Using the ARDL-ECM approach to investigate the nexus between support price and wheat production

An empirical evidence from Pakistan

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Received 26 October 2018
Revised 11 February 2019
Accepted 1 March 2019

Abstract

Purpose – The purpose of this paper is to examine the effect of support price on wheat production in Pakistan during the period 1971–2016.

Design/methodology/approach – To capture the effect of support price on wheat production, the authors estimated the long-run linkage by using the ARDL bounds testing approach to cointegration.

Findings – This study confirmed the presence of a positive and long-term effect of area under cultivation, support price and fertilizer consumption on wheat production through ARDL bounds test. The results showed that both in the long run and short run, support price plays an important role in the enhancement of wheat production. The authors also found that the coefficients of the area under cultivation and fertilizer consumption variables were statistically significant and positive both in the long run and short run.

Originality/value – The use of the ARDL approach that examines the long-run and short-run effects of support price on wheat production in Pakistan makes the current study unique. An emerging economic literature suggests that only limited research has been conducted in this area.

Keywords Pakistan, ARDL, Support price, Wheat production

Paper type Research paper

1. Introduction

Agriculture sector has a dominant role in the economy of Pakistan and it directly supports the population of the country. It has about 26 percent contribution to the economic GDP. The arable land of Pakistan is about 22.45m hectares, out of which 6.34m hectares land is irrigated with canal water, about 12.52m hectares land is cultivated through tube wells and other water sources, and remaining 3.59m hectares is not associated with the water (GOP, 2013). Wheat is considered to be the main staple food in many countries including Pakistan as it is the important cereal crop and the sustainable production of wheat is the major concern of many countries (Rehman *et al.*, 2017a, b; Rehman, Jingdong, Kabir and Hussain, 2017). The Government of Pakistan is still paying attention to improve different varieties of wheat by providing the agricultural credit support to boost the production (Chandio and Jiang, 2018; Rehman *et al.*, 2017a, b; Rehman, Jingdong, Kabir and Hussain, 2017). Previous research on wheat crop in Pakistan has shown that the farmers are deliberate to introduce new varieties to

Journal of Asian Business and Economic Studies
Vol. 26 No. 1, 2019
pp. 139-152
Emerald Publishing Limited
2515-964X
DOI 10.1108/JABES-10-2018-0084

promote cultivation (Iqbal *et al.*, 2002; Chandio and Jiang, 2018). During 1997, about 1m hectares area was used for the production of wheat crop in the country, which is near about 51 percent of the entire wheat producing region (Smale *et al.*, 2002). Although the production of wheat has doubled in the past three years, the country has imported a huge quantity of wheat to meet its rapidly growing population needs. During 2007–2008, the country imported 8.5–15.9 percent wheat (Ahmad and Farooq, 2010). Wheat is the key food crop in Pakistan because it is widely used as a source of food in everyday life and also a low-cost source of animal feed (Chandio *et al.*, 2018). In the past several decades, the usage of pesticides and fertilizers has increased potentially, playing a chief role in many countries to boost the production of wheat. However, if the cultivated farmland meets the recent climatic potential, it can also boost the wheat production up to 70 percent, mainly through improved irrigation and fertilizer (Mueller *et al.*, 2012). Due to huge variations in the geographical conditions and under comparable climatic conditions, there are vast yield gaps in many countries, indicating inconsistent increase in wheat yield (Licker *et al.*, 2010; Liu *et al.*, 2007, 2013). In different arid regions, the rain water harvesting has been practiced successfully to collect to runoff water and transport it to planting areas (Qiang *et al.*, 2006). The adoption of suitable water harvesting techniques is required to boost production, and micro-basins can increase the efficiency of water (Zakaria *et al.*, 2012). When it is covered with the pliable, the wheat grain production increases by 87 percent (Yazdi *et al.*, 2011). Wheat is the major food source in Pakistan which is used daily. In Pakistan, a number of researchers such as Hussain *et al.* (2012), Buriro *et al.* (2013), Ahmad *et al.* (2015), Chandio *et al.* (2018) and Chandio and Jiang (2018) have examined the impact of credit on wheat productivity, technical efficiency of wheat and determinants of the adoption of improved wheat varieties. Thus, this empirical study differs from earlier studies by attempting to examine the effect of support price and non-price factors on wheat production in Pakistan over the period 1971–2016 by using the ARDL approach and to suggest policy guidelines for high wheat production in Pakistan.

2. Existing review of literature

The security of food is the major issue in today's world. United nation and other international organizations are very pessimistic about the current food situation in the world. The food situation is also serious in Pakistan. Wheat and other food prices rise steeply. In addition, the price rises in the energy, transportation costs, housing, health and education costs also have eroded this situation and made the lives of poorest segments of society unaffordable (Mahmood, 2008; Niaz, 2008). In the production of wheat crop, the water management strategy for the past five years has got the attention to increase the production rationalization of irrigation water. In the study of simulation, the water productivity and wheat crop have improved (Timsina *et al.*, 2008). The authorization of wheat support prices from the agencies is considered as legal in Pakistan. The major purpose of announcing support prices or property prices is to limit the price of bulk commodities so that they should not exceed the distributed support price levels. If the price exceeds this level, the government is prepared to buy goods that support the price. If the price is much higher than the target price, the growers sell their output on the open market (Farooq *et al.*, 2001; Schiff and Valdes, 1992; Thiele, 2003). Wheat is considered to be famous food crop in Pakistan. However, the invasion of weed is a major bottleneck in increasing wheat yield and accounts for more than 48 percent of potential wheat yield losses (Khan and Haq, 2002). Wheat yields may also vary among farmer farms with similar topographical characteristics and access to various input resources. The main differences in the management practices employed by these farms are considered to be the major source of variation in the productivity. Furthermore, it is necessary to identify the technical level of wheat farmers and to identify important factors for wheat production, as most of the farmers are poorly resourcedeither they do not have the right knowledge regarding production or cannot follow the production practices (Ahmad *et al.*, 2002; Hussain *et al.*, 2011). The yield losses are severe when the resources are limited and crops production occurs simultaneously (Shehzad *et al.*, 2013; Hussain *et al.*, 2015). The yield of crops decreases when weed competition increases, which results in strong struggle and competitive pressure on crops (Fahad *et al.*, 2014). The wheat crop which is considered the traditional crop is planted in the flat basin submerged in the irrigation water. However, such type of irrigation causes huge water losses. The losses caused by vanishing and deep seepage exacerbate severe water shortages, which contribute to further groundwater over-exploitation. In addition, different methods and techniques are necessary to boost the production of crops by employing agricultural technology (Rehman *et al.*, 2015, 2017a, b; Rehman, Jingdong, Kabir and Hussain, 2017). The rain water also plays a vital role in the production of food crops and about 80 percent of the world agricultural land is associated with it. The agricultural risk of rainwater feeding is higher on the land receiving rain. Rainfall in semi-arid areas is insufficient for cash crop growth. Therefore, when rainfall does not meet the crop's appropriate soil moisture conditions, supplemental irrigation is used (Oweis, 1999; Oweis and Hachum, 2009). The research by Chandio *et al.* (2018) on short-term loan and long-term loan revealed that short-term loans have high positive effects on wheat production in Pakistan. Similarly, Chandio and Jiang (2018) suggested that, among other considerations, formal education and farming experience of the heads of households, access to credit, extension contact, landholding size and tube-well ownership are the main determinants of the adoption of improved wheat varieties by wheat farmers in Sindh, Pakistan.

3. Data and methodology

3.1 Data description

The study uses time series data covering the period from 1971 to 2016. Annual time series data on wheat production in (000 tons), area under cultivation in (000 hectares), support price in (Pakistani rupees/40 Kg) and fertilizer consumption in (000 N/T) are sourced from the economic survey of Pakistan (various issues).

3.2 Empirical methodology

The objective of the study is to link wheat production controlling for the effect of support price, area under cultivation and fertilizer consumption. This association is given in the form of a long-linear empirical model that can be specified as:

$$\ln\mathrm{WP}_t = \alpha_0 + \alpha_1 \ln\mathrm{AR}_t + \alpha_2 \ln\mathrm{SP}_t + \alpha_3 \ln\mathrm{FER}_t + \varepsilon_t, \tag{1}$$

where ln represents the natural logarithm; WP denotes the wheat production; AR represents area under cultivation; SP represents support price; FER represents fertilizer consumption and ε_t is a standard error term. Following Nwani and Bassey Orie (2016) and Nwani *et al.* (2016), the present paper uses the ARDL approach proposed by Pesaran *et al.* (2001). The ARDL[1] approach provides some desirable advantages over the other traditional cointegration approaches like EG[2] and JJCA[3]. On the other hand, these cointegration approaches require that all variables be integrated into the same order. The ARDL test process provides effective results, whether the variables are integrated at *I*(0) or integrated at *I*(1) or mutually co-integrated (Pesaran *et al.*, 2001). A small size of observations and several order of integration of the study variables make ARDL the preferred method of this study. The equation of an ARDL model is specified as:

$$\Delta\ln\mathrm{WP}_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\Delta\ln\mathrm{WP}_{t-i} + \sum_{i=1}^{p} \beta_{2i}\Delta\ln\mathrm{AR}_{t-i} + \sum_{i=1}^{p} \beta_{3i}\Delta\ln\mathrm{SP}_{t-i} + \sum_{i=1}^{p} \beta_{4i}\Delta\ln\mathrm{FER}_{t-i}$$

$$+ \beta_5 \ln\mathrm{WP}_{t-1} + \beta_6 \ln\mathrm{AR}_{t-1} + \beta_7 \ln\mathrm{SP}_{t-1} + \beta_8 \ln\mathrm{FER}_{t-1} + \varepsilon_t, \tag{2}$$

where Δ denotes the difference operator. The test includes the F-test of the joint significance of the coefficient of lagged variables to verify that there is a long-term linkage among the variables. The null hypothesis of no long-term association existing among the variables (H_0: $\beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$) is tested following Pesaran *et al.* (2001). The decision of H_0 can be rejected or accepted is mostly based on the following conditions: If the value of F-test > upper critical bound (UCB), then reject H_0 and the variables of the study are co-integrated, if the value of F-test < lower critical bound (LCB), then accept H_0 and the variables of the present study are not co-integrated; however, if value of F-test ⩾ LCB and ⩽ UCB, then the decision is inconclusive. The error correction model (ECM) for the estimation of the short-run linkages can be formulated as follow:

$$\Delta \ln WP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta \ln WP_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta \ln AR_{t-i} + \sum_{i=1}^{p} \beta_{3i} \Delta \ln SP_{t-i} + \sum_{i=1}^{p} \beta_{4i} \Delta \ln FER_{t-i} + \alpha_1 ECT_{t-1} + \varepsilon_t. \quad (3)$$

The statistically significant and negative sign of ECM_{t-1} coefficient (α_1) implies that any long-run disequilibrium among dependent variables and a number of independent variables will converge back to the long-term equilibrium association.

4. Empirical results

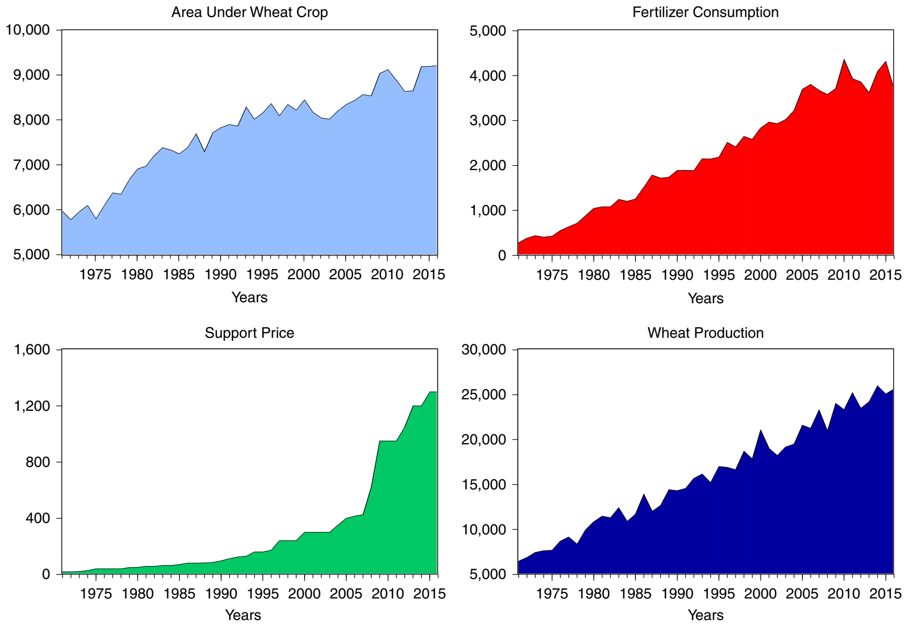
4.1 Descriptive statistics and correlation analysis

The descriptive statistics indicate that wheat production, area under cultivation, support price and fertilizer consumption are normally distributed, as indicated by Jarque–Bera statistics (see Table I). The pair-wise correlations analysis describes that area under cultivation, support price and fertilizer consumption are positively associated with wheat production. Area under cultivation and support price are positively correlated with fertilizer consumption. The positive correlation exists among support price and fertilizer consumption. Trend of the study variables is displayed in Figure 1.

	lnWP	lnAR	lnSP	lnFER
Mean	9.609112	8.947177	5.063261	7.476796
Median	9.675244	8.991450	4.975000	7.671923
Max.	10.16504	9.129564	7.170000	8.380227
Min.	8.775905	8.665113	2.900000	5.646153
SD	0.402775	0.134525	1.258271	0.762955
Skewness	−0.431861	−0.712168	0.153187	−0.816312
Kurtosis	2.092407	2.459323	1.970739	2.599246
Jarque–Bera	3.008669	4.448702	2.210384	5.416624
Probability	0.222165	0.108138	0.331147	0.066649
Sum	442.0191	411.5701	232.9100	343.9326
Sum SD	7.300243	0.814363	71.24601	26.19449
Observations	46	46	46	46
lnWP	1.0000			
lnAR	0.6753	1.0000		
lnSP	0.4674	0.3922	1.0000	
lnFER	0.3512	0.2831	0.1762	1.0000

Notes: max., maximum; min., minimum; sum SD, sum of SD

Table I. Summary of descriptive statistics and correlation matrix



Notes: Area under wheat crop is measured in (000 hectares); fertilizer consumption is measured in ("000" nutrient tonnes); support price of wheat crop is measured in (Rs per 40 kg) and wheat production is measured in (000 tonnes), respectively

Figure 1.
Trends of the variables

4.2 Unit root analysis

This study assesses the long-run linkage between area under cultivation, support price, fertilizer consumption and wheat production, before applying the ARDL (see Footnote 1) method; it is a pre-condition to find out the order of integration of the variables. The ARDL (see Footnote 1) approach can be valid if the series is stationary at $I(0)$ or $I(1)$ or $I(0)/I(1)$ i.e. integrating order of mixed. The most important assumption of the ARDL (see Footnote 1) method is that the series must be integrated at $I(0)$ or $I(1)$ if any variable of the study is integrated at $I(2)$, it is only then the F-test becomes invalid to take decision regarding the presence of long-run association. Therefore, in this study, we have used two unit root tests, i.e., ADF[4] and PP[5]. The results of the ADF and P–P unit root tests presented in Table I reveal that the variables of the study are stationary at different order; while lnWP and lnFER are integrated at level $I(0)$, other variables such as lnAR and lnSP are integrated $I(1)$ (Table II).

4.3 Lag length criteria

After checking the unit root test, the next stage is to use the ARDL (see Footnote 1) approach to check the long-term relationship between the series. It is necessary to choose the appropriate lag length before applying the ARDL bounds test. In addition, the choice of lag length should be exercised with caution, as inappropriate lag length can lead to biased results and cannot be accepted for policy analysis. Consequently, to confirm that the lag length is chosen appropriately, we use the AIC[6] to illustrate the relative lag length. The AIC (see Footnote 6) criterion gives robust results and has excellent performance compared to the SC[7] and HQ[8]. The results are presented in Table III. We determined that the lag 1 fits our sample size. Moreover, confirmation to choose the

Table II.
Results of unit root tests

Variables	ADF test (at level)		ADF test (at first difference)		P–P test (at level)		P–P test (at first difference)	
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend
lnWP	−2.463375	−4.017828***	−8.251481***	−8.870495***	−2.248176	−3.967858***	−11.71264***	−22.57660***
lnAR	−1.332634	−2.270279	−8.912218***	−9.043208***	−1.332634	−2.270279	−8.912218***	−9.043208***
lnSP	−0.438368	−2.584670	−5.905473***	−5.833560***	−0.395604	−2.604481	−6.370506***	−6.196696***
lnFER	−3.798497***	−2.204039	−6.350330***	−6.238104***	−11.09454***	−2.499489	−6.350913***	−7.963166***

Notes: **,***Mean the rejection of null hypothesis at 5 and 1 percent levels of significance, respectively appropriate lag length under the VAR approach has been determined in Figure 2, by showing the polynomial graph. In this graph, all the blue dots are inside the circle that confirms that at lag 1, estimations would be applicable to get good outcomes (Table II).

4.4 Bound test approach

This study used the AIC (see Footnote 6) to select the lag length for ARDL approach (proposed by Pesaran *et al.*, 2001; Narayan and Narayan, 2005). Our findings of the cointegration test based on the ARDL bounds testing approach are detailed in Table IV. Results reveal that the calculated F-statistics are 10.270, 4.985 and 5.813, which are greater than UCB at 1 and 5 percent of significance levels when wheat production, area and fertilizer consumption are used as dependent variables. The outcomes of bounds test conclude that there are three cointegrating vectors which validate the presence of long-run linkage between wheat production, area under cultivation and fertilizer consumption in Pakistan. In addition, this paper also used JJCA (see Footnote 3) to check the robustness of long-run association. Results in Table V show that there are two cointegration vectors among wheat production, area under cultivation, support price and fertilizer consumption, which confirm the robustness of long-run association.

4.5 Long-run and short-run analysis

This study confirmed the long-run cointegration among wheat production and its determinant when wheat production is used as the dependent variable. Here, the study has estimated both long-run and short-run elasticities using Equations (2) and (3). Table VI demonstrates the long-run and short-run results. For the long-run results (see Table VI, Panel A), all explanatory variables positively and significantly affected wheat production. In long run, the impact of area under cultivation on wheat production is

			VAR lag order selection criteria			
Lag	LogL	LR[a]	FPE[b]	AIC	SC	HQ
0	97.01182	na	2.06e-07	−4.043992	−3.884980	−3.984425
1	273.1569	313.9978*	1.96e-10*	−11.00682*	−10.21176*	−10.70899*
2	287.0438	22.33975	2.18e-10	−10.91495	−9.483837	−10.37885
3	298.8304	16.91119	2.73e-10	−10.73176	−8.664596	−9.957385
4	306.9667	10.25880	4.18e-10	−10.38986	−7.686646	−9.377217

Notes: [a]LR for sequential modified LR test statistic (each test at 5 percent level); [b]final prediction error (FPE). *Denotes the lag order selected by the criterion

Table III. Lag order selection

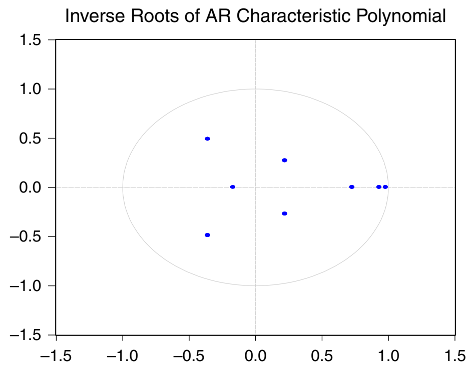


Figure 2. Optimal lag selection criteria under VAR model in polynomial graph

Table IV.
Results of ARDL cointegration test

Variable	LnWP	LnAR	LnSP	LnFER
Optimal lag structure	(1, 0, 0, 0)	(1, 0, 0, 0)	(1, 0, 0, 0)	(1, 0, 1, 0)
F-statistics	10.27062***	4.985628**	1.443394	5.813190***
Critical values (%)	1	5	10	
Lower bounds *I*(0)	4.29	3.23	2.72	
Upper bounds *I*(1)	5.61	4.35	3.77	
Diagnostic tests	Statistics	Statistics	Statistics	Statistics
R^2	0.500502	0.327235	0.647250	0.434619
Adj-R^2	0.451771	0.261599	0.276862	0.363946
F^2 statistics	10.2706***	4.9856***	0.2768 (0.1086)	6.1497***
χ^2 NORMAL	3.1647 (0.2054)	0.9235 (0.6301)	1.2705 (0.3298)	0.2116 (0.8995)
χ^2 SERIAL	0.6299 (0.6002)	0.2671 (0.7670)	1.8248 (0.1591)	0.2928 (0.7478)
χ^2 ARCH	0.0076 (0.9306)	0.2015 (0.8183)	1.7129 (0.1679)	0.0182 (0.8932)
χ^2 White	0.9985 (0.4193)	1.0487 (0.3940)	1.6472 (0.1260)	1.1996 (0.3238)
χ^2 RESET	0.4473 (0.5174)	1.1262 (0.2668)	0.6098 (0.5454)	0.6322 (0.5309)

Notes: **,***Denote the probability and the significant levels at 5 and 1 percent, respectively

Table V.
Results of Johansen cointegration test

Null hypo.	Trace test statistic	*p*-value	Null hypo.	Maximum eigenvalue	*p*-value
$r=0$	60.93311***	0.0019	$r=0$	28.37345**	0.0396
$r\leqslant 1$	32.55966**	0.0234	$r\leqslant 1$	23.42932**	0.0233
$r\leqslant 2$	9.130335	0.3535	$r\leqslant 2$	9.027878	0.2838
$r\leqslant 3$	0.102456	0.7489	$r\leqslant 3$	0.102456	0.7489

Notes: *r* represents the number of cointegrating equation. **,***Show the rejection of the null hypothesis at 5 and 1 percent levels of significance, respectively

Table VI.
Results of long-run and short-run coefficients employing the ARDL approach

	Dependent variable is lnWP: ARDL (1, 0, 0, 0) selected based on AIC			
Variable	Coefficient	SE	*T*-ratio	*p*-value
Panel A: long-run estimation				
lnAR	0.786398***	0.247725	3.174481	0.0028
lnSP	0.121680***	0.015432	7.884982	0.0000
lnFER	0.192283***	0.045670	4.210272	0.0001
C	0.658034	1.947773	0.337839	0.7372
Panel B: short-run estimation				
ΔlnAR	0.877174***	0.296747	2.955963	0.0051
ΔlnSP	0.135726***	0.023975	5.661246	0.0000
ΔlnFER	0.214479***	0.054957	3.902636	0.0003
ECM (−1)	−1.115432***	0.126128	−8.843661	0.0000
Panel C: residual diagnostic tests				
R^2	0.985502			
Adjusted R^2	0.984088			
Durbin–Watson stat	1.863229			
F-statistic	12.1708***			
χ^2 SERIAL	0.2058 (0.8148)			
χ^2 NORMAL	3.1647 (0.2054)			
χ^2 ARCH	0.0502 (0.9511)			
χ^2 White	0.7241 (0.7268)			
χ^2 RESET	0.6688 (0.5074)			

Note: ***Significant at 1 percent

positive and highly significant. A 1 percent increase in area under cultivation will boost wheat production by 0.78 percent. Likewise, the support price is positively and significantly associated with wheat production. It is found that 1 percent increase in support price will cause 0.12 percent wheat production increase. Similarly, wheat production will enhance by 0.19 percent due to a 1 percent increase in fertilizer consumption. The short-run results (see Table VI, Panel B) indicate a positive and highly significant effect of area under cultivation on wheat production. It is noted that a 1 percent increase in area under cultivation raises 0.87 percent wheat production. Meanwhile, in short-run estimation, the effect of support price on wheat production is positive and highly significant. The result reveals 0.13 percent of wheat production boost due to 1 percent increase in support price. The short-run coefficient of fertilizer consumption indicates that fertilizer consumption has a significant and positive effect on wheat production. A 1 percent increase in fertilizer consumption enhances wheat production by 0.21 percent. The empirical findings of this paper are contradicted with the results carried out in most of the previous studies such as Bashir *et al.* (2010), Buriro *et al.* (2015), Chandio *et al.* (2016, 2018). Most of these studies in the past used primary data and OLS regression approach was adopted to analyze the data; however, this empirical paper used annual time series data over the period 1971–2016 and followed ARDL approach to cointegration in order to examine the short- and long-run association in the model with desired variables. The values of R^2 and adjusted R^2 were estimated to be 98 percent, which confirms that the model is strongly good fitted. The calculated F-statistic is 12.1708. The error correction term (ECT_{t-1}) is negative and statistically significant at 1 percent significance level along with a high coefficient, which reveal that the disequilibrium can be adjusted to the long-run with higher speed, having any prior-year shock in the explanatory variables. In earlier studies (for instance, Narayan and Narayan, 2005; Qamruzzaman and Jianguo, 2017; Paul, 2014), we performed a model stability test through several diagnostic tests including Jarque–Bera normality test, LM serial correlation test, white heteroskedasticity, autoregressive conditional heteroskedasticity test, Ramsey Reset test, respectively. The results are shown in Table VI (Panel C). The empirical findings of this study reveal that the ARDL model has passed all the diagnostic tests successfully. Meanwhile, this study has conducted two stability tests such as CUSUM[9] and CUSUMSQ[10] to investigate the stability of long- and short-run parameters. These stability tests have been suggested by Pesaran and Shin (1999). The graphs of both stability tests presented in Figures 3 and 4 identify that plots for both stability tests are between critical boundaries

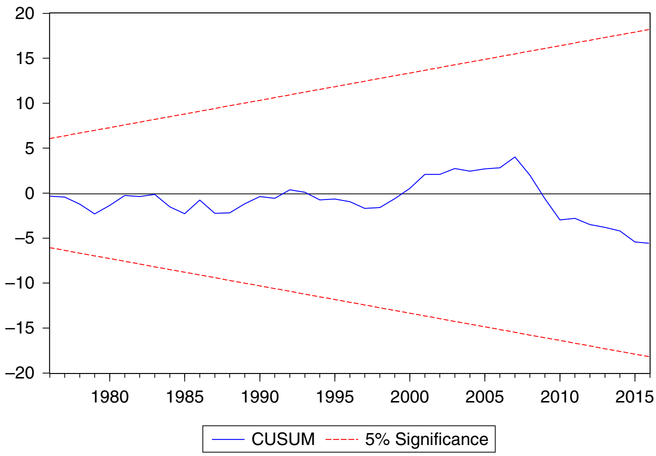


Figure 3.
Plot of cumulative sum of recursive residuals

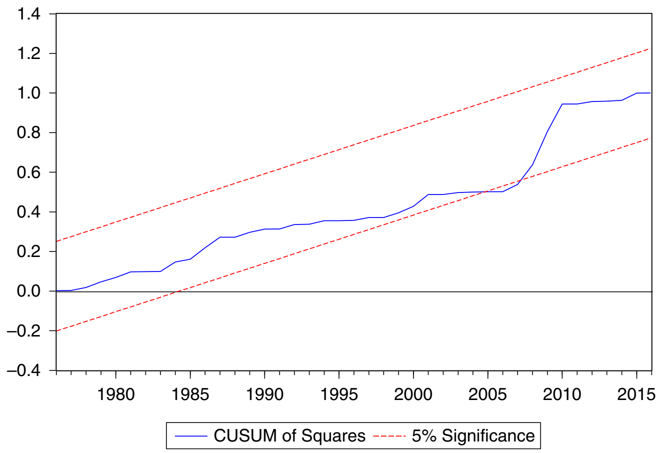


Figure 4.
Plot of cumulative sum of squares of recursive residuals

at 5 percent level of significance. This confirmed the accuracy of long-run and short-run parameters which have impact on wheat production over the period 1971–2016.

The outcomes of correlogram statistics indicated and confirmed that there is no autocorrelation and partial correlation in the ARDL model, as the Q-Stat remains statistically insignificant at 1 and 5 percent of significance levels (see Table VII).

5. Conclusions

This study examined the long-run and short-run effect of support price on wheat production in Pakistan over the period 1971–2016 by using the ARDL approach proposed by Pesaran *et al.* (2001). The order of integration of the study variables is tested by employing ADF and PP unit root tests. The outcomes reveal that the calculated *F*-tests in the ARDL bounds

Autocorrelation	Partial correlation	Lags	AC	PAC	Q-stat	Prob.
. I . I	. I . I	1	0.027	0.027	0.0352	0.851
.*I . I	.*I . I	2	−0.101	−0.102	0.5386	0.764
. I . I	. I . I	3	0.045	0.051	0.6403	0.887
.*I . I	.*I . I	4	−0.079	−0.094	0.9638	0.915
.*I . I	.*I . I	5	−0.095	−0.081	1.4459	0.919
. I*. I	. I*. I	6	0.158	0.148	2.8027	0.833
. I*. I	. I*. I	7	0.097	0.079	3.3260	0.853
.*I . I	.*I . I	8	−0.128	−0.109	4.2662	0.832
. I*. I	. I*. I	9	0.183	0.193	6.2231	0.717
.*I . I	.*I . I	10	−0.094	−0.137	6.7563	0.748
.*I . I	. I . I	11	−0.135	−0.045	7.8877	0.723
. I . I	. I . I	12	−0.010	−0.059	7.8942	0.793
.*I . I	**I . I	13	−0.178	−0.233	9.9947	0.694
.*I . I	. I . I	14	−0.103	−0.044	10.715	0.708
. I . I	.*I . I	15	−0.050	−0.165	10.892	0.760
.*I . I	.*I . I	16	−0.082	−0.154	11.378	0.786
.*I . I	. I . I	17	−0.076	−0.025	11.817	0.811
. I . I	.*I . I	18	0.042	−0.081	11.957	0.849
. I . I	. I . I	19	0.010	0.066	11.965	0.887
.*I . I	.*I . I	20	−0.192	−0.181	15.076	0.772

Table VII.
Outcomes of correlogram statistics

testing approach to cointegration were greater than UCB at 1 and 5 percent of significance levels, as adopted from Pesaran *et al.* (2001). Consequently, this empirical study concludes that all explanatory variables stimulate wheat production in the long run. This study also observed that the elasticities of area under cultivation, support price and fertilizer consumption toward wheat production were positively and statistically significant influenced in both the long-run and the short-run periods. Furthermore, through timely announcement of support price, being minimum guaranteed price sustained for wheat before the beginning of planting season, one can ensure that the production of wheat can be obtained in order to meet the increasing demand of the consumers at different levels like local, national and international.

Notes

1. The autoregressive distributed lag (ARDL) bounds testing approach of cointegration.
2. See Engle and Granger's (1987) cointegration approach.
3. See Johansen and Juselius's (1990) cointegration approach.
4. See augmented Dickey and Fuller (1979).
5. See Phillips and Perron (1988).
6. Akaike information criterion (AIC).
7. Schwarz information criterion (SC).
8. Hannan–Quinn information criterion (HQ).
9. CUSUM the cumulative sum recursive residuals.
10. CUSUMSQ the cumulative of square of recursive residuals.

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