

Wheat Consumption Determinants and Food Security Challenges: Evidence from Pakistan

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Abstract: This study aims to explore the wheat consumption determinants in Pakistan as well as to analyze the own price, cross price, and income elasticity of demand for wheat. For estimation purpose, time series data were used based on annual observations covering the period from 1972-2020. Autoregressive Distributed Lag approach (ARDL) econometric technique was applied to analyze the existence of a long-term connection among wheat demand and wheat consumption determinants. Based on empirical analysis, the results of wheat prices, real GDP, and population show that wheat is a necessity staple food in Pakistan. Further, results of rice prices and corn consumption reveal that rice and corn commodities are substitutes to wheat with less elastic demand in Pakistan. The estimated result of wheat imports exhibits a direct and significant impact on wheat consumption. Overall, the results suggest that domestic efforts required to reduce the wheat demand and supply gap such as, through advanced innovative production techniques, latest wheat varieties, land expansion, and exploring the additional water resources for irrigated agriculture. Additionally, this study recommends policy makers, Pakistan government and stakeholders to pay attention on increasing domestic wheat production in order to lessen the wheat imports, saving useful foreign exchange, and to resolve the food security issues in Pakistan.

Key-Words: Wheat Consumption Determinants, Own Price Elasticity, Cross Price Elasticity, Income Elasticity, Wheat Supply and Demand Gap, Food Security, Autoregressive Distribute Lag (ARDL).

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1 Introduction

The agriculture sector is the backbone of Pakistan economy. It is one of the major sector of economic activity of a country. Its contribution in the country GDP is 19.2% and creates employment opportunities approximately 38.5% of the working force. More than 65-70% of the country population depend on agriculture for their livelihood [1]. Major sub-sector of agriculture are crops. From all important food crops, wheat is one of the major staple crop of Pakistan and therefore, it is essential for the country food security. It contributed 9.2% to agriculture value added and 1.8 percent to GDP. Pakistan is one of the main wheat producers in the globe. In Pakistan, the biggest cropped area is under wheat cultivation. Current year wheat is cultivated on an area of 9178 thousand hectares [1]. Though, sometimes domestic wheat production not sufficient according to the population needs, which is currently 229 million and population growth is

estimated as 1.9% percent. Therefore, to ensure food security and to meet the domestic demand for wheat the government has dependent on wheat imports. In the fiscal year 21, wheat imports were estimated at 983.3 US million\$ [2] [1]. It is estimated that imports cover 10 to 20 percent of country consumption needs [3]. Poor families in Pakistan spend major share of income (23% of total income) on wheat Furthermore, it has been reported that country current demand for wheat is more than its output and if per year population grow at an expected rate of 1.9%, then it anticipated that country will endure a wheat net importer [4].

Due to the strategic importance of wheat as it is the main food ingredient, the government intervenes by providing not only the guarantee of supplying the consumers with wheat at affordable prices, but also by supporting the producers in the market. Therefore, through subsidy, government provides wheat at a lower price to the consumer and a support

price of wheat to market producers [3]. In Pakistan, the demand for wheat is highly price-inelastic [5], and sometime production is not sufficient to meet demand for wheat due to higher population growth [3]. Rapid population growth will create a serious food security challenges in upcoming years in Pakistan. Currently, it is calculated that in Pakistan approximately 53 million peoples are living below the poverty line and unemployment rate in current year has been reached at 16 percent [2].

Additionally, the pandemic COVID-19 has revealed a severe effect on the worldwide economic situation. The food security situation in the developed and developing economies is getting worse with the evolution of the COVID-19 pandemic. [6] and [7] report highlight that around 271.8 million peoples were intensively insecure from food because of disparaging effect of COVID-19 globally. Likewise, 20 to 30 percent population, which is, 40-62 million peoples of Pakistan have been suffering severe food insecurity because of Pandemic, and other socio-economic, environmental, and climatic problems [8]. Moreover, during this pandemic era, Pakistan inflation rate was increased by 8.2 percent from May 2019 -May 2020 and food inflation increased in the rural (13.73%), and urban areas 10.94% [6] [7] [8] [9].

Overall, these socio-economic indicators may even lead to worsen the food security challenges in Pakistan.

[10] in Pakistan a huge gap exist among actual and acquired output, that suffers because of inadequate technology, improper usage of inputs, unavailability of water and land utilization, lack of knowledge about control of insects and pests. As a result, these factors adversely affect the production. The water scarcity issue in agriculture have a detrimental effect on the Pakistan economy because this sector directly subsidizes its gross domestic product (GDP), and greater than 40% of labor force directly or indirectly involved in it [11]. Wheat crop in Pakistan are planted on a float basin that is directly flooded with water for irrigation. Water losses are huge under this form of irrigation. Evaporation and deep percolation losses also a reason of severe shortage to crops linked to overexploitation of ground water, motivating the research for another methods of water application to crops, e.g., Raised Bed (RB) technology, to fulfil the water demand [10].

[12] report that in the middle of the 21st century, one of the serious challenges for farmers will be to fulfill the food needs of nine billion peoples.

Production of more food with less quantity of water in Arid and Semi-Arid lands is a challenge for today's agriculture [13]. Water scarcity issue leads to land degradation because of rain-fed agriculture [14], and a reduction in food production, especially in agriculture and semi-agriculture African areas [15]. Almost 80% of global agriculture consist of rain-fed land, which produces 80% of the food globally [16] [17]. In North Africa and West Asia 95% of land is rain-fed, and almost 40% land has been used in Uzbekistan due to water scarcity, causing despoiled fields [18] [19].

Wheat being a widely consumable staple food and major Rabi crop of Pakistan, carries a significant tag to ensure the country food security. Wheat is harvested in all of the four provinces of Pakistan. Specially Punjab and Sindh. Only Punjab contributed 70-75% to the total annual wheat production of Pakistan. Since 1975, 27% increase in total area and 52% increase in yield per hectare for wheat are reported. While, 33% increase in wheat availability per capita was deemed insufficient. In this situation, imports of wheat were the most apparent result due to higher growth of population. To fulfill the dream of food self-sufficiency, government facilitated farmers by providing high yielding varieties, fertilizers at a subsidized rate, irrigation water at a lower rate than tube well water etc. Though, these facilities have not been able to reach the desire level of output mainly due to (i) poor economic conditions of the farmers, lack of knowledge on the latest useful techniques and advancement. (ii) low price of production at harvesting time made the farmers insecure about investments they have done for inputs. (iii) inappropriate land levelling along with late sowing resulted in lower production. (iv) Insufficiency, inequity, and unreliability in water distribution are mutually affect the farmers irrigation calendars for the wheat crop. Water stress to wheat at sensitive stages, hinders the entire effort of production [20].

During 2020-21, the total water availability for crops in Kharif 2020 reached to 65.1 Million Acre Feet (MAF) viewing a minor decline of 0.1 percent relative to 65.2 MAF of Kharif 2019-20. Rabi season 2020-21 got 31.2 MAF, displaying a slight rise of 2% compare to 29.2 Rabi 2019-20 [1]. The water consumption for wheat is 4372 M³ per hectare and 4639 M³ per hectare in Punjab and Pakistan, respectively [21] but on farm availability is only 50 percent of the agronomic needs [22]. The water irrigation inequity, and scarcity is one of the major factors in exploiting the yield potential of wheat in Pakistan. The inequity and scarcity are much more pronounced at the end of distributaries and

watercourses. The efficiency and equity of irrigation water at the farm level is imperative to ensure country wheat self-sufficiency [23].

Limited water leads to vulnerability to water scarcity settings, causing wheat biomass to lessen wheat crops [24] [25] [26]. Poor and meagrely distributed rainfall in arid regions of Pakistan further worsens this situation. Losses ranging from very low yields to complete losses under severe water stress in wheat crops have been well documented [25]. Additionally, the Pakistan government still needs an improvement for the production of wheat in various varieties. As prior literature reported that the slow growth rate of crop variety replacement by farmers encouraging a new variety of wheat in Pakistan [27] [28].

[4] projected the demand and supply of wheat in Pakistan from 2008 to 2030. Their results indicate that if population grow at an assumed rate 1.8 percent per year, then wheat demand will rise from 19 million tonnes to 30 million tonnes by 2030. The forecasted estimates of wheat supply determined from the production function technique highlight that by 2030, wheat production will reach 28 million tons. The wheat demand is projected to be more than its supply. In other words, the country is likely to suffer a deficit in wheat. The findings postulate that if production technology remains constant and production growth will be slower, the wheat deficit will become wider. Hence, suitable policy measures required to overcome the likely deficit in wheat. Similarly, [23] agriculture sustainability and wheat self-sufficiency is dependent on timely sowing of wheat, balance usage of fertilizers, Judicious usage of water irrigation, increase the usage of certified and pure seeds, expand the knowledge and technologies frontier, and improve farm management practices to increase productivity in Pakistan.

Different economic theories provide the background for analyzing the demand of any commodity. The demand of any commodity depends on its own price, income, price of other related commodities, taste and preferences of consumer, and seasonal effects. Similarly, the demand of wheat dependent on many direct and indirect factors. Internal factors include wheat price, per capita income, and wheat supply. External factors include price of substitute and complementary goods, population of a country, inflation, preferences and taste of a consumer [29] [30] [31] [32]. Positive elasticity of income shows that at higher income level, demand for wheat increases and vice versa. On the contrary, at low level of per capita income wheat demand also

increases due to poverty. Increasing poverty and hunger index are the fundamental challenges to make sure food security in the world [29].

Wheat is more income elastic relative to rice and other related products. [33] estimated own and cross price elasticities for hard red winter and hard spring wheat, soft red and white wheat, and durum wheat. Their findings indicate that soft wheat varieties respond less to their own price relative to hard wheat varieties. However, the results show that the cross-price elasticities of hard red winter, hard red spring, and soft wheat varieties are economic substitutes. [34] estimated the short-term and long-term wheat elasticities of demand for Pakistan. The study findings suggest that income is the fundamental determinant of wheat consumption in the long run. Whereas, in the short run wheat prices is the key factor that affect the wheat consumption.

Low domestic prices of wheat put a burden on wheat imports [35] [36] [37]. [38] analyzed the speculative wheat demand determinants and their influence on consumer loss for district Mandi Bahuddin, Pakistan. Their findings show that the lower-income consumers speculate on wheat price and drive prices up around 8.92% above the normal prices, costing them to drop consumer welfare and surplus. The results determined that if consumer avoid speculation they may enjoy wheat price lower than 8.92% price and benefit from increased consumer welfare and surplus. Similarly, [39] analyzed the behaviour of prices in two significant exporting markets of Russia. The results reveal that Russia behaves competitively in wheat exports to Egypt and turkey. Though, it gets market power in Turkey with 13.5 % estimated mark-up. Later on, [40] investigated factors that expand the domestic wheat process product consumption in Korea. Their results indicate that high quality, safety and size of processing companies are the important factors that expand the domestic wheat processed product consumption.

Additionally, [41] analyzed the influence of domestic political instability on trade of wheat in Egypt. Their findings show that the severe inverse demand shock of 2011, caused by the political instability of country that resulted from the Arab spring. Further, results reveal that in Egypt urban demand persist longer relative to rural, which is fulfilled through wheat imports. Any delay in wheat imports increased food unsustainability and vulnerability in Egypt.

Also, [42] reported that in the urban areas wheat demand is significantly higher than rural areas in Bangladesh. Moreover, [43] investigated the wheat demand determinants in Sub-Saharan Africa. Their

findings indicate that rising income level, population growth and increasing female labor force participation are the main drivers. Further, results show that share of expenditure on wheat in urban area is generally larger than in rural areas and Africa has satisfied a large part of wheat demand through imports and partly through domestic production.

Further, [44] reported that production, consumption and imports are the key drivers of food security in Egypt. [45] analyzed the determinants of wheat consumption in Egypt. Their findings suggest that own price, GDP per capita and population growth are the determinants of wheat consumption. Moreover, rice prices, corn and barely consumption are substitutes for wheat in Egypt.

Overall, from the literature review it can be noted that the existing literature has focused on the wheat production, supply and availability in Pakistan

[23] [4] [28] [34] [5] [8]. Whereas, demand of wheat with alternative consumption shift in the context of Pakistan is missing in the literature. There is a significant need to uncover the challenges related to wheat demand in Pakistan. Motivated by the growing body of literature, this study will cover this gap in the context of Pakistan. This study will attempt to answer all of the following questions that are not appropriately addressed in the existing literature. What are the alternative food staple crops available for wheat consumption in Pakistan? What are the economic and demographic factors increasing the demand of wheat in Pakistan? What are the significant food security problems are facing the population of Pakistan? How government may address these issues through sustainable policy practices? To address all these questions this study carried out with following research objectives:

1. To investigate the wheat consumption determinants with substitute shift of wheat consumption in Pakistan.
2. To analyze the short-term and long-term impact of demand determinants on wheat consumption.
3. To examines the own, cross price elasticity, and income elasticity of demand for wheat in Pakistan.
4. To decrease wheat imports through alternative food consumption and stabilize food security.

The study findings show that the wheat production and consumption gap are anticipated to increase further in the upcoming years due to higher population growth that will exert a continuous pressure on wheat consumption, and that would be a reason for food insecurity issues in Pakistan in the upcoming years. A sustainable food security policy

is required to overcome the upcoming food security issues in Pakistan.

This study will contribute to the empirical literature by investigating the wheat demand determinant and substitute shifts of wheat demand in the context of Pakistan. As previous literature was only focused on the wheat production, wheat supply and its availability in the markets. The contribution of this study is significant in the empirical literature by suggesting the alternative wheat substitute commodities in order to shift the wheat demand with alternative consumption shift. Further, this study highlights the upcoming food security challenges in Pakistan, and suggests some useful policy recommendations for policy makers in order to overcome the food security issues in Pakistan.

The other parts of the study are arranged as follows. Section 2. describes the material and methods. Section 3. explains the empirical results of the study. The last section concludes the study results and suggests some policy recommendations.

2 Material and Methods

2.1 Theoretical Framework

According to Keynesian school of thought, country aggregate domestic consumption depends on the aggregate level of per Capita income [46]. The aggregate demand function shows its association among own price, per capita income, and other related commodities (Substitutes and Complementary). On the basis of aggregate demand theory, wheat demand of an economy depends on own price of wheat, income of consumer, and substitute prices [29]. Any commodity that has more substitutes, the quantity demanded of that commodity will be less elastic [45]. Hence, the demand theory functional relationship can be explained as:

$$Qd_x = f(P_x, Y_t, P_s, P_c) \quad (1)$$

Where Qd_x is the quantity demand of commodity X, P_x price of commodity X, Y_t level of per capita income at time period t. P_s is the price of substitution commodity, P_c price of complementary commodity.

2.2 Empirical Model

On the basis of different macroeconomic theories, wheat demand dependent on its own price, income of the consumer, price of related staple food crop, and exogenous factors such as population size, and inflation rate [43]. Hence, the country demand for

wheat depends on wheat price, price of related staple food crops such as (Rice, Corn, Barely, and Sorghum etc), population per capita, gross domestic product and rate of inflation [45]. Therefore, to analyze the determinants of wheat demand and food security challenges in the context of Pakistan. This study used the double log econometric model to measures the elasticities of each variable in the model.

$$Qd_x = \beta_0 + \beta_1 P_x + \beta_2 Y_t + \beta_3 P_s + \beta_4 P_c + \varepsilon \quad (2)$$

This study transformed the generalized aggregate demand (AD) according to the theoretical framework and data accessibility connected to the important determinants of wheat demand. The dependent association of wheat consumption (WC) was specified with substitutable primary foods like, Rice prices (RP), Corn consumption (CC). Due to unavailability of corn prices data, this study used the corn consumption data as a substitute variable. Further key variables which effect the wheat demand are Real Gross Domestic Product (RGDP), Population (POP), Wheat Imports (WI), and Inflation. This research included wheat import in the model in order to fulfill the production and consumption gap as Pakistan government relied heavily on imports. The modified form of wheat aggregate demand equation as follows:

$$WC_t = \beta_0 + \beta_1 WP_t + \beta_2 RP_t + \beta_3 CC_t + \beta_4 RGDP_t + \beta_5 POP_t + \beta_6 WI_t + \beta_7 INF_t + \varepsilon_t \quad (3)$$

In order to calculate the elasticities of wheat consumption for both short-term and long-term dynamics, this study taken the natural log of all variables given in equation 3. The linear double log model has fundamental features, though we can calculate the elasticities coefficient that shows the percentage changes in dependent in dependent variable due to percentage changes in the explanatory variables [47]. By taking the log of equation (3), following given below model has been estimated:

$$\begin{aligned} \ln WC_t = & \beta_0 + \beta_1 \ln WP_t + \beta_2 \ln RP_t + \\ & \beta_3 \ln CC_t + \beta_4 \ln RGDP_t + \beta_5 \ln POP_t + \\ & \beta_6 \ln WI_t + \beta_7 \ln INF_t + \varepsilon_t \end{aligned} \quad (4)$$

Equation (4) shows that all variables in natural logarithmic form. The dependent variable in this equation is WC_t and the independent variables are

$WP_t, RP_t, CC_t, RGDP_t, POP_t, WI_t, INF_t$. α_0 is the intercept parameter of the model and β_1 to β_7 are slope parameters, "t" shows the time duration, ε_t is the error term. All selected variables brief detail is given in table 1.

2.3 Data Sources

To examine the main objectives, this study collected the time series data based on annual observations from 1972 to 2020. The data is collected from various published secondary sources such as WDI, IFS, Bureau of Statistics, various issues of Pakistan economic survey, Index Mundi, and Punjab Food Department.

2.4 Estimation Techniques

To investigate the wheat demand determinants, this study used the linear double-log model. The linear double log has fundamental characteristics through which we can examine the elasticities of each candidate variable in order to explain the short and long run relationship [45] [47]. Therefore, to examines the short-term and long-term elasticities of wheat consumption determinants this study employed an Autoregressive Distributive Lag approach (ARDL). Different influential variables of wheat consumption has been used in the estimated model in order to analyze own price, cross price and income elasticities along with control variables e.g., wheat imports, inflation, and country population.

The bound test of ARDL was proposed by Pesaran et al. (2001). The ARDL model has an ability, it simultaneously works with the coefficients of short and long term and suitable for both I(0) level, and I(1) first order stationary variables [45] [48].

This study we investigated the determinants of wheat consumption by complementary analysis. Additionally, we projected the wheat consumption, country population, and wheat production from 2021 to 2100 along with this study measured the projected gap among wheat consumption and wheat production on the basis of projected population.

Table1. Variables Description

Variables	Description	Units	Data Sources
WC_t	Wheat consumption	Metric Tonnes	Index Mundi
WP_t	Wheat Prices	PKR per 40 kg	Bureau of statistics, Economic survey, Punjab Food Department.
RP_t	Rice Prices	PKR per 40 kg	Bureau of Statistics, Economic Survey.
CC_t	Corn Consumption	Metric Tonnes	Index Mundi
$RGDP_t$	Real Gross Domestic Product	Millions, Domestic Currency (base year 2005)	International financial Statistics (IFS)
POP_t	Total Population	Millions	World Development Indicator (WDI)
WI_t	Wheat Imports	Metric Tonnes	Index Mundi
INF_t	Inflation, consumer prices	Annual percentage	(WDI)

Source: Authors own's collections

Source: Authors own calculations

Notes: **, *** indicates significance at 5% and 1%

3 Results and Discussion

3.1 Stationarity Results

This study applied an ARDL model to investigate the wheat consumption determinants and food security challenges in Pakistan. Before applying ARDL estimation technique, in the first step to check the stationarity of each candidate variable unit root test was applied. The findings of unit root test given in below table 2.

Table2. Unit Root-ADF Test Results

Variables	ADF Test	
	I(0) T-Stat	I(1) T-Stat
WC_t	-1.2131 (0.8954)	-3.7357** (0.0302)
WP_t	-0.7308 (0.8290)	-6.8934*** (0.000)
RP_t	-0.9215 (0.7729)	-6.6432*** (0.000)
CC_t	1.0558 (0.9966)	-7.2673*** (0.000)
WI_t	-3.1661** (0.0283)	-5.4801*** (0.0003)
$RGDP_t$	-0.9586 (0.9400)	-5.0924*** (0.0008)
POP_t	-3.5725** (0.011)	-0.4978 (0.8819)
INF_t	-3.2392** (0.0237)	-8.0281*** (0.000)

Table 2. highlight the Augmented Dicky-Fuller (ADF) test results. The results of ADF test shows that the variables wheat consumption, wheat prices, Rice prices, Corn consumption, and real GDP are integrated in order one I(1). However, wheat imports, population and inflation are integrated at level I(0). Hence, the variables used in the model are a combination of both variables integrated at I(0) and I(1) that is essential to adopt the ARDL estimation technique for short and long-term dynamics.

3.2 Lag Length Criteria

The time series data usually shows the behaviour of time trend and effects of current values relatives to earlier period (lag) value. Any ups and down in the time series data instigate the issue of autocorrelation. The autocorrelation problem can be eliminated through suitable lag selection. In time series data the process of lag selection is applied to change the given variable in to growth form, that is helpful for removing the issue of autocorrelation in the data set.

[35] claimed that for autocorrelation removal in the data set lag difference and Cochrane-Orcutt methods are applicable. Therefore, this study applied an optimal lag length and various estimation techniques like Schwarz Bayesian Criterion (SC), Hannan Quinn Criterion (HQ), Akaike Information Criterion

(AIC), etc. The method of AIC is more effective relative to HQ and SC. However, HQ and SC results are consistent relative to AIC [45] [48]. The estimated findings of lag selection criteria are given in table 3.

Table 3. Lag length Criteria

Lag	AIC	SC	HQ	Source: Authors own Calculations Note
1	-22.51	-19.91	-21.55	
2	-25.24	-20.05	-23.32	
3	-27.49	-19.70*	-24.60	
4	-32.96*	-22.58	-29.11*	

s: * indicates lag order selected by the criterion
 AIC: Akaike Information Criteria
 SC: Schwarz information Criteria
 HQ: Hannan-Quinn Information Criteria

Table 3. shows the results of lag length criteria. This study selected AIC approach for optimal lag length followed by [45]. After selection of optimal lag length, ARDL model is estimated by using E-Views 09 computer package.

3.3 Co-integration Test

In order to investigate the long-term relationship among candidate variables applied the ARDL-Bound Test. Table A1. report the results of ARDL-bound test (See Appendix A1). The results of bound test reveal that the calculated value of F-stat is higher than upper bound at each level of significance that highlight the rejection of null hypothesis (No long-term connection exist among candidate variables) and acceptance of alternative hypothesis (long run relationship exist among variables). Overall, the results of bound test report the existence of long-term association among wheat consumption and its determinants (WP, RP, CC, RGDP, WI, POP, INF). In other words, the results show that co-integration relationship exist between estimated variables.

3.4 ARDL-Based Long-Term Results

After analyzing the cointegration between variables estimated the long-term and short-term coefficients. ARDL-based model results of long-term is given in table 4.

Table 4. report the estimated results of long-term coefficients. The dependent variable of this study is wheat consumption and independent variables are envisioned to determine the key demographic and economic drivers that raise the demand for wheat in Pakistan. The intercept parameter value 3.0459 is positively significant at

5% significance level reveal that by keeping the explanatory variables fixed, the exogenous factors

Table 4. ARDL-based long Run estimations

Dependent Variable LWC			
Variables	Coefficient	T-stat	P-value
LWP_t	-0.0580	-2.5126	0.0121**
LRP_t	0.3143	2.2963	0.0291**
LCC_t	-0.2401	-3.0454	0.0049***
INF_t	-0.0025	-0.1350	0.8935
LWI_t	0.0302	3.8609	0.0006***
$LRGDP_t$	0.3982	4.8223	0.0000***
$LPOP_t$	0.3818	1.9225	0.0644*
C	3.0459	2.4575	0.0202**

Source: Author's own contribution

Notes: *, **, *** indicates significance at 10%, 5%, and 1% level

like meat, fruit, vegetables etc., affect the wheat consumption in Pakistan positively. Further, the coefficient associated with WP_t is -0.0580 and statistically significant at five percent significance level. The negative sign associated with coefficient of wheat prices indicate that the famous law of demand holds for Pakistan wheat consumption. According to law of demand, when prices goes up peoples willing to demand less quantity and vice versa. Hence, as the prices of wheat goes up peoples willing to demand less quantity of wheat, and when prices go down they willing to spend more on wheat quantity [29]. The coefficient of wheat prices shows that as 1% decrease in wheat prices tend to increase the wheat consumption by 5.8% in Pakistan. Wheat demand is less elastic in Pakistan because wheat is the necessity good of Pakistan. The findings are consistent with [30] claimed that global prices of wheat are not necessary to determine the domestic consumption of wheat. Whereas, domestic prices of wheat affect the wheat consumption. [49] view that wheat prices significantly affect the wheat supply but donot significantly affect the wheat demand. [45] concluded that law of demand holds in the context of Egypt. Conversely, [50] explained that law of demand does not hold in case of Iran because they considered wheat as a giffen good.

Rice is a complementary food in various countries of the world, and others countries consume rice as a substitute of wheat. This study

used the rice prices (RP_t) variable as an explanatory variable to investigate the association among rice and wheat food in Pakistan. The coefficient associated with rice prices is positive (0.3143) at 5% significance level indicate that rice prices have a negative effect on wheat consumption in Pakistan. In other words, it shows substitute relationship among rice and wheat food in Pakistan. As prices of rice decline, peoples of Pakistan are willing to demand more rice by substituting the consumption of wheat. Overall, the findings show that in the long-term rice consumption as a substitute for wheat consumption in Pakistan. The coefficient of rice prices exhibits that as one percent decrease in rice prices wheat consumption decreases by 31 percent. Rice is less-elastic substitution for wheat in Pakistan. Our results are consistent with [45] [50] who claimed that rice is substitutable food for wheat and it has the capacity to decrease the imports of wheat. Overall, on the basis of results Pakistan government should develop an inclusive policy for food security, specifically the consumer demand for wheat and rice food.

The coefficient of corn consumption is negatively significant at 1% level. The results display that corn consumption has an inverse significant effect on wheat consumption in Pakistan. The estimated coefficient of corn consumption is -0.2401. Hence, the elasticity of corn consumption is -0.24 reveal that in the long run both corn and wheat consumed as a substitute in Pakistan. The estimated coefficient of corn displays that corn is less-elastic substitution with consumption of wheat in Pakistan. As 1% percent increase in corn consumption tends to decrease the wheat consumption by 24 percent and vice versa. Our findings are in line with [51] who claimed wheat flour can be substituted with corn flour but adding up of fruits enhance the bread contents and quality. Additionally, our results are also consistent with [45]. Overall, results show that the cross-price elasticity of rice is higher than corn in Pakistan.

The inflation estimated coefficient is negative (-0.0025) but not significant in case of Pakistan. It may be because wheat is the necessity commodity of Pakistan. Hence, an increase in the inflation rate donot affect the wheat demand in Pakistan.

The wheat imports estimated coefficient is positive (0.0302) and significant at 1% level exhibit a wheat imports direct and significant impact on wheat consumption in Pakistan. The results show that a 1% increase in wheat imports tends to raise the wheat consumption by 3.2% in the long-term. The coefficient associated with wheat imports explain the domestic wheat production deficiency

and reliance on wheat imports. This result is similar with the [41] found that temporary barriers in wheat imports increased the food insecurity and vulnerability in Egypt. On the contrary, [50] highlight that wheat imports donot affect the domestic prices, and wheat imports can be decreased through domestic production and consumption shifts.

The real GDP estimated value is positive and statistically significant at one percent level. The estimated coefficient of real GDP is 0.3982, exhibit that as 1% increase in country GDP leads to increase the wheat consumption by 39.82 percent. Hence, the estimated value of real GDP show that wheat demand is income elastic. Country wheat demands increases at higher real GDP level, because at higher income level people demand more wheat by considering wheat as a necessity commodity [43]. The poverty rate is high in Pakistan which is the cause of higher wheat demand in Pakistan. The poor people first priority is to spend on necessary commodities to survive. Our results are consistent with [45] who found for Egypt and contrast with [50] whose findings claimed that peoples in Iran considered wheat as an inferior commodity with the increasing level of income.

The coefficient associated with total population is positive (0.3818) and significant at ten percent level reveal that total population has both economically and statistically significant impact on consumption of wheat in Pakistan. The estimated results show that as 1% increase in population tends to increase the wheat demand by 38%. Population has elastic wheat demand that positively affect the wheat demand at national level [45] [52]. [49] and [53] found that population is a key driver of wheat demand. Increasing population size put upward burden on wheat demand, as peoples are ready to buy more wheat. It is expected that increasing level of population growth and wheat demand will generate food insecurity issues in Pakistan. To ensure food security and to meet the consumer demands an extensive wheat production, substitute consumption and wheat import policy is needed for Pakistan.

3.5 ARDL- Short Run Analysis

The estimated results of short-run elasticities are given in below table 5 with speed of adjustment coefficient.

Table 5. results report that the estimated short run coefficient of wheat consumption is insignificant. Similarly, the short run estimated value rice prices are positive but not significant. However, the lag coefficient of rice prices is

inversely significant at one percent level reveal that lower rice prices in previous period increases the wheat consumption in current period. Our results are consistent with [54] who claimed that rice is substitutable food for wheat and has the potency to

Table 5. ARDL-based Short Run Estimations

Dependent Variable LWC_t			
Variables	Coefficient	T-Stat	P-Value
D(LWC _t)	-0.0672	-0.5220	0.6065
D(LRP _t)	0.2055	1.6902	0.1017
D(LRP(-1))	-0.3434	-4.1869	0.0002***
D(LCC)	-0.2784	-3.3631	0.0022***
D(INF)	-0.0030	-0.1341	0.8942
D(LWI)	-0.0020	-0.2694	0.7895
D(LWI(-1))	-0.0031	-0.3371	0.7385
D(LWI (-2))	-0.0212	-2.7824	0.0094***
D(LRGDP)	0.5865	1.0926	0.2835
D(LRGDP(-1))	2.1176	3.5561	0.0013***
D(LPOP)	0.4429	1.9711	0.0583*
ECM(-1)	-1.1599	-6.933	0.0000***

Source: Authors Own Contribution

Notes: *, **, *** at 10%, 5%, and 1% significance level

decrease the country wheat imports. Peoples used rice as a complementary food for wheat in the short-term. The estimated coefficient of corn consumption is negative and statistically significant at 1% level show that in the short run peoples used corn as a substitutable food for wheat. Corn consumption behave same as in the long run. Our findings are in line with [51] who claimed that wheat flour has substitution with corn flour.

In the short run, the estimated value of inflation is insignificant. The inflation results are same as the long run which indicate that due to the effect of inflation people donot change the wheat demand because wheat is the necessary food of Pakistan. The estimated short run coefficient of wheat imports and fist lag period of wheat imports are negative and insignificant. However, the estimated coefficient of second lag period of wheat imports is also negative but statistically significant at 1% level show that previous period wheat imports reduced the current consumption of wheat. This result is in line with [45]. The short run coefficient of RGDP is insignificant but the first lag period of RGDP coefficient is positively significant at 1% level reveal that previous period real GDP affect positively on current wheat consumption. If peoples have more income in previous period they spend higher on current consumption of wheat by considering wheat as a necessity commodity. Our findings are in contrast with [50] who explains the inverse income elasticity of demand for wheat by claiming that consumer in Iran heed wheat as an

inferior good with the increasing level of income. In our analysis the positive sign of income elasticity of demand display that peoples change attitude positively for wheat with the increasing level of income. In other words, when consumer income increases peoples increase the wheat demand. Hence, people get ready to demand more wheat at increasing income level show that in Pakistan people have low level of income and usually face food security challenges. Our results are in line with [45].

The estimated short run coefficient of population is directly significant at one percent level. The finding is same as in the long run. Steadily [49] [53], and [45] established that population size is the key determinant of wheat consumption.

The estimated coefficients of co-integration calculate the speed of adjustment. If variability occur in consumption of wheat, the coefficient of error correction model (ECM) highlight the convergence period. The negative and significant ECM coefficient exhibits the existence of long- term co-integration association among the given variables, and the estimated model shows a convergence behaviour. The estimated coefficient of ECM(-1) is -1.16 and significant at 1% level reveal that the estimated model has higher adjustment speed [48]. The estimated coefficient of ECM (-1) indicate that if any disequilibrium occurs in wheat consumption, the coefficient of adjustment speed is high (1.16) remarkably.

3.6 Diagnostic Testing

The estimated results of residual diagnostic testing given in table 6. In order to test, the heteroskedasticity exists in the model or not. This study applies the Breusch Pagan (BP) test. The test result shows that the test statistics value of BP test is very low and insignificant indicates the acceptance of hypothesis that “no heteroskedasticity” exist in the estimated model.

Similarly, in order to check our sample data series is normally distributed or not we employ the Jarque Berra Test (JB). The test results indicate that the test-statistics value of JB test is low and insignificant reveal that data is normally distributed.

Likewise, in order to test whether there is a problem of autocorrelation in the data set or not. We use the LM test and the test-statistic of LM calculated value is low and insignificant shows the acceptance of null hypothesis “no autocorrelation” exist in the estimated data set, and the results are valid for policy implications.

Additionally, to check the structural stability of the model this study estimated the structural stability of model through Cummulative Sum (CUSUM) and Cummulative sum of square (CUSUMQ), see appendix (Figure 1&2). The estimated results of CUSM and CUSUMQ are lying within 5% bound reveal that there is no structural instability exist in the estimated model, and also slope coefficients of the estimated model identify the presence of long-run relationship [45] [55] [56]. Additionally, the estimated results of diagnostic tests (BP, JB and LM) report that the model is good fitted and has the capacity to suggest some valuable policy recommendations.

Table 6. Residual Diagnostic and Stability Analysis

Diagnostic Test	Test Statistics	P-value
Breusch-Pegan Goldfrey (BP)- Heteroskedasticity Test	1.1915	0.3313
Jarque Bera Test (JB) (Normality Test)	1.1146	0.5727
Autocorrelation Test (LM Test)	0.7987	0.4602

Source: Authors Own Contributions

3.7 Forecasted Consumption and Production Gap analysis based on Population

This study make a graphical analysis of wheat demand with the growing population rate in Pakistan. Figure 3, given in appendix explained the actual and projected value of wheat consumption, wheat production, total population, wheat consumption, and production gap in Pakistan. The forecasted estimates show that in the beginning of 1975 to 1986 Pakistan achieved near self-sufficiency in wheat production. The period from 1987 to 2001 showing a small wheat consumption and production gap which was fulfilled through wheat imports. In 2003, the graph showing negative two million MT gap among wheat consumption and production. In that period, Pakistan exported wheat approximately 0.193 million MT. From 2004 to 2020 the graph showing self-sufficiency in wheat production and in that duration, Pakistan exported approximately 16 million MT of wheat (Data Source: Index Mundi). Overall, from 1975 to 2020 trend shows that Pakistan was somewhere a net importer and somewhere a net exporter. This trend is showing irregularity in food policy of Pakistan.

However, the forecasted years trends from 2021 to 2100 showing an increasing production and consumption gap which may be a reason of food insecurity issues in Pakistan. The projected population trend shows that higher population growth will exert a continuous pressure on wheat production. The increasing consumption and production gap will put upward pressure on imports of wheat which creates food insecurity. In 2020, the consumption of wheat in Pakistan was 26 million MT and increasing at an increasing rate. The forecasting analysis shows that in 2050 the consumption of wheat would be 38 million MT because of the pressure of population. The forecasting analysis highlight that Pakistan need a 57 million MT of wheat to feed the 491million population of Pakistan in 2100. The production of wheat in 2020 was 26 million MT that would be around 32 million MT in 2050 and 43 million MT in 2100. In contrast, in 2020 consumption of wheat in Pakistan was 26 million MT and will be 38 million MT in 2050, and by 2100 the consumption would reach around 57 million MT. Likewise, population growth rate is increasing at an increasing rate, in 2020 the Pakistan population was 221 million, that would be double in 2086, and in 2100 it would reach around 491million. Overall, the forecasting analysis highlight that in the future Pakistan will face a severe food security problem as the demand and supply gap of wheat is going up over the projected period, in addition to population would be double in upcoming 65 years.

4 Conclusion and Policy Recommendations

Wheat is one of the major food crop and play a vital role in Pakistan national diet. It is widely consumable staple food in Pakistan. Worldwide, wheat is extensively consumable commodity and play a vital role in food security. This study conducted to explore the wheat consumption determinants in Pakistan. Additionally, we calculated the own price, cross price elasticity of demand, and income elasticity of demand for wheat. For estimation purpose, utilized the annual time series data covering the period from 1972-2020. To estimate the short-term and long-term co-integration relationship among candidate variable ARDL econometric technique is applied. Wheat prices shows an inverse relationship between wheat consumption indicate that law of demand holds for Pakistan. The possible reason is that consumers of Pakistan are ready to buy more wheat as prices of wheat declines, because wheat is an essential food

commodity in Pakistan. The findings of rice prices and corn consumption displays a significant effect on consumption of wheat. Hence, wheat, rice, and corn commodities are consumed as substitutes in Pakistan. This result reveal that demand of wheat fluctuates relatively when prices of rice and corn declines in Pakistan. The estimated coefficient of RGDP shows a direct significant impact on wheat consumption in Pakistan indicate that wheat is a necessity commodity in Pakistan. The result of RGDP highlight that peoples of Pakistan willing to buy more wheat as their income is increasing. The income behaviour of wheat meets the conditions of economic theories related to the necessity commodity. In Pakistan, population growth rate is high. The estimated results indicate that increasing rate of population put an upward pressure on wheat consumption in Pakistan. In Pakistan, the government fulfilled the wheat production and consumption fulfilled through wheat imports. The coefficient of wheat imports report a significant direct influence on wheat consumption in Pakistan. Further, the estimated result of inflation is insignificant indicate that inflation does not affect the wheat consumption in Pakistan. It may be because wheat is a necessity commodity in Pakistan and if inflation rate goes high, people donot decrease the demand for wheat. Further, the findings of projected analysis highlight that Pakistan from 1975 to 2020 was near self-sufficient in wheat. This duration sometime Pakistan was somewhere a net exporter and somewhere a net importer shows irregularity in food policy of Pakistan. However, our projected findings highlight that food insecurity issues may arise in Pakistan in the upcoming years due to the increasing growth rate of population which put an upward pressure on wheat demand. There is possibility that wheat consumption and production gap is increasing over the coming years.

This study's contribution is very important in the empirical literature especially in the context of Pakistan. This is the first study that investigates the determinants of wheat consumption as well as highlights the alternative substitute shift of wheat like corn and rice in Pakistan. Further, this study projected wheat demand and supply gap based on the growing population rate of Pakistan for the upcoming 79 years, and highlights the food security challenges that Pakistan will face in the upcoming years as previous literature had focused on the wheat production, supply and its availability. Therefore, this study's findings will not only contribute to the empirical literature but also suggests policies to policy makers in order to

explore ways to increase the wheat production and hence decrease the wheat demand and supply gap.

On the basis of empirical analysis, this study suggests some useful policy recommendation that should need to be addressed in order to fulfill the demand for wheat in Pakistan.

1. An inclusive policy required for substitutable wheat consumption regarding rice and corn.
2. Government should pay attention on alternative wheat production policies to meet the domestic demand for wheat consumption.
3. Pakistan government should focus on identifying further water resources for irrigated agriculture and alternative water production technology.
4. Government should manage the domestic production of wheat more than the population growth in order to decrease the country wheat imports. Wheat imports can be decreased by imposing tariff on imports and by shifting the population consumption pattern to substitutable commodities.
5. A comprehensive policy is needed for wheat imports and wheat output in order to fulfill the gap among wheat demand and supply. Government should pay attention on pro-poor agriculture growth in order to fulfill the wheat demand and substitutable staple commodities.
6. Mapping needed to meet the wheat consumption. Hence, ministry of food and agriculture should manage the increasing level of wheat demand.
7. Latest production techniques and advanced wheat varieties would be beneficial to increase the production of wheat.

4.1 Future Directions

Research is needed for wheat demand, production gap and substitutable shifts of staple food crops at micro level. Micro level research is required to analyze the deficiencies in wheat production and apply advanced techniques to raise the wheat production. Further, research required to investigate the wheat production pattern and lacking problems, through Pakistan economy may achieve wheat production self-sufficiency.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

All authors equally contributed in this research regarding the data collection, empirical analysis, and writing of the manuscript. Sania Shaheen conceived the study idea, reviewed the literature, collected data and completed the writeup of this research.

Lal K. Almas provided the technical support, model development, abstract, and suggested the policy recommendations. Muhammad Usman did the empirical analysis of this study.

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Appendix

A1. Bound Testing-Cointegration

Test -Stat	Value	Significance level	I(0)	I(1)
F-Stat	8.1186	10%	2.03	3.13
		5%	2.32	3.5
		2.5%	2.6	3.84
		1%	2.96	4.26

Fig. 1: Cummulative sum of recursive residuals (CUSUM)

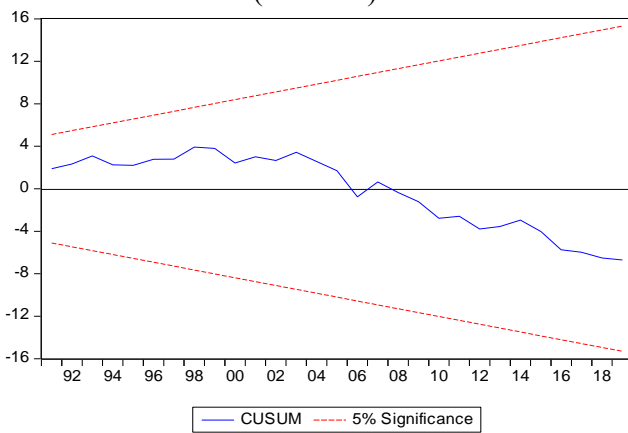


Fig. 2: Cummulative sum of square recursive residuals (CUSUMQ)

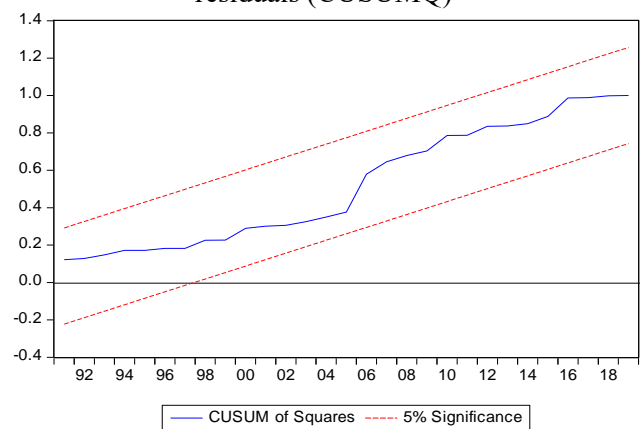


Fig. 3: Wheat Demand with growing Population Rate in Pakistan

