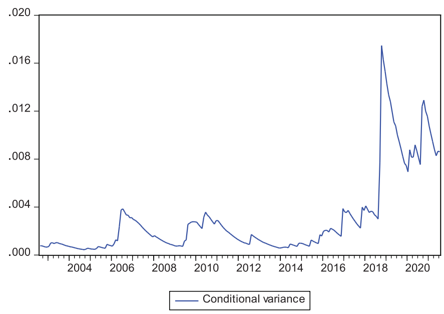



**Pulse Mash**

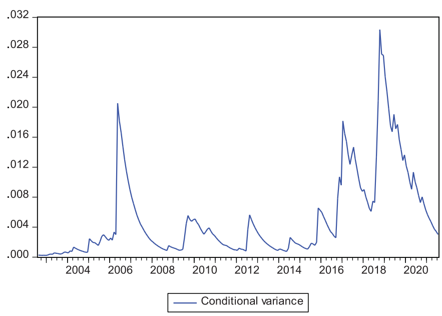
Bahawalpur



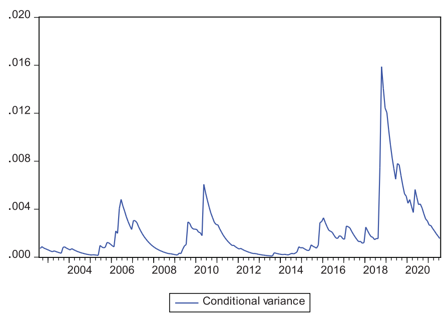

Faisalabad



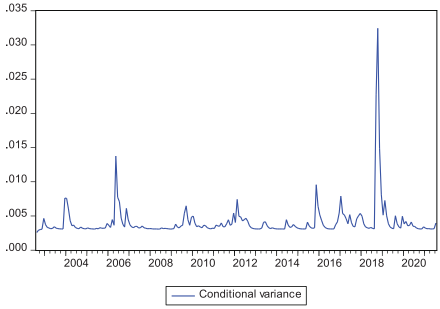

Hyderabad



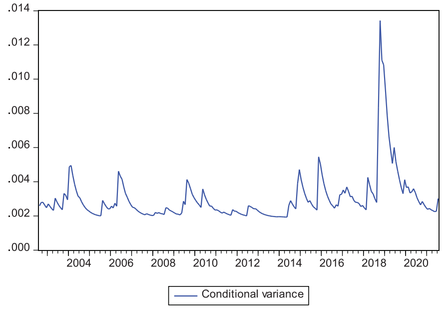

Islamabad



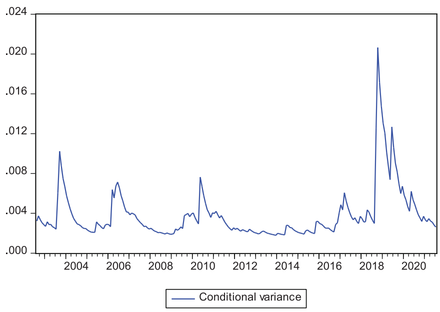
Karachi



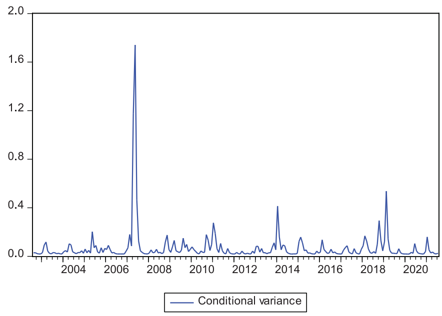

Multan



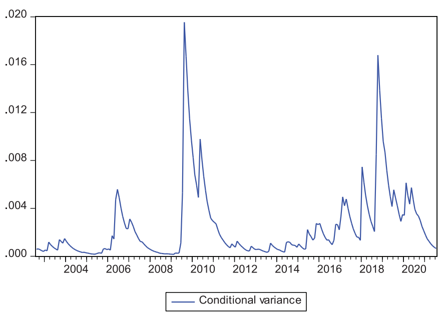

Peshawar



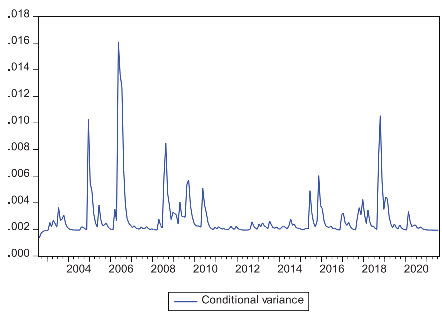

Quetta



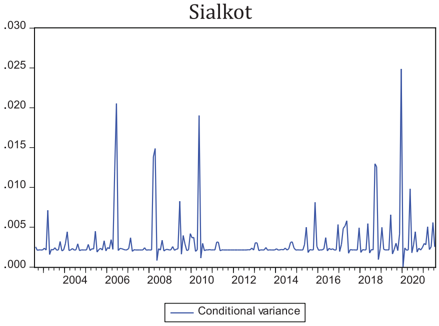

Rawalpindi



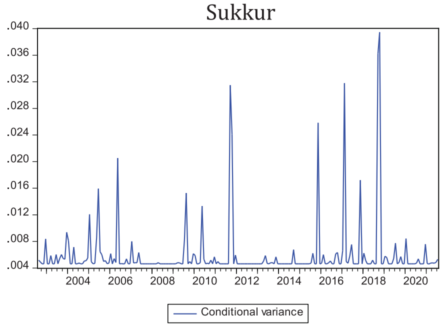

Sargodha



Sialkot

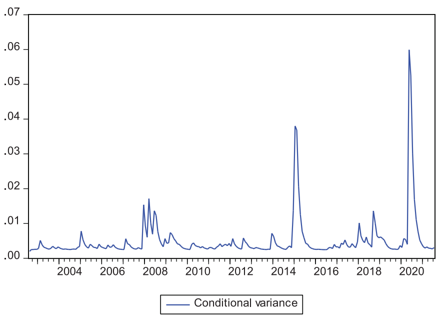



Sukkur

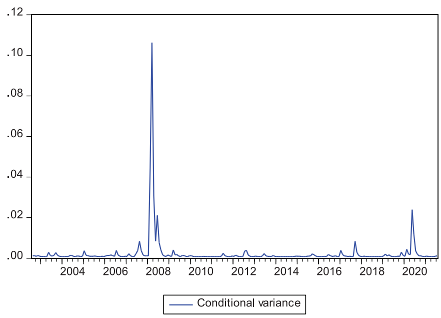



**Pulse Masoor**

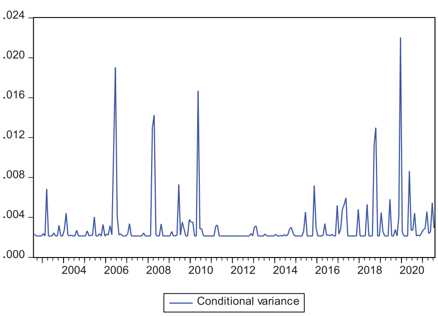
Faisalabad



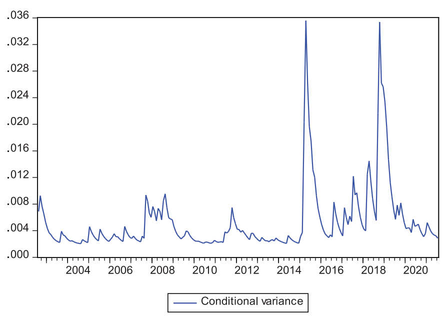

Hyderabad



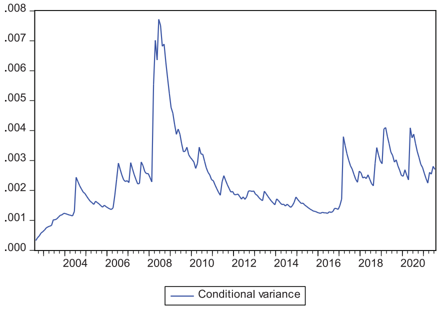

Islamabad



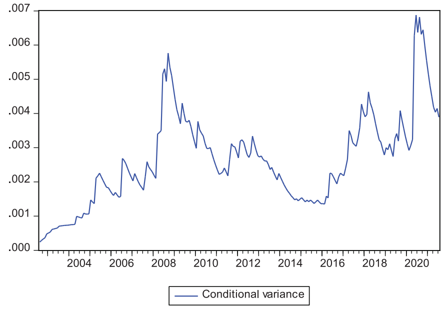

Khuzdar



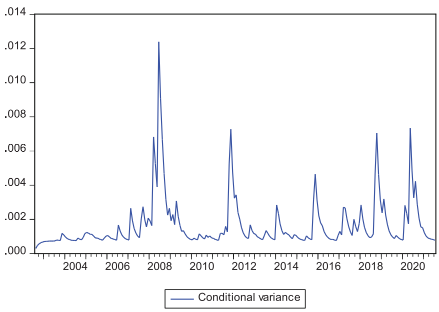
Peshawar



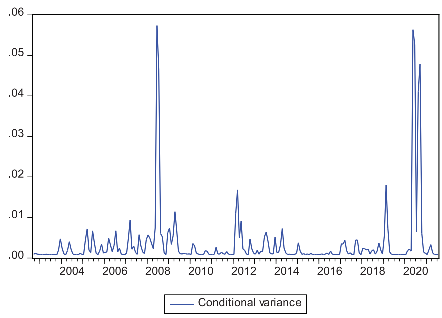

Quetta



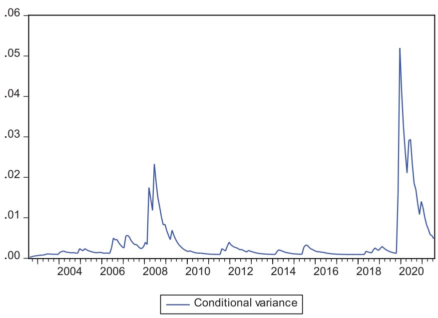

Rawalpindi



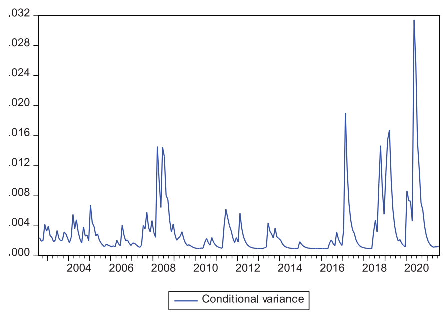

Sargodha




Sialkot

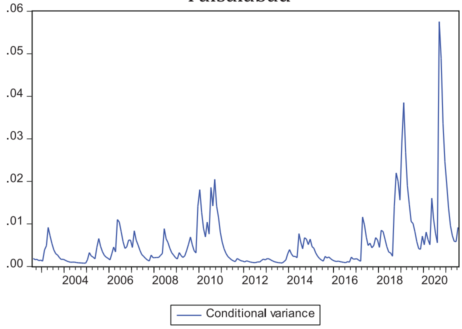



Sukkur

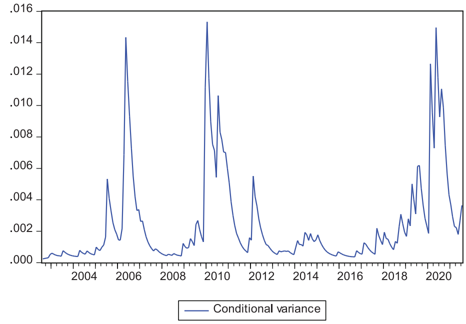


## Mung

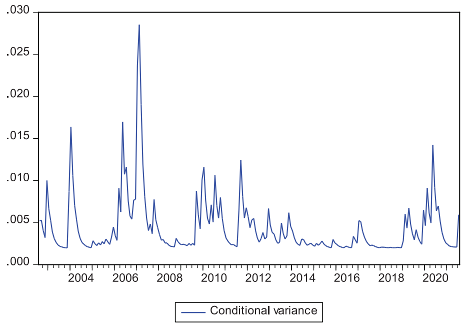
Faisalabad



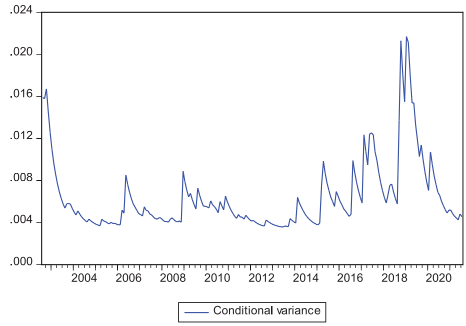

Islamabad



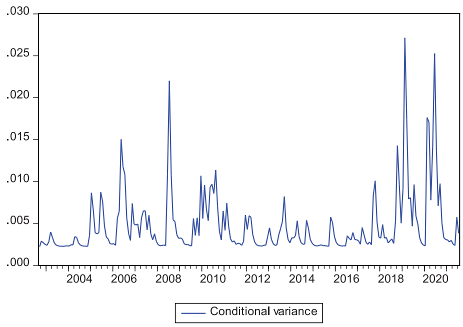

Karachi



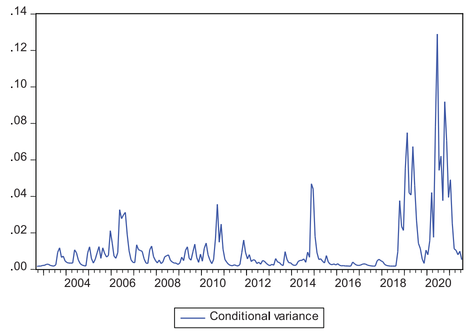

Khuzdar

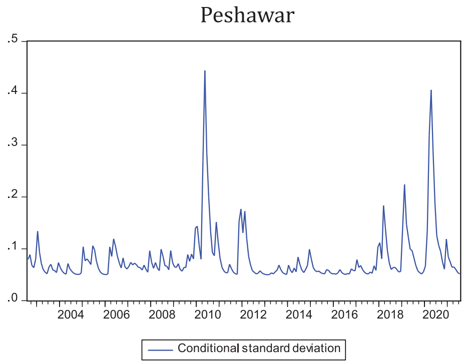


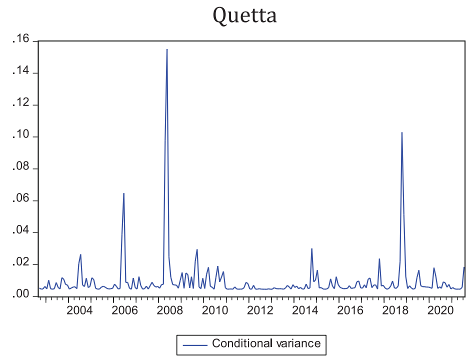

Lahore

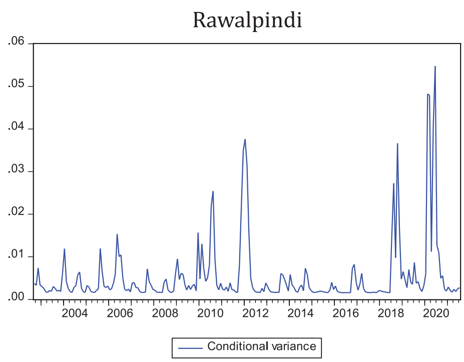


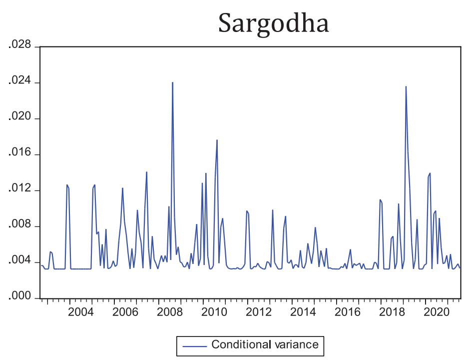

Multan

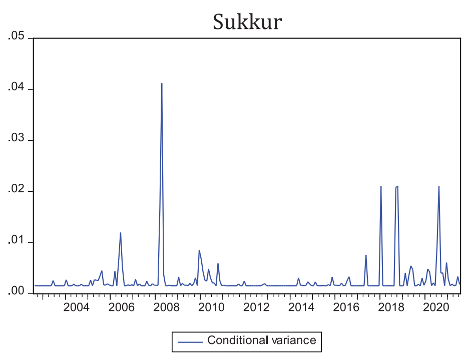



Peshawar
.5
.4
.3
.2
.1
.0
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional standard deviation


Quetta
.16
.14
.12
.10
.08
.06
.04
.02
.00
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance

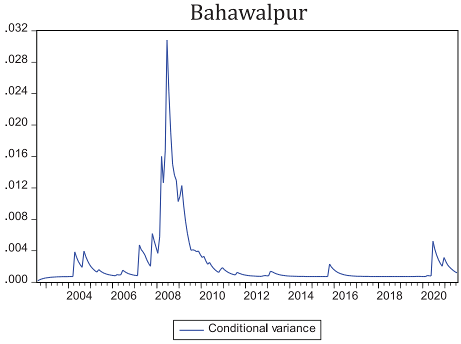

Rawalpindi
.06
.05
.04
.03
.02
.01
.00
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance


Sargodha
.028
.024
.020
.016
.012
.008
.004
.000
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance

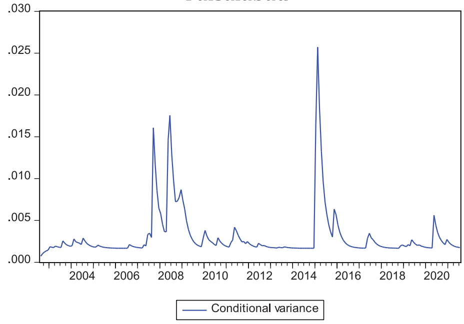

Sukkur
.05
.04
.03
.02
.01
.00
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance

**IRRI RICE**

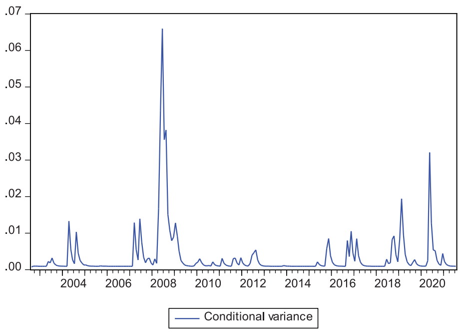
Bahawalpur



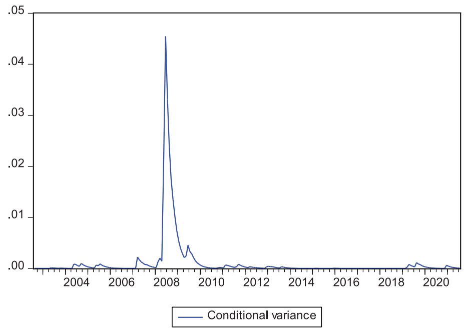

Faisalabad



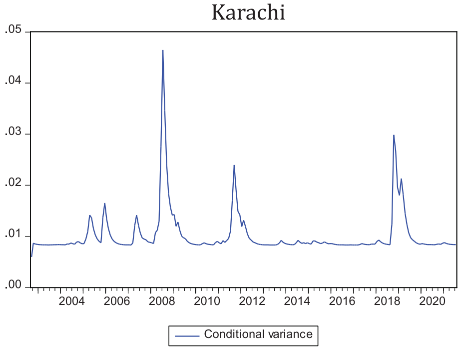

Hyderabad



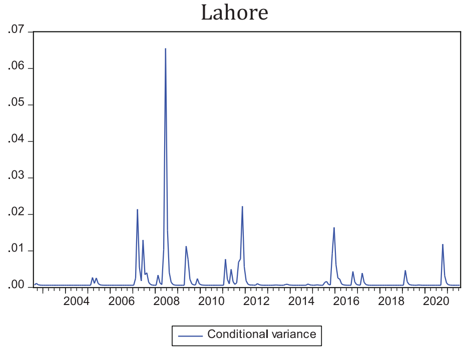

Islamabad



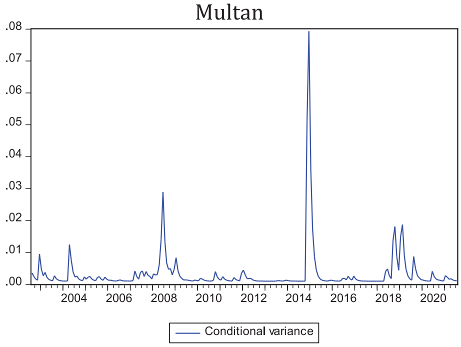

Karachi



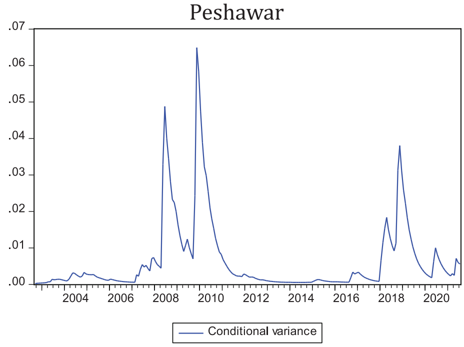

Lahore



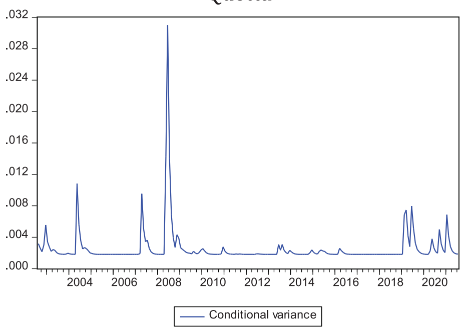
Multan



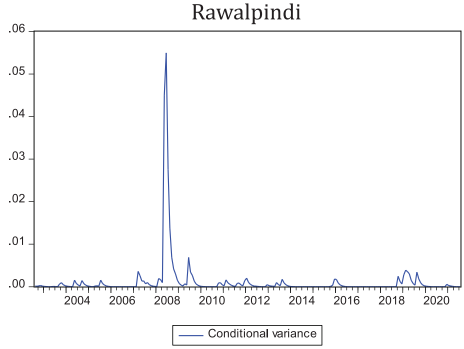

Peshawar



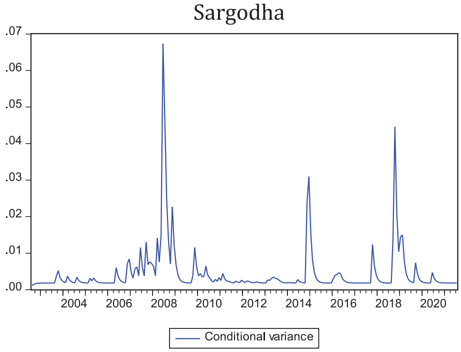

Quetta



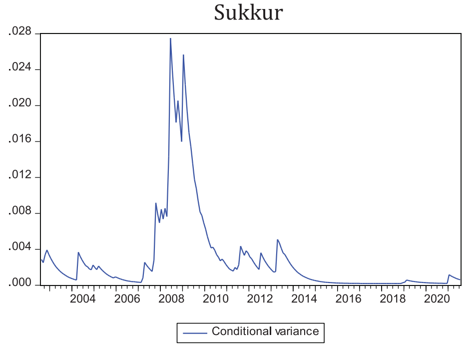

Rawalpindi




Sargodha

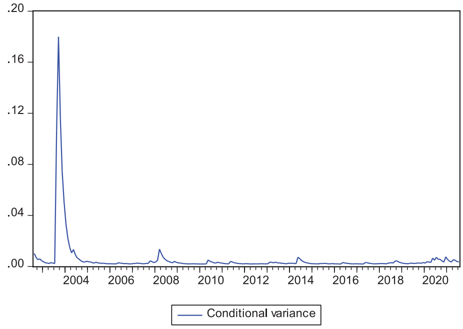



Sukkur

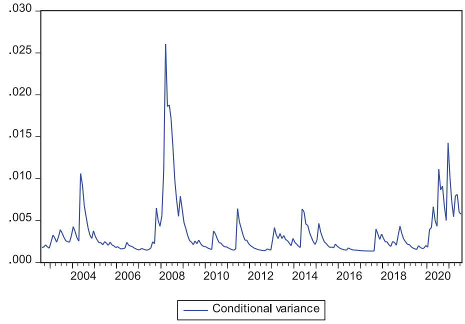


## Wheat

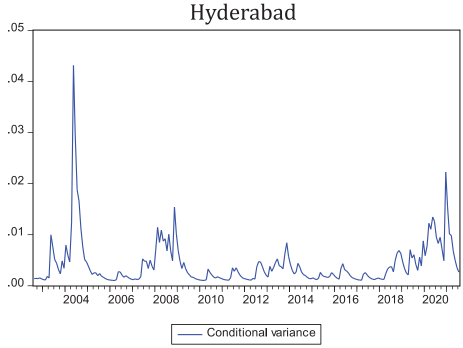
Bahawalpur



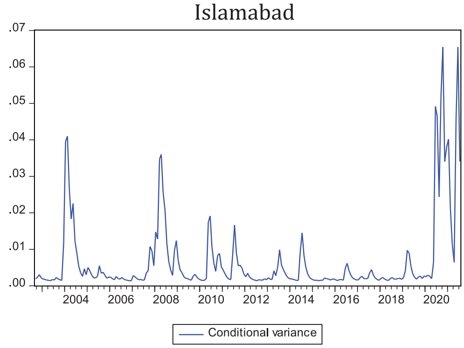

Faisalabad



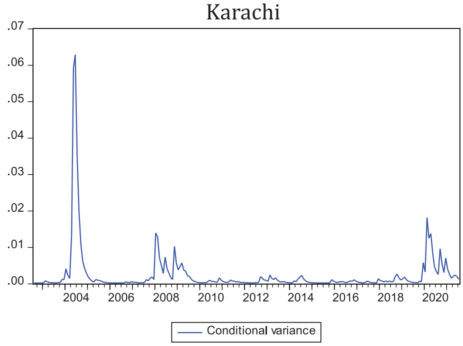

Hyderabad



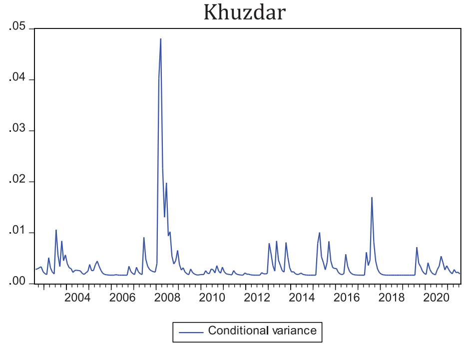

Islamabad



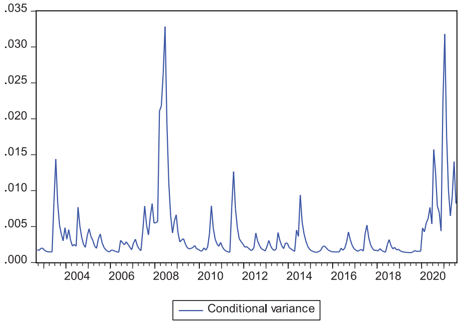

Karachi



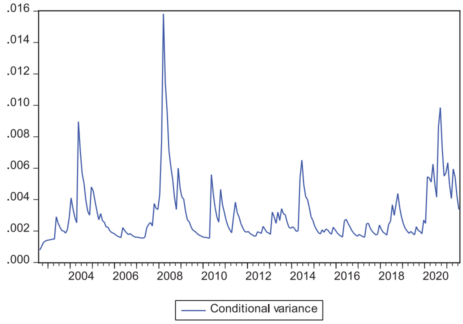

Khuzdar



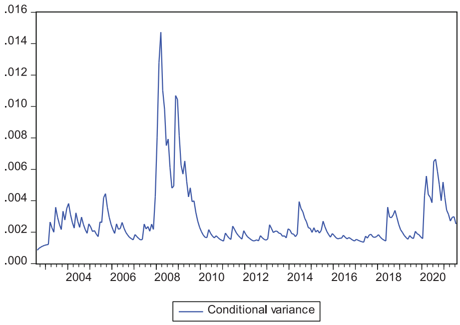
Lahore



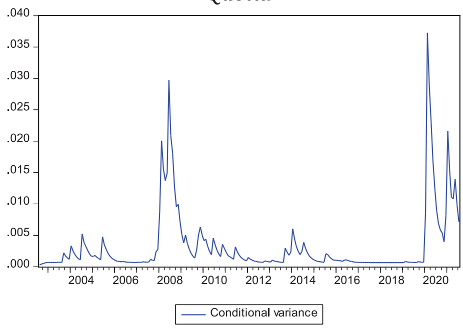

Multan



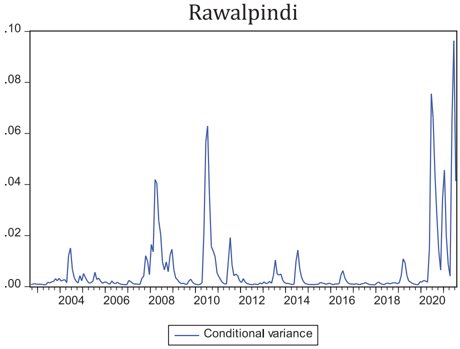

Peshawar



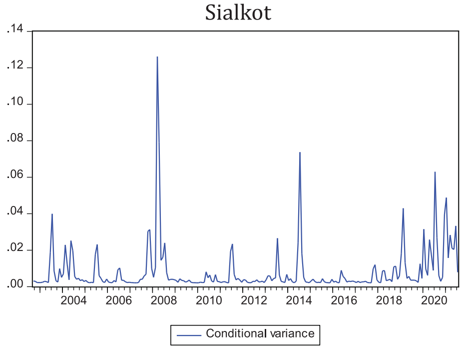

Quetta

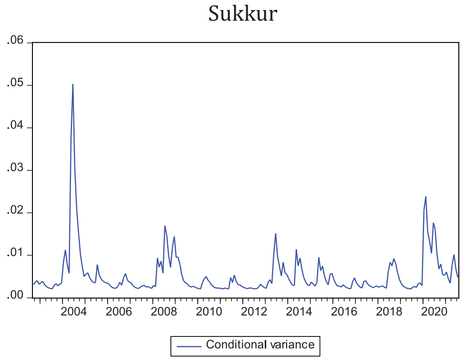



Rawalpindi

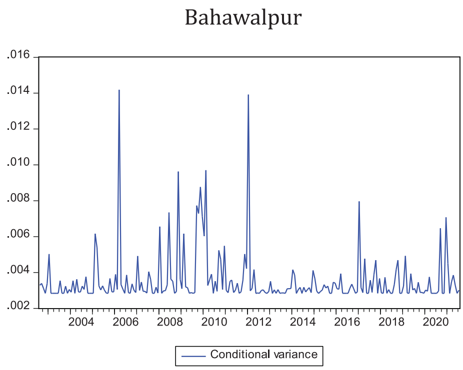


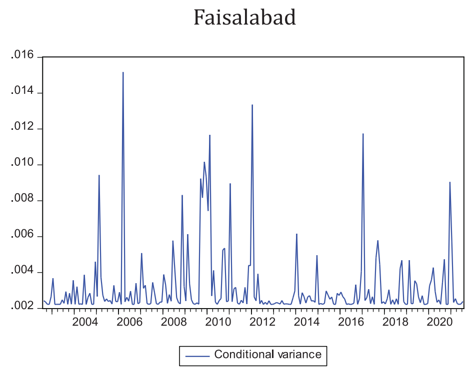

Sialkot

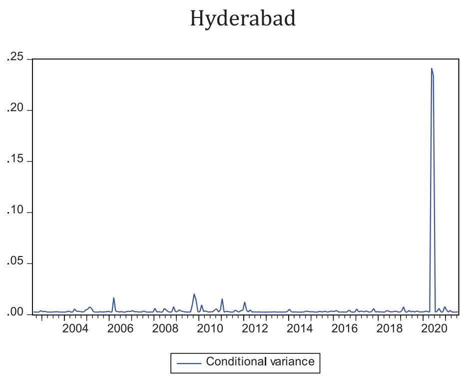


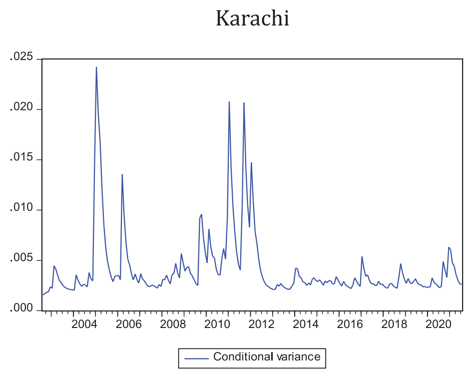

Sukkur
.06
.05
.04
.03
.02
.01
.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
Conditional variance

## Sugar

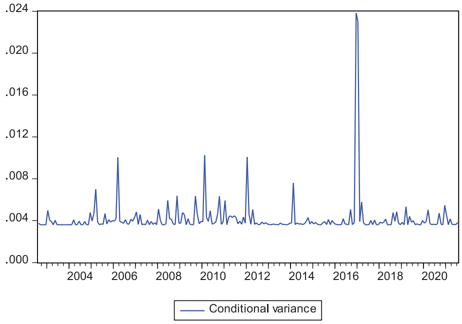

Bahawalpur
.016
.014
.012
.010
.008
.006
.004
.002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Conditional variance


Faisalabad
.016
.014
.012
.010
.008
.006
.004
.002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Conditional variance

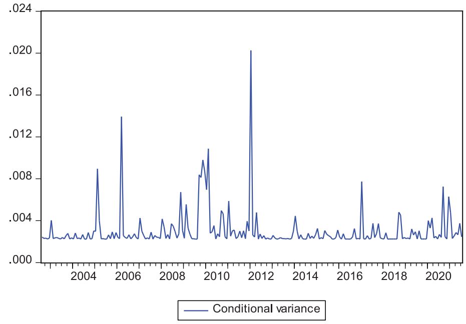

Hyderabad
.25
.20
.15
.10
.05
.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
Conditional variance


Karachi
.025
.020
.015
.010
.005
.000
2004
2006
2008
2010
2012
2014
2016
2018
2020
Conditional variance

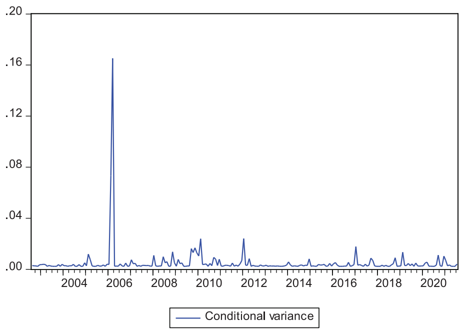
Khuzdar



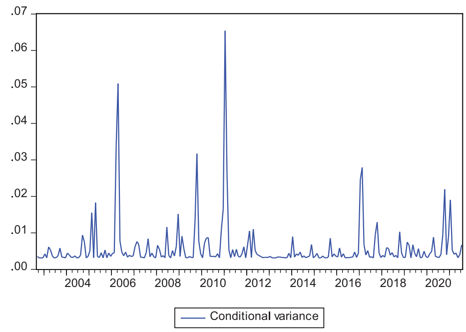

Lahore



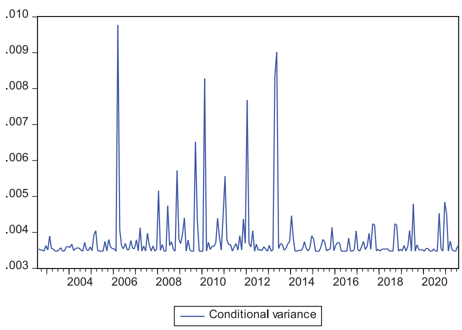

Multan



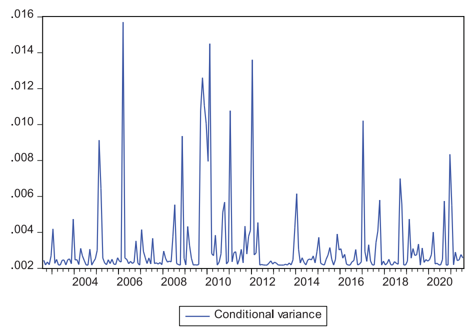

Peshawar

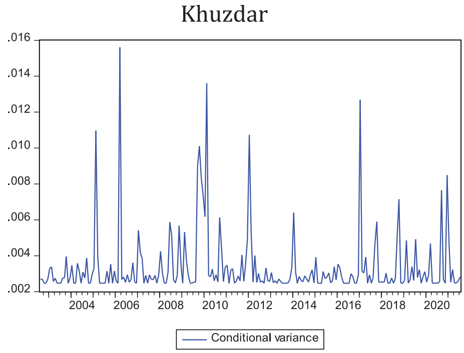


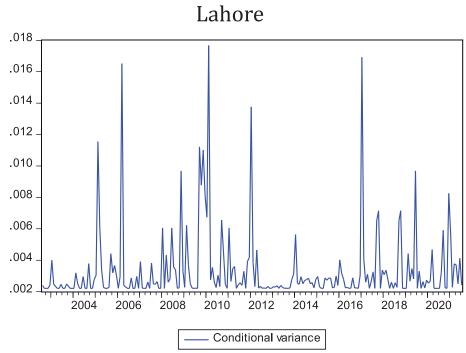

Quetta

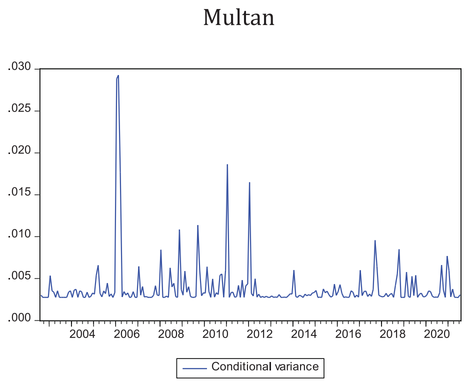



Rawalpindi

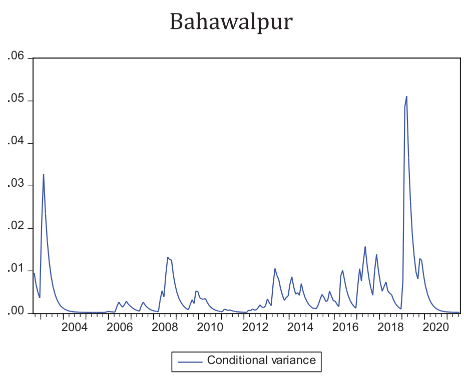


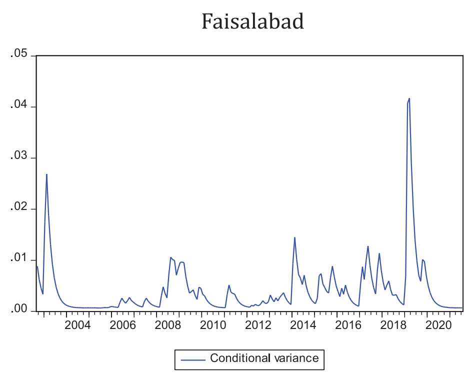

Khuzdar
.016
.014
.012
.010
.008
.006
.004
.002
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance


Lahore
.018
.016
.014
.012
.010
.008
.006
.004
.002
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance

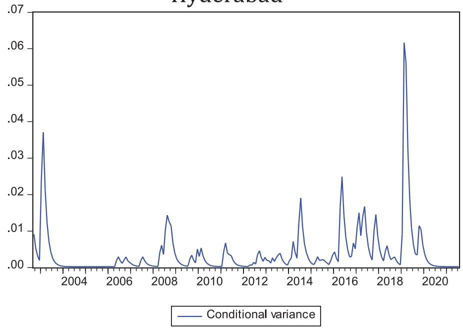

Multan
.030
.025
.020
.015
.010
.005
.000
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance

## Tea

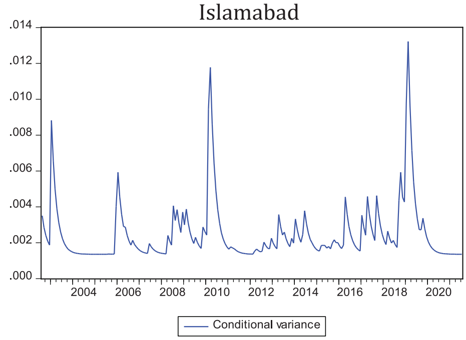

Bahawalpur
.06
.05
.04
.03
.02
.01
.00
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance


Faisalabad
.05
.04
.03
.02
.01
.00
2004 2006 2008 2010 2012 2014 2016 2018 2020
Conditional variance

Hyderabad




Islamabad

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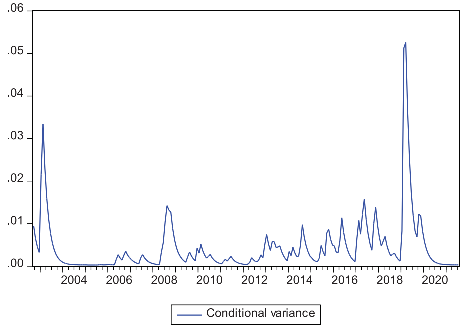


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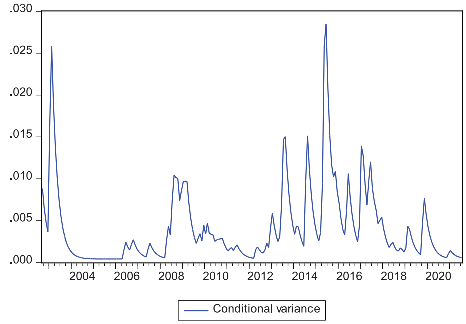


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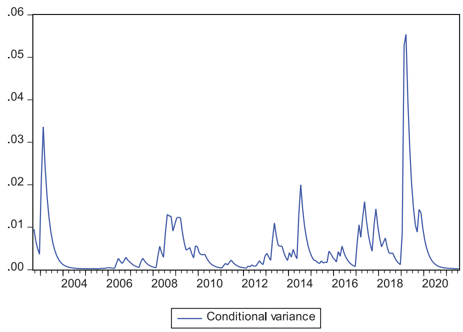


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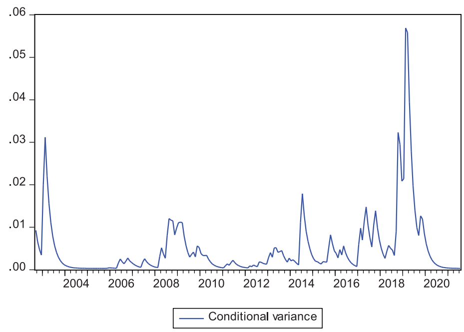
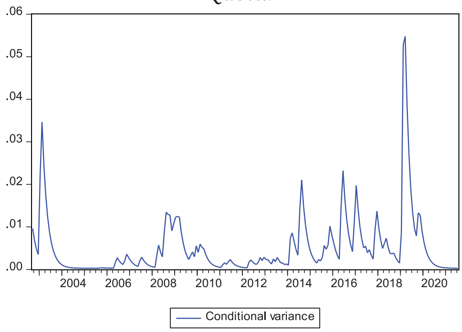
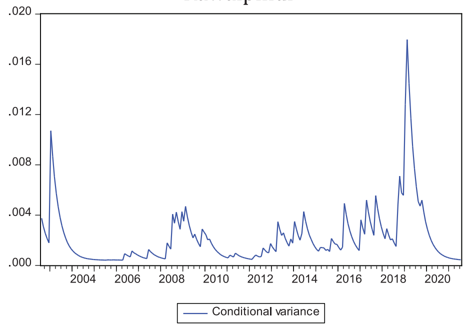


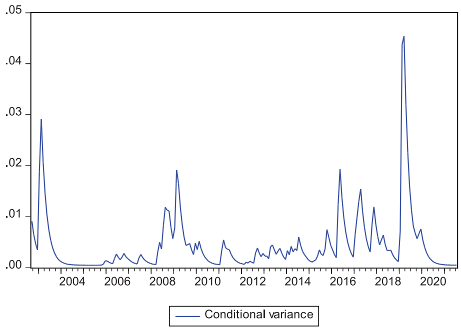
Quetta



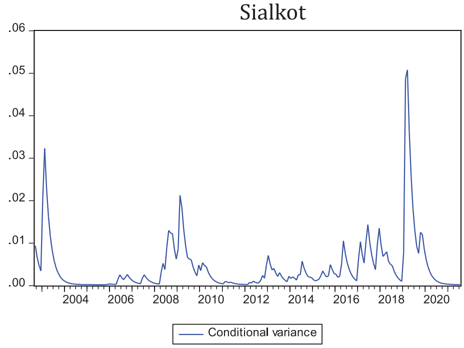

Rawalpindi




Sargodha




Sialkot




Sukkur

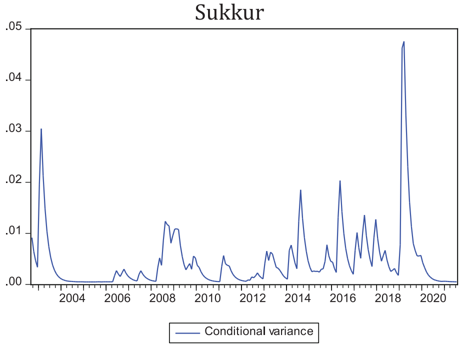
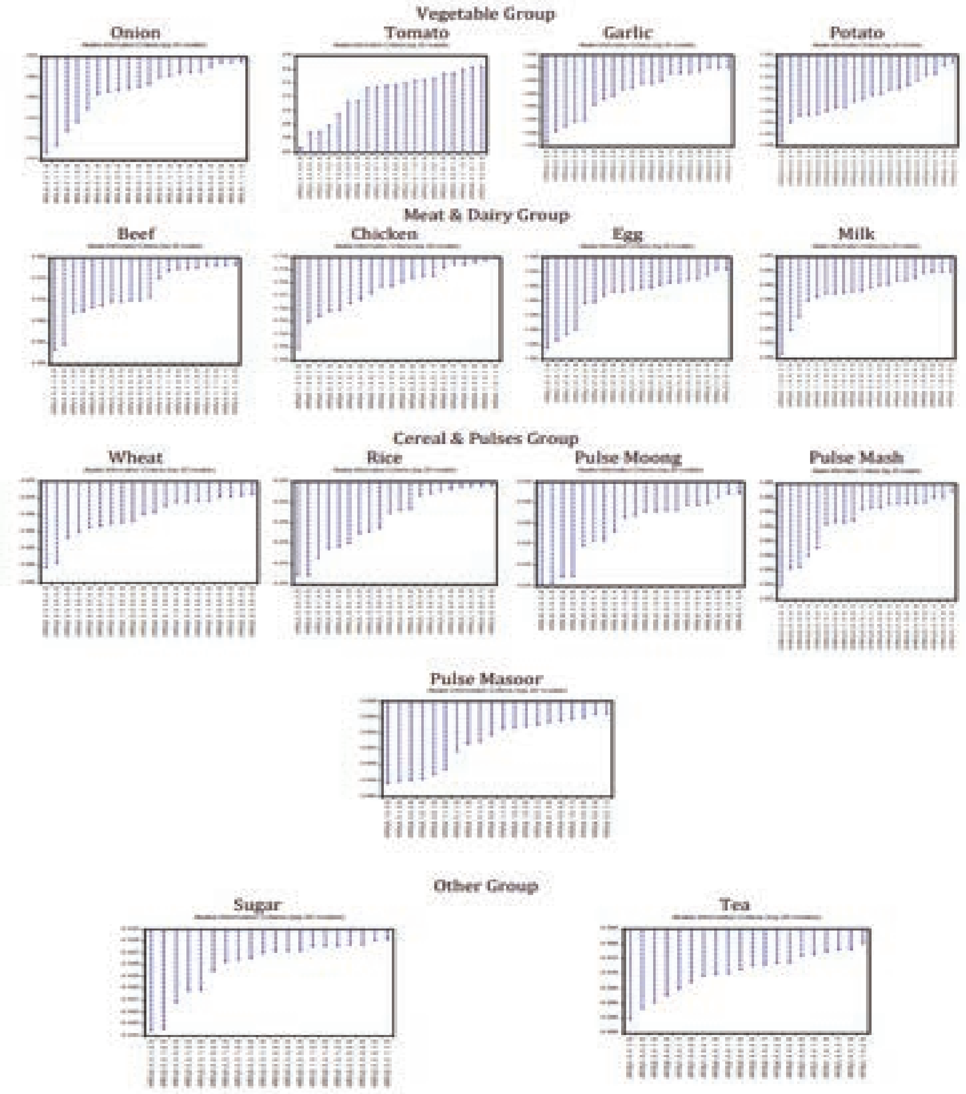
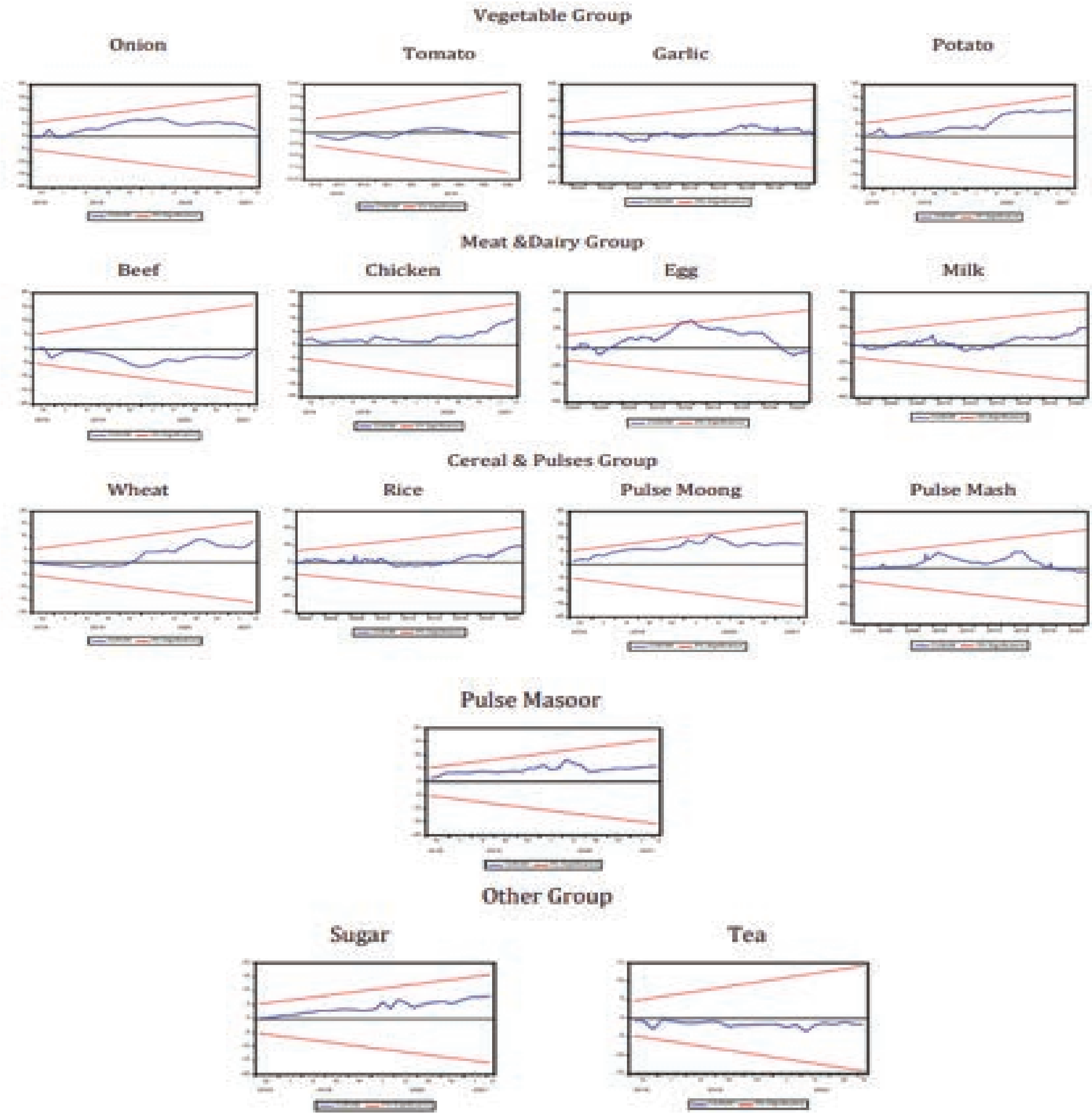


*Figure A-3: Akaike Information Criteria*




*Source: Author's illustration*

*Figure A-4: CUSUM Stability Test*




*Source: Authors' illustration*

# PART II

## FARM PRODUCTIVITY & FOOD PRICES

*Policy Briefs*

# HOUSEHOLD MARKET PARTICIPATION, ACCESS, AND FARM PRODUCTIVITY IN AJK

Khush Bukhat Zahid

## BACKGROUND

Barriers to market access and understanding product performance are the key factors in overcoming market failure. The majority of small farmers in Azad Jammu and Kashmir (AJK) have little access to the market. Due to this market failure, there is a dire need to improve market access and invest in infrastructure. Higher market participation can increase productivity. Since higher productivity increases yields, higher yields, in turn, may increase market participation because of the availability of additional crops to be sold.

Our findings reveal that the agriculture sector employs 8 per cent of the active labour force. Around 72 per cent of the households own agricultural land. The average size of the farm was assessed to be 1.1 acres. Only 10 per cent of households sell and contribute to market participation indicating that 90 per cent of the households are subsistence farmers who grew crops for their own consumption. Only 31 per cent of subsistence farmers are able to meet their households' consumption demands. The average income per harvest of commercial farmers is PKR 81,086, which is very low (SDG 2021).

In AJK, crop and marketing promotion plans have not been devised. Due to a lack of infrastructure and financial assistance, the area is characterised by low productivity and limited market access. Although many other factors contribute to agricultural productivity, such as technological advancement, regulatory framework, and optimal use of material inputs, these elements may not have an impact on agricultural performance unless better marketing conditions prevail. Landowners in AJK, who are often peasants, have limited financial and technical resources. Therefore, policy intervention in this area is critical.

## PURPOSE AND SCOPE

The paper on which this policy brief is based, evaluated farm productivity and household market participation, given the prevailing market access conditions, to establish a linkage between these for the agriculture market of the AJK. Specifically, the research aimed to:

- Measure the impact of farm variables on farm production and technical efficiency.
- Estimate the linkage between market participation and market access conditions in addition to farm-level efficiencies.

The underlying research provides policy alternatives for improving farm-level production efficiencies as well as food production and market participation. This would also be useful for developing policies to address farm-level constraints and hurdles to market access.

### FARM-LEVEL TECHNICAL INEFFICIENCY

The findings demonstrate that farm-level technical inefficiencies exist. The result shows that more educated individuals contribute negatively to technical efficiency perhaps because educated individuals shift to other occupations, such as government jobs. The results also show that as the farm size increases, technical inefficiency decreases. On larger farms, a wider variety of crops can be grown and new technology and machines can be used to enhance production. Moreover, because of stronger financial and social standing, large farmers have more access to information, farm machinery, and extension services. Surprisingly, the increase in irrigation increases farm inefficiency As far as land fragmentation is concerned, the more the land is fragmented and cultivated in parcels, the lower its inefficiency. The reason could be that it is easier for farmers to manage and monitor smaller farms, which reduces inefficiency. Using advanced machines and tractors also reduces farm technical inefficiency.

The analysis shows that there is a potential to raise farm efficiency by 42 per cent by using current technology and other measures. Moreover, for some farmers, efficiency can be increased by up to 40 per cent strengthening their managerial capacity with the same level of inputs and technology.

## FACTORS AFFECTING MARKET PARTICIPATION

The analysis of market participation shows that a higher farm efficiency score is likely to increase market participation. Similarly, the more the farms are located closer to the roads and markets, the higher the chances of market participation. The relationship between family size and market participation is negative because larger families mostly process products for their immediate consumption at home, such as spices, maize, and wheat flour. Therefore, less produce is left for marketing. Having access to the internet also contributes positively to market participation.

## KEY INFORMANT INTERVIEWS (KIIs)

Key informants, which included field specialists and representatives of a private farm, were also asked about farm efficiency and market participation in the AJK. The field specialists said they assist farmers in improving productivity in a variety of ways, which include quick information provision, introducing efficient farm practices, providing education and training, demonstrating efficient farm practices, helping with irrigation, and enhancing soil fertility. In terms of impact-based policy help, the field specialists said that their departments provide support for inputs, technical aspects, and financial needs. While official departments also provide pesticides, fertilizers, and other inputs to farmers, the provision rate is less than 50 per cent. Other services provided include tackling climate change and disasters and finding new research-based ways to increase the productivity of the farmer, extension services through personal interactions, group contacts, and mass contact. Moreover, the farmers are also helped with gaining market access, switching to commercial farming,

## POLICY RECOMMENDATIONS

Based on the empirical analysis and KIIs, the following policy measures are proposed to enhance the productivity of the agriculture sector in AJK.

### Markets & Marketing

- Access to markets is very important, especially for small farmers. Therefore, there is a need to provide local agriculture markets with the help of the private sector, at least at the tehsil level where small farmers have access to sell their products. A special marketing mechanism for small farmers is necessary so that they can easily approach the market for selling their products.

- The agricultural extension system should be market-oriented and the system should be reorganised to meet the challenges of the market. Extension agents, who are the ones in close contact with the community, should be well-equipped with updated information about marketing and should be provided with good training to improve their management skills in the changing environment.

- Strategies need to be devised to equip farmers with marketing skills and opportunities so that their products can reach the market faster and at a lower cost. In addition, proper storage, packaging facilities, and transport mechanisms should be provided.

- Higher expected returns encourage farmers to enter the market for those capable of generating marketable surpluses. Farmers' access to market pricing systems and information is very important for enhancing the agricultural sector's economic output.

### Credit and Loans

- The provision of loans to the farmers for value addition of their products is important so that the products can be marketed in the marketplace. Credit and short-term loans have a significant impact on market participation. Therefore, easy access to credit and loans to convert traditional agriculture to modern commercial farming can increase market participation.

### Village- and Region-Specific Farming

- One product one village policy is necessary for the AJK to increase farm production.
- Each district should be allocated to specific crops where those crops are suitable for cultivation. The north region is suitable for horticulture crops and the south region is suitable for cereal crops, fodder, citrus fruits, etc.
- Ensure the use of land according to soil classification and impose restrictions for the use of cultivable land for any other purpose.
- Increasing farm size by bringing more land under cultivation and programmes that encourage landowners to utilise wastelands will help to increase farm efficiency.
- Introduce the cooperative farming system for small farmers who have small landholdings.
- Penalties for not using their cultivable land for farming for more than five years.

### Monitoring and Evaluation

- To evaluate the impact of development schemes, advisory support systems, monitoring, and evaluation mechanisms can assist in reorganising schemes to achieve desired goals.
- The creation of off-farm employment and investment opportunities will help inefficient farmers to start agro-related enterprises.
- The findings also show that increasing production efficiency also increases market participation. As a result, greater infrastructure and farmer-friendly policies are required to remove input and output market inefficiencies, lowering production.

### Infrastructure, R&D, and Inputs

- Provide improved quality seeds, plants, and other agriculture inputs that are available at the doorstep of the farmers. For farm inputs to be effective, high-quality inputs should be available to every farmer timely and in sufficient quantity.
- Since quality seed is a basic unit of production, certified seeds of cereals, pulses, crop seeds, vegetable seeds, and fruits are compulsory for profitable farming. Therefore, the establishment of a seed production unit in the Agriculture Department is recommended. The unit can play a critical role in promoting and ensuring the development of approved planting materials.
- It is suggested that a research institute dedicated to agriculture in mountainous regions be established. In distinct agroecological zones, soil and climatic conditions vary and/or are rain-fed. Crop varieties developed specifically for mountainous environments are required for productive farming in this region. Moreover, appropriate post-cultivation procedures that are suitable for the region need to be adapted. The crops are already under water stress and water requirements would increase due to rising temperatures. Therefore, increasing water storage capacity in the region is critical for ensuring agricultural production system sustainability and market participation.
- Technology and infrastructure (roads,

storage and warehouses, and transport facilities), along with training, can improve the management capabilities of the agricultural community. It will enhance technical efficiency and market participation.

- Water channels need to be built near rivers, streams, and aquifers to bring more area under irrigation.

**Training and Skills**

- Agricultural skills should be enhanced through training to create awareness and interest so that more educated people are involved in agriculture.

# THE IMPACT OF MAJOR PUBLIC POLICIES ON COTTON PRODUCTION IN PAKISTAN

Irfan Ahmed Baig, Sami Ullah, Shoaib Nasir and Wakeel Ur Rehman

## INTRODUCTION

In Pakistan, cotton accounts for 0.6 per cent share of GDP and 3.1 per cent of total agriculture value addition. Cotton has the longest value chain among all crops with a major contribution in Pakistan's foreign exchange earnings. Pakistan exports USD 836 million worth of raw cotton and yarn, while cotton-based product exports are USD 9.5 billion, which is more than half of the total exports of the country. Over the past couple of decades, the cotton crop's performance has been dismal in terms of cotton area, production, and profitability. The table below reflects the reduction in cotton area in Punjab (which contributes around 70% of the total cotton acreage) but also the cotton production and yield which has gone down drastically.

One of the reasons for the adverse performance of cotton production is the replacement of the cotton crop with its competitive Kharif crops, i.e., sugarcane, maize, and rice primarily. It has interesting insights from the policy perspective as well. Other causes of low cotton production reported in the literature include an increasing cost of production, climatic changes, pest attacks, poor seed quality, adulterated inputs, and conventional farming practices. More importantly, other studies have also indicated several policy divergences that have significantly influenced the decision of the farmers to grow a specific summer (Kharif) crop. These policies include incentives for competitive crops, including ensuring a consistent supply chain supporting the private sector to procure from the farmers, indicative/support prices, and subsidising input.

*Table: Major Crops Area in the Cotton-Wheat Zone of Punjab*

| Year | Area (Thousand Hectares) | | | |
|---|---|---|---|---|
| | Sugarcane | Rice | Maize | Cotton |
| 2013-14 | 293.4 | 225.4 | 78.9 | 1,840.88 |
| 2014-15 | 282.88 | 277.61 | 75.9 | 1,930.29 |
| 2015-16 | 293 | 279.23 | 80.8 | 1,864.74 |
| 2016-17 | 338.72 | 295.83 | 158.6 | 1,554.36 |
| 2017-18 | 395.37 | 294.2 | 140.4 | 1,791.53 |
| 2018-19 | 338.9 | 313.61 | 204.1 | 1,686.3 |
| 2019-20 | 309.8 | 380.4 | 146.2 | 1,699.16 |

*Source: Economic Survey of Pakistan (Various Issues)*

Policies that have resulted in lower cotton production include the reliance on outdated seed technology, meagre investments in agriculture (especially for cotton), old chemistry for the IPM, volatile farm prices, primitive ginning technology, less favourable terms of trade for cotton in comparison to competing crops (e.g., sugarcane, rice, and maize).

## OBJECTIVES

Keeping in view the importance of the cotton crop and the challenges it is facing, a holistic analysis of the impact of policies on the competitiveness and efficiency of cotton, the impact of crop production patterns on the economy, and an evaluation of various factors that have affected cropping decisions was carried out.

## FINDINGS

The analysis shows that cotton generated PKR 40,175/ha in labour income and injected PKR 100 billion into the rural economy. In comparison, rice and sugarcane generated PKR Rs. 37,209/ha and PKR 57,100/ha in labour income and added PKR 113 billion and PKR 416 to the rural economy, respectively. The nominal protection coefficients (NPCs) of cotton, sugarcane, and rice were estimated to be 1.01, 1.41, and 1.05, respectively. It shows that cotton is the least protected crop under the existing set of policies. The effective protection coefficient (EPC), which is the measure of private value added (PVA) compared to the social or economic value added, shows that cotton producers across Pakistan are not protected, while sugarcane and rice producers are protected under the current set of policies. The EPC shows that cotton producers are implicitly taxed in Pakistan, while sugarcane producers are subsided.

The domestic resources cost (DRC) is the indicator of the opportunity cost of the domestic resources and the social value added per unit of the crop. The DRC shows that Pakistan has a comparative advantage in producing all the crops as the DRC of cotton, sugarcane, and rice are 0.47, 0.30, and 0.34, respectively. The implicit taxation of cotton implies that farm resources are transferred away from cotton production, which adversely affects cotton producers' incentives, farm investments, and rural growth in Pakistan.

## RECOMMENDATIONS

Since cotton, sugarcane, and rice are important crops in Pakistan, the provincial governments should make all-out efforts to ensure competition in the markets, improve marketing infrastructure, and market intelligence to help farmers get better prices for their produce. Efforts also need to be directed to improve the processing of paddy and ginning of seed cotton to fetch higher prices in the world markets.

Excessive fluctuations in market prices, however, have adverse implications for resource use and productivity, farm incomes and household welfare. Therefore, ways and means ought to be found and steps taken to insulate domestic producers from excessive fluctuations in market prices. However, this is predicated on the availability and development of institutional capacity to continuously monitor and analyze the developments in the domestic and world markets.

# DYNAMICS OF FOOD PRICES IN MAJOR CITIES OF PAKISTAN

Nigar Zehra and Fouzia Sohail

## BACKGROUND

In Pakistan, food prices are volatile implying uncertainty of food prices. In developing countries like Pakistan, household food expenditure share is between 50 to 70 per cent. Hence, an increase in food prices severely hurt consumers. The determinants of food prices are divided into three groups, i.e., exogenous shocks, market conditions and political environment, and endogenous shocks. It is explained that exogenous factors are the root cause of price fluctuation. These include extreme weather shocks, economic shocks, international commodity price shocks and oil price shocks. The extent of their influences or the saturation of their effect on the native economy partly rests on the market conditions and political situation of the certain country. Endogenous shocks, which include trade policies, speculative activities, weak administrative control, the role of the middleman, and hoarding, among other things, amplify the effect of other factors present in the first and second groups.

This brief is based on the paper "Dynamics of Food Prices in Major Cities of Pakistan." The paper evaluated the individual price dynamics using the micro-data of 15 major food commodities[1] in 14 cities of Pakistan[2] from 2002 to 2021. The paper assessed the volatility in monthly prices of the 15 food commodities and observed the impact of various exogenous and endogenous covariates on food prices over the years.

## METHODOLOGY

The patterns of price change of each product were evaluated based on various indicators, such as the duration of price spells, the frequency of price change, the direction of price change, the average size of price change, and the degree of synchronisation of price change. The impacts of various exogenous and endogenous factors were evaluated using standard deviation and autoregressive conditional heteroscedasticity (ARCH)/generalized ARCH (GARCH) and integrated Garch (IGARCH) models. The identification of the factors responsible for changes in food prices was done using the ARDL bound test separately for the price of each commodity.

## MAIN FINDINGS

### The Pattern of Price Adjustment over Time

Among the food commodities studies, vegetables, farm chicken, and eggs had the most flexible prices. The prices of almost all the food products changed less frequently in Khuzdar city. On the other hand, the prices of most commodities, particularly milk and beef, changed more frequently in big metropolitan cities.

Most of the commodities displayed an increase in prices followed by a decrease. Thus, the frequencies of

[1] The commodities are beef, chicken, rice, wheat, mash, mung, masoor, tomatoes, potatoes, garlic, onions, sugar, tea, milk, and eggs.

[2] The cities are Bahawalpur, Faisalabad, Hyderabad, Islamabad, Karachi, Khuzdar, Lahore, Multan, Peshawar, Quetta, Rawalpindi, Sargodha, Sialkot, and Sukkur.

both an increase and a decrease were higher. These included eggs, farm chicken, tomatoes, onions, and potatoes. On the other hand, some commodities, such as tea, milk, beef and rice, exhibited a higher frequency of price increases with seldom decreases in prices of tea, milk, beef and rice.

The prices of tomatoes had the greatest magnitude of price change, followed by onions. Huge variations in tomato prices are due to production and supply shocks. On the other hand, although milk and beef prices decreased seldom, the magnitude of the decrease was relatively high. At the city level, small but frequent increases in the prices of pulses were recorded. The intensive and extensive margins of inflation for pulses show the transmission of international prices into the domestic market.

As for the synchronisation of price change across cities, tea exhibited a higher degree of synchronisation among products. Since the price of tea mainly depends on international prices and the exchange rate, its price change simultaneously in all cities. Among other commodities, the prices of tomatoes, farm chicken, refined sugar, onions, and farm eggs were also synchronised, while the remaining commodities were quasi-synchronised. Although the price list of food items is released by the government to maintain the harmonized system, these results show the problem of implementation and control of prevailing prices across cities.

### Volatility Assessment

The prices of beef, chicken, eggs, sugar and all vegetables were found to be highly volatile as compared to other commodities. The prices of mash, mung, masoor, IRRI rice, wheat, milk, and tea in most of the cities were volatile because of past variance. On the other hand, the main reason for volatility in the prices of sugar, eggs, onions, potatoes, tomatoes, and garlic was the external factors in most of the cities.

### Factors Affecting Food Prices

The following factors affected food prices in the selected cities from 2002 to 2021.

- There was a negative and significant impact of the real effective exchange rate on wheat prices in the long run.
- The real interest rate had mixed effects on food prices in the long run. It inversely affected wheat and rice prices but had a direct effect on tea prices.
- It is noticed that the increase in international crude oil prices significantly increased the prices of chicken, beef, eggs, wheat, rice, sugar, tea, and vegetables, except garlic, in the long run. This shows that international food price transmission plays a major role in domestic food commodity prices in the long run.
- In the long run, an increase in local production of tomatoes, eggs, mash, masoor, and sugar significantly reduces their prices.
- The government policy of adjusting (increasing) wheat support prices also has a positive and significant impact on wheat prices.
- The convergence of the prices of onions, tomatoes, potatoes, chicken, eggs, wheat, and tea to the equilibrium is relatively faster as compared to the prices of beef, milk, mash, and sugar.

## KEY POLICY RECOMMENDATIONS

- The prices of pulses in all cities changed by small amounts but frequently. Since most of the demand for pulses is fulfilled through imports in Pakistan, changes in international prices of pulses are transmitted to the domestic market. While political and overall economic stability is the key factors to dampen the effect of exogenous shocks, there is a need to increase local production of this low water consumption crop.
- The government should formulate a system to monitor the market prices of highly volatile food commodities (beef, chicken, eggs, sugar, and vegetables). It would help to stabilize food prices.

- The results of this study show that the wheat support price increase the price of wheat. However, an increase in wheat prices will decrease the production of other agricultural commodities and ultimately hurt the consumers. Hence, there is a need to increase the per acre yield of wheat instead.

- To encourage investment in crop production by local farmers, it is important to provide loans at low rates.

- The results exhibit that the high crude oil prices increase the food prices of most of the commodities, but the high international crude oil prices are out of the government's control. Therefore, the government should provide crude oil at a subsidised rate to the producers to reduce the input cost.

- Furthermore, there is a need to construct a proper transportation system from farms (villages) to the urban markets to reduce transportation cost.

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