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Does Support Price Policy Drive Yield Rate? An Econometric Investigation of Wheat and Sugarcane Crops in Pakistan

Maryam Ishaq[1], Ismat Nasim[2], Atiq ur Rehman[3]

[1] Department of Economics, The University of Lahore, Lahore, Pakistan. Email: maryam.ishaq@econ.uol.edu.pk
[2] Lecturer, Department of Economics, The Government Sadiq College Women University, Bahawalpur, Pakistan. Email: ismat.nasim@gscwu.edu.pk
[3] Regional Business Head, United Bank Limited, Pakistan. Email: atiqrehman.pk86@gmail.com

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ABSTRACT

The governments of developing economies incentivize the cultivators of their most strategic crops by offering them minimum support price for their yield. This study aims at identifying distinctively the short-run dynamics and the long-run causal linkage of support price and yield rates for two major food crops of the country; wheat and sugarcane. Employing advance time-series econometric estimators of Error Correction Model (ECM) and Fully Modified OLS (FMOLS) cointegration regression, results indicate the valid existence of hypothesized relationship over both short and longer time horizons. Each year, the short-term divergence of two crop yields from their long-run equilibrium paths turns out to be corrected with high speed of adjustment. The long-run association between two variables is also found evident with decent magnitude and high degree of statistical significance. These findings favour the use of support prices as a long-term policy tool for encouraging cultivation of wheat and sugarcane crops in country. However, the overall welfare consequences of such a policy should never be over-rated in a society like Pakistan which is largely characterized by horrific levels of corruption and innumerable administrative bottlenecks.

Corresponding Author's Email: ismat.nasim@gscwu.edu.pk

1. Introduction

Wheat and sugarcane are two major food crops of Pakistan. The two crops hold their individual strategic importance in country's domestic consumption and international trading patterns. Punjab and Sindh, two of the most densely populated provinces of the country with largest areas of agricultural land are the key contributors to the annual yield of two crops. Wheat is grown over 76 percent of the total agricultural land in Punjab and contributes a share of 77 percent (approximately) in total agricultural production of the country (19.28 million tons)[1]. Approximately, 80 percent of the rural population depend for their incomes on agricultural sector and direct or indirectly earn their livelihood from wheat production and other associated industries[2]. After wheat, sugar is the second largest agro-industry in Pakistan. A number of 72 sugar mills are operational in various parts of the country, giving a contribution of 4.2 percent in total manufacturing of the country. In year 2019, the sugarcane crop gave rise to export revenue amounting $342 million that 1.45 percent (approximately) of total export earnings of the country[3]. Government of Pakistan has long intervened in the wheat and sugar sectors of the country, the two being largest contributors to agricultural and manufacturing output, employment, rural income, and overall GDP of the country.

The key objective behind such an intervention is twofold; (a) to ensure consumer affordability by maintaining the local prices of two crops below the import parity price, and (b)

[1] Statistics are taken from Statistical Year Book of Pakistan (2020-21).
[2] Statistics are taken from the official website of Trade Development Authority of Pakistan .
[3] Statistics are taken from the official website of Trade Development Authority of Pakistan .

to safeguard producers' interest by preventing them from unnecessary and unforeseen market price fluctuations and in the form of guaranteeing them Minimum Support Price (MSP). Such policy actions from government have contributed proven success in optimizing market prices and annual yield of two crops. Nevertheless, such policies do not come without economic costs since they serve as one of the most critical sources of distortions to market signals which are seriously followed by famers and the traders from private sector, thus determining their immediate production responses and their future course of action (Faruqee et al., 1997). It is unanimously agreed between policy makers that it is undesirable to maintain the market prices of food crops artificially low. Unless a modest price stabilization mechanism is set in place, it is also not advisable to allow operating crop markets at liberal (natural) market mechanisms.

This is because such liberalization may have a variety of economic and political aftermaths, particularly in the form of instable (hyper) market prices, hoarding or low output levels, and even phasing out of government (partial or complete) intervention in the procurement and marketing of major food and non-food crops of the country. At provincial level, the price support policy in Pakistan is implemented through Provincial Food Departments (PFDs). Provincial governments in collaboration with federal government assume the duty of determining support prices (at annual basis) and also make necessary arrangements for crop procurement (wheat in particular). Talking about wheat, at federal level, it is procured through Pakistan Agricultural Storage and Services Corporation (PASSCO). Maintaining stocks of major crops and addressing food security concerns are also amongst the major reasons why the government intervene (Khan, Ahmad, & Rasheed, 2003).

The present study assumes a meaningful association between support price and the yield performance of two major food crops (wheat and sugarcane) in Pakistan. It is undeniable fact that the yield rates of all the major crops of the country are significantly characterized by structural breaks. It is thus important to investigate and recognize the hypothesized relationship between the support price and the yield rates at both shorter and longer time horizons. The key objective of holding this research is therefore two fold (a) to examine the short-run dynamics of the proposed relationship between support price and the yield rates under the belief that significant breaks points are present in our sample data set, and (b) to see if there exists a long-run causal association between two variables. Examining the proposed relationship may uncover some very interesting facts about the nature of association between support price and the crop production across different time horizons, therefore, bearing strong implications for policy makers and several of the government food security and procurement institutions.

The forthcoming sections of the study are organized as follows: Section 2 of the paper gives a detailed review of the historical trends of support price and yield performance of wheat and sugarcane crops in the past few years. Section 3 gives review of earlier research on this subject from distant and recent past. Evidence is majorly sought from research conducted on major food crops receiving public support in Pakistan and India. Section 4 lays down the methodology for empirically estimating our subject relationship between support prices of wheat and sugarcane and their annual yield performance. Section 5 presents results and the associated discussion on the econometric investigation conducted in preceding section. And finally, Section 6 of the paper presents the concluding remarks and the implications of support price policy as a public policy tool in Pakistan.

2. Support Price Changes and Yield Performance of Wheat and Sugarcane - An Overview from the Recent Past

Starting from the third quarter of year 2018, Pakistan's economy is faced with some major challenges. In August 2018, General elections were held in the country and Pakistan Tehreek e Insaaf came into rule. Soon after taking charge, the new government introduced a variety of institutional reforms. Escalating prices, particularly food prices, was a major challenge faced by government; however, no concrete policy could be devised for combatting this issue. As a consequence, food prices started inflating in an unleashed manner, thus, constituting a major share of rising cost of living in the country. While the new government was struggling against various odds, the eruption of Covid-19 added fuel to the fire. Production of food crops doesn't receive much of the effects of the lockdown series since, the rural areas remained less affected (relatively) by partial and/or complete lockdown imposed by provincial and federal governments of the country, Nevertheless, all the major channels of distribution and the access to consumer

markets remained significantly disrupted which caused serious shortage of food items at all the retail points of the country.

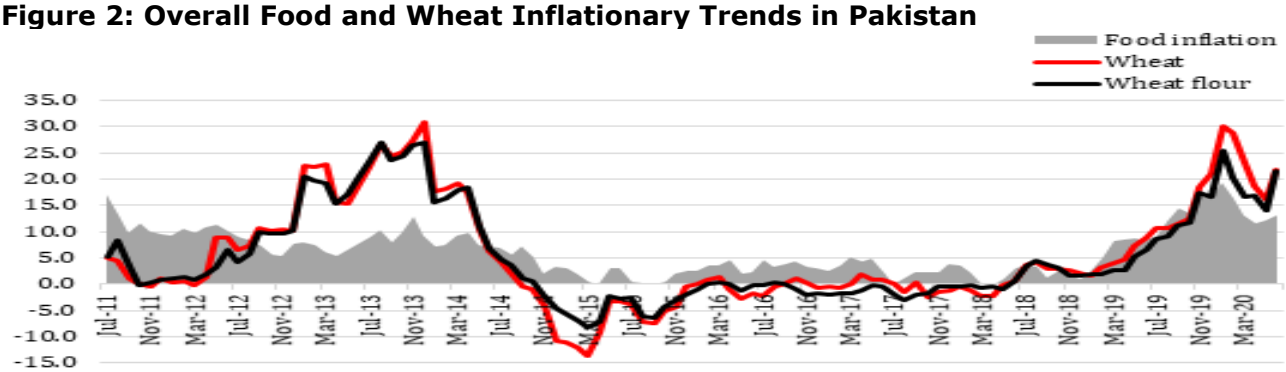
Figure 1: Food and Headline Inflationary Trends in Pakistan

Source: Estimates from Pakistan Institute of Development Economics (PIDE)

The administrative mismanagement and lacking governance called for a more effective role of policy making around price determination and supply of major food grains of the country. On the front of wheat crop, to ensure its smooth procurement and unhindered supply and for incentivizing wheat producers, the institution of Agricultural Storage and Services Corporation (PASSCO) is responsible for procuring wheat on Minimum Support Price (MSP). Evaluating against the situation of wheat supply in the country (excess or shortage), MSP is determined by Economic Coordination Committee (ECC) of the federal government which ensures farmers to receive fair price of their yield and helps them to decide their production plans in the years to come. Keeping in view the rising cost of production of major food crops in the country (particularly in the form of power supplies, seeds and fertilizers and agricultural machinery) the Ministry of National Food Security and Research is constantly trying to convince federal government to give modest rise to MSP of wheat. In response to this advice, the ECC has raised MSP for wheat by 38% since year 2019 till year 2020-21. The support price for wheat which was PKR 1300/40 kg during the year 2018-19 jacked up to PKR 1800/40 kg by 2020-21. A rise of another 13% was suggested by ECC during the first quarter of the year 2022 which gave another big push to MSP upward thus bringing the wheat support price to its historical levels of PKR 2200/40 kg.

For last one decade, it is evidently seen that wheat and wheat flour (the staple food item of Pakistan) has been the chief contributor to the food inflation prevailing in the country. In FIGURE 2, at the outset, it can be seen that wheat inflation is serving as the main driver of food inflation in the country. However, research evidence on this association suggests otherwise. Research has shown that the plausible association between food prices and overall inflation level of the country is rather weak (Jalil, Zulfiqar, Anwar, Iqbal, & Khan, 2023; J. Parikh & Singh, 2007). Jalil et al. (2023) estimate the correlation coefficients for association between food inflation in Pakistan against support price of wheat and its retail price. Their findings strongly suggest that the correlation between retail price of wheat and food inflation is way higher than the one existing between wheat MSP and food inflation.

Figure 2: Overall Food and Wheat Inflationary Trends in Pakistan



Source: Estimates from Pakistan Institute of Development Economics (PIDE

Despite of rising wheat support price at a very fast past, government of Pakistan has gained no substantial success in incentivizing farmers for increasing wheat production volumes. Intense inflation prevailing in the country has led to sharp increase in the purchase price of inputs. Owing to its strategic importance, government of Pakistan exercises heavy intervention in all major wheat markets of the country. Resultantly, retail price of wheat and that of wheat flour grows at a less sharp rate, relative to other crops of the country which are subject to lower degree of government control. Consequently, the farmers have now started seeing the crop rather less profitable. The cost of wheat production is rising at a much faster pace than the growth in wheat MSP offered by government. This has led to a decline in farmers' profitability by 17 percent in a period of just three years (from 2017 to 2020). The declining trends in profitability from wheat production is preventing farmers from expanding wheat cultivation in future, thus, further widening the gap between demand and supply of wheat and wheat flour in the country.

Table 1: Cost-Benefit Analysis of Wheat (Rs./40 Kg)

Year	2018-19	2019-20	2020-21	% increase in 2019-20 (with base 2017-18)	% increase in 2020-21 (with base 2017 18)
Cost of Production	985	1046 (6.2)[4]	1242 (18.7)	19.7	42.1
Farm Gate Prices	1300	1400 (7.7)	1650 (17.9)	7.7	26.9
Profit	315	354 (12.4)	408 (15.3)	-17	-4.2

Source: Statistical Year Book of Pakistan (various years)

The state of sugarcane crop is no different from that of wheat. Pakistan is 7th largest sugar producer and exporter worldwide. Globally, the country is the 8th largest consumer of sugar. The country has started producing surplus sugar since year 2010-11. However, from year 2020, the country is into a state of sugar crisis which sharply has exacerbated its market price since then. The price of sugar in the country has been highly volatile since 2018. This is primarily because of immense gaps of supply and demand of sugar and various types of market inefficiencies, including hoarding by sugar mill owners and private stockists. The burden of such imbalances and inefficiencies are directly born by consumers and government of Pakistan has shown grave concerns on such state of affairs. As a remedy, federal government of the country has taken some serious steps towards betterment of the situation in the form of support price, ceiling, subsidy, etc. but nothing could work unfortunately.

The province of Punjab in the country serves as the largest contributor to sugarcane production (more than 64 percent). It is a widespread belief that cotton production in Punjab is largely superseded by sugarcane production. In general, such a claim is not true, as revealed by statistics. However, the figures from southern parts of the province seem somehow compatible with such a claim. For other parts of the province (central, western and northern Punjab), the area under cultivation for both cotton and sugarcane is largely taken over by rice and maize production. The primary reason behind cotton rapidly losing its cultivation areas is the low productivity and the profitability of the crop, relative to other competing crops.

Table 2: Profit (Rs/Acre) Wheat and Sugarcane

Crop	Profit (Rs/Acre) 2017-18	2018-19	2019-20	Yield (40 Kg/Acre) (2019-20)	Increase in Profit (Rs/Acre) in 2019-20 with base 2017-18	% change in profit in 2018-19 with base 2017-18	% change in 2019-20 with base 2017 -18
Wheat	13206	9765	10974	31	-2232	-26	-17
Sugarcane	35,280	30,870	35,280	630	0	-13	0

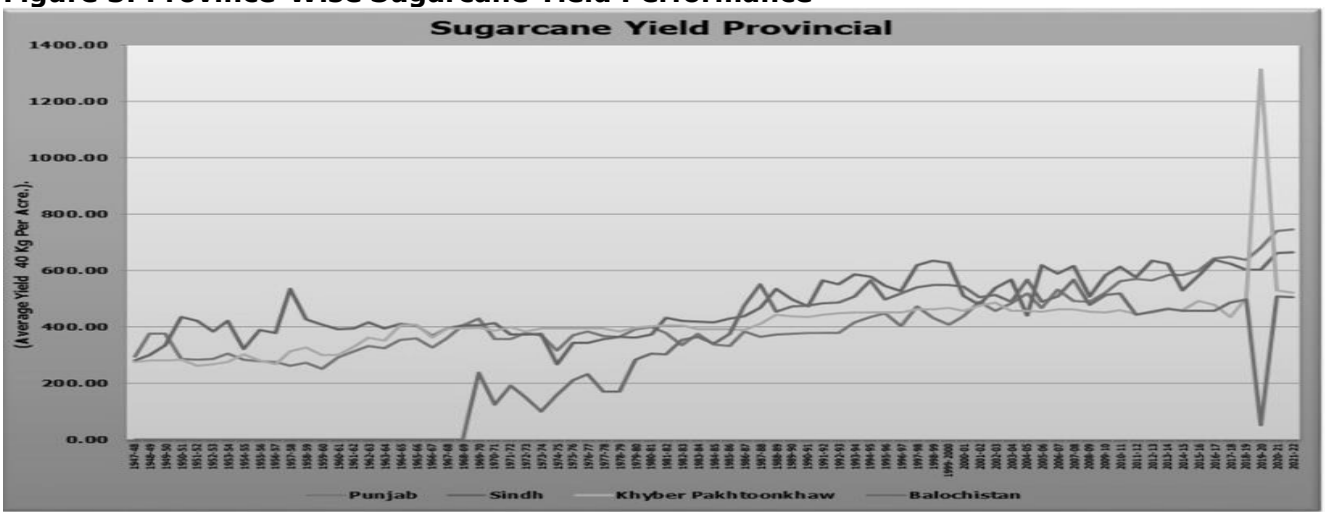
Source: Statistical Year Book of Pakistan (various years)

The growing inclination of farmers towards sugarcane cultivation in Southern Punjab is well explained by sucrose recovery levels. Sugar mills as a consequence therefore encourage cultivators to grow more of sugarcane than other crops which may expand their crushing capacities at overwhelming rates. Looking at the significance of support price of sugarcane, unlike wheat, the profitability of sugarcane production does not seem to be driven by its support price at the outset. Such a belief is largely backed by the fact that government is in no way involved

[4] The growth rates relative to immediate previous year are given in parenthesis.

in the procurement of sugarcane (unlike the case of wheat), this impairs it to implement support price at farm gate level.

Figure 3: Province-Wise Sugarcane Yield Performance



Source: Agriculture Marketing Information Service (AMIS), Pakistan

This is in contrast with the case of wheat in the country where more than 60 percent of production is procured and distributed by government (through PASSCO), thus, facilitating to exercise support price at farm gate level. It is therefore generally believed that the areas of Punjab, where sugarcane production seems to be growing at the expenses of cotton production, such a trend is not support by rising support price of sugarcane.

3. Literature Review

Looking back at the earlier literature on the plausible linkage between support price and agricultural yield, the empirical evidence for less developed countries (LDCs) support the notion. A vast strand of literature has pointed out the lack of financial support extended by governments of LDCs and the consequent low annual yields of various crops. The studies also have emphatically raised the significance of support price policies in motivating cultivators to expand their future production volumes (Hayami & Ruttan, 1971; Johnson, 1975; Peterson, 1979; Schuh, 1975; Schultz, 1968). The causal linkage between the support price and the crop production volumes for Pakistan is less often studied however. The findings on the subject for country are rather mixed, nevertheless, majority of the research endorse a positive long-run supply response towards support price. However, there exists a clear-cut differentiation between short-run causal effects of support price and yield and the ones existing in longer-run. This section of the paper will therefore pay more attention to the studies who have empirically investigated this linkage over both shorter and longer time horizons individually.Starting with the most recent research, Chandio, Jiang, and Rehman (2019) confirm the existence of valid short- and long-run effects of support price on wheat production in Pakistan. Using time-series data sets, the study establishes the short- and long-run dynamics of wheat production in the country against its support price, area under wheat cultivation and fertilizer consumption for wheat production purpose. In addition to support price series, sizeable long-run coefficients are also obtained on part of area under wheat cultivation and fertilizer consumption. In another research, studying the impact of price- and non-price factors on rice and wheat crops,

Niamatullah, Zaman, and Khan (2010) estimate the significance of support price (the price factor) and fertilizer offtake (non-price factor) for rice production and wheat acreage trends in North Western Frontier Province (the now Khyber Pakhtukhan province) of Pakistan. Results of the study strongly advocate the inter-relationship of rice production against both its support price and fertilizer offtake with high statistical significance. The results hold valid both for shorter- and longer run, yielding sizeable response elasticities across both time horizons. For wheat acreage, the effects of support price do not turn out to be substantial, however, the acreage trends are found to be highly sensitive towards fertilizer offtake. The study also emphasizes that the real usefulness of support prices should never be gauged in isolation, since, its fiscal side is as important to study as its other aspects. In this context, a very comprehensive analysis is conducted by Shahzad, Razzaq, and Qing (2019). The study takes into account the financial aspects of wheat support policy of Pakistan and reveals that the current policy is significantly

conducive for wheat production in the country. The country's cost of production for wheat is way higher than that of its neighbour state India. Therefore, to maintain the profits of cultivators, the government of Pakistan is bound to offer higher support prices to farmers with sharp growth rates in each subsequent year. However, at the same time, it is placing overwhelming burden on country's public expenditure. The continuous rise in the market price of wheat and wheat flour has severely affected the consumers also and has caused serious damage to its competitiveness in the world market. The study suggests redistribution or rerouting of government spending on wheat in a different way. Efforts should be made towards cutting down the input cost of wheat production, therefore, inputs (fertilizers and seeds in particular) should be subsidised. To lower down the production cost, subsidy should be given on inputs rather than wheat procurement which will prevent government in future to make hefty spending in the name of wheat support pricing. Similar type of suggestions is raised by Ahmad (2009) while conducting a critical review around the state of food security in Pakistan. Through descriptive statistics, the author indicates that since the year 190-91, the increase in the support price of wheat has been to the tune of 458 percent in comparison to wheat production which has risen just by 51.7 percent during this period. These statistics yield no significant support in favour of any valid long-run association existing between support price of wheat and growth in its annual yield. Rise in support price as a policy tool thus seem to be of less efficacy for incentivizing wheat cultivators. The study strongly recommends the use of government funds in in a more thoughtful way. This may include subsidizing wheat production inputs like fertilizers, technology, seeds, etc., so that the funds which either are spent lavishly in the name of support price or import of wheat could be brought into more rewarding purpose.

A considerable body of works is available that addresses varying aspects of MSP policy in the context of Indian agriculture sector. Following are the research works that stand out as most relevant in this regard. A pioneering study in this context is conducted by K. S. Parikh, Ganesh-Kumar, and Darbha (2003). The author holds rise in MSP primarily responsible for decline in both agricultural and non-agricultural GDP of India. Subsequently, this had led to a decline in total GDP of the country too-A fact that owes to the rising inflationary trends and falling investment levels in the agriculture sector. This in turn adversely affects the overall state of the Indian economy. In a 2007 Planning Commission report, on the impact of rising MSP, J. Parikh and Singh (2007) address the relevant fiscal policy aspects for rice and wheat in various states of India. The results turned out to be quite different from the ones reported by K. S. Parikh et al. (2003) proving a substantial fall in consumers' aggregate expenditure on consumption of rice owing to expanding proportion of subsides on PDS (Public Distribution System) rice. The report shows an increase in the aggregate consumer expenditure on rice to a small margin which is the result of an increase in the effective price of wheat. Not only this, but there is a rise in the incomes of both rice and wheat producers due to continuous growth in MSP. This owes to the increased rates of realized effective price (a blend of procurement and market prices) thus showing clearly positive impact on the production on wheat and rice as the MSP rises. On the whole, the report recommends the extension of procurement system by three to four folds which were to be supported by fiscal policies to carry out the procurement operations effectively. The adverse effects of support price are also identified by Jha and Srinivasan (2006).

Similar to K. S. Parikh et al. (2003), the authors are also of the view that brining down MSP gradually may have several positive implications. According to them, in a decentralized system, the purchase of PDS requirements involves substantial cost being bought in open market. Resultantly, the cost of operating PDS rises. If the state policies favour reduction in support price, such costs tend to lower down which will consequently bring down the market price of wheat. Hence, a substantial rise in wheat consumption will be observed across all income groups and consumer welfare will improve at the end. Chand (2003) studied the effects of support price on the yield performance of various crops in India and found that the efficacy of support price policy tends to favour selective crops. The study also highlighted the usefulness of support price policy by stating that the food policy centred on support price policy has safeguarded the interests and the profitability of farmers' community in a very proficient way. The disproportionate usefulness of rice support policy for various states of India is also observed by Ali, Sidhu, and Vatta (2012). The study evidently finds that the support price of rice holds strong positive implications for surplus-producing provinces of the country that is Punjab and Adhra Pradesh. On the other hand, for the states of the country lagging in rice production, the support policy does not show any significant ability of incentivizing rice cultivators. In a recent study, Aditya et al. (2017) estimates

the linkage between the cultivators' awareness about the significance and usefulness of support price with the diversification of popular crops in India. The results of the study make astonishing revelations. For the crops grown in rabi and kharif seasons, only 23.72% and 20.04% of farmers, respectively, in the rural areas of India know about the support price of the crop they are sowing. Another interesting revelation made by the study is that the awareness about the support price does not play much significant role in motivating farmers to specialize in cropping. The study strongly recommends that to realize the fruits of support prices for various crops in the country, an effective and efficient procurement system is needed to be put in place besides creating country-wide awareness about the significance of support price amongst farmers.

Summarizing the insight acquired from reviewing earlier works, it is difficult to produce a single verdict on the usefulness of support price as an incentive for farmers. Results produced by various researches are yielding mixed findings. A key finding from this revisit of literature points to the fact that though the support price in Pakistan is found to be significantly driving wheat yield trends, nevertheless, there are some other factors in operation which are giving significant contribution (in conjunction with support price) in materializing the positive effects of support price towards crop performance in the country. This includes the area under cultivation and fertilizers use. In contrast, another strand of literature contest the positive implications of support price by stating that such a policy is adding burden to public spending, affecting the consumer welfare and lowering down the competitiveness of Pakistani crop in international grain markets. Such disadvantages owe to the rise in support price which is giving a constant upward push to the market price of the crop with every passing year. Through research, recommendations are also raised for re-routing the amounts of public funds spent on support price towards subsidizing production inputs (technology, seeds and fertilizers in particular), so that the welfare gains of public spending on agriculture sector could be more evenly distributed to both cultivators and consumers. Keeping in view the indecisiveness and the lack of statistical support on the real usefulness of support price, the forthcoming section of the paper will employ modern econometric procedures to validate (invalidate) the proposed relationship between support price and the growth performance of crop yield. Using annual time-series sample data sets, the analysis is conducted for two major crops of Pakistan; wheat and sugarcane; the two crops directly or indirectly raising significant contributions to country's agriculture sector GDP.

4. Empirical Methodology

In econometric literature, a variety of empirical procedures are devised for estimating short- and long-run causal relationship between time-variant data series. The family of residual-based cointegration testing procedures are most popular of all, offering ease of computation as well as decently relatable interpretations in terms of economic theory. The residual-based cointegration testing methods suggest that two or more non-stationary data series may (plausibly) establish some meaningful and intuitively correct relationship. Such an association prevents regression errors from growing further in long-run. Amongst the family of residual based cointegration estimators, the Error Correction Models (ECM) have received enormous popularity. For investigating the short-run dynamics of yield and support price linkage, the study follows the two-step error correction method proposed by Gregory & Hansen (Gregory & Hansen, 1996a, 1996b). The type of Error Correction Models (ECMs) rest on the behavioral assumption that two or more time-series may demonstrate a dynamic short-run relationship which may lead to long-run equilibrium. The transient disequilibrium is captured by the inclusion of a disequilibrium term in the ECM which picks up the extent of departure of the model time series from their long-run equilibrium. When that happens, and assuming the variables are cointegrated, one or both of the variables will adjust to restore the equilibrium.As said earlier, the relationship between fluctuations in support price and the crop yield can be modeled through error correction representation under two distinct steps.

$$yield_{it} = \alpha + \beta sp_{it} + \varepsilon_t \quad (1$$

Where i = wheat and sugarcane and t = is the time subscript.

The first step of error correction modeling involves estimating the residuals $\varepsilon_t = yield_{it} - \alpha - \beta sp_{it}$ from a static regression stated in equation (1) above. The second step involves modelling the residual series under error correction representation by formulating an autoregressive function of yield and sp as follows:

$$\Delta yield_{it} = \gamma + \rho\varepsilon_{t-1} + \sum_{i=1}^{k} \mu_i \Delta yield_{it-k} + \sum_{i=1}^{k} \lambda_i \Delta sp_{it-k} + \nu_t \quad (2$$

In a situation where residuals (ε_(t-1) term) exhibits mean reversion, the yield and sp series will be concluded as cointegrated in long-run, otherwise not. ECM's tendency of reflecting cointegration between two or more time-series owes to the phenomenon of Granger representation theorem. According to this, a statistically significant error correction representation may occur between two or more time-series (only) in the instance of their significant cointegrating relationship. Such a belief holds strong implications for valid long-run co-movement between two or more time-series suggesting that a statistically significant error correction coefficient can be taken as evidence in support of valid cointegration between our two model variables i.e. yield and sp. The residuals obtained in step one of ECM are the representative of the misalignments or disequilibrium in the system and tells us the magnitude of short-lived fluctuations (disequilibrium) in yield variable from its long-run equilibrium. Having a negative and statistically significant error correction (EC) term (EC Coefficient= ρ,ρ<0) indicates the valid error correction process in place i.e. sufficient periodic adjustments are made by the model variables at (statistically) significant speed, so that yield may demonstrate significant convergence in each period towards its long-run equilibrium. Having established that the dynamic relationship between yield and sp is strong enough to offer (statistically) significant short-run adjustments to yield for attaining its long-run equilibrium, the other key objective of this study to estimate the magnitude of the long-run association between yield of two crops with their respective support price. For this purpose, Fully Modified Ordinary Least Squares (FMOLS) cointegration regression estimator is used to obtain the point estimates for the hypothesized relationship. The estimator is originally designed by Phillips and Hansen (1990) for two or more unit root series, aimed at producing optimal estimates of cointegration regression. The estimator offers such a modification to least squares scheme of estimation that the problems of serial correlation and the endogenity in model regressors could be effectively addressed which usually arise a consequence of cointegration relationships (Phillips, 1992).

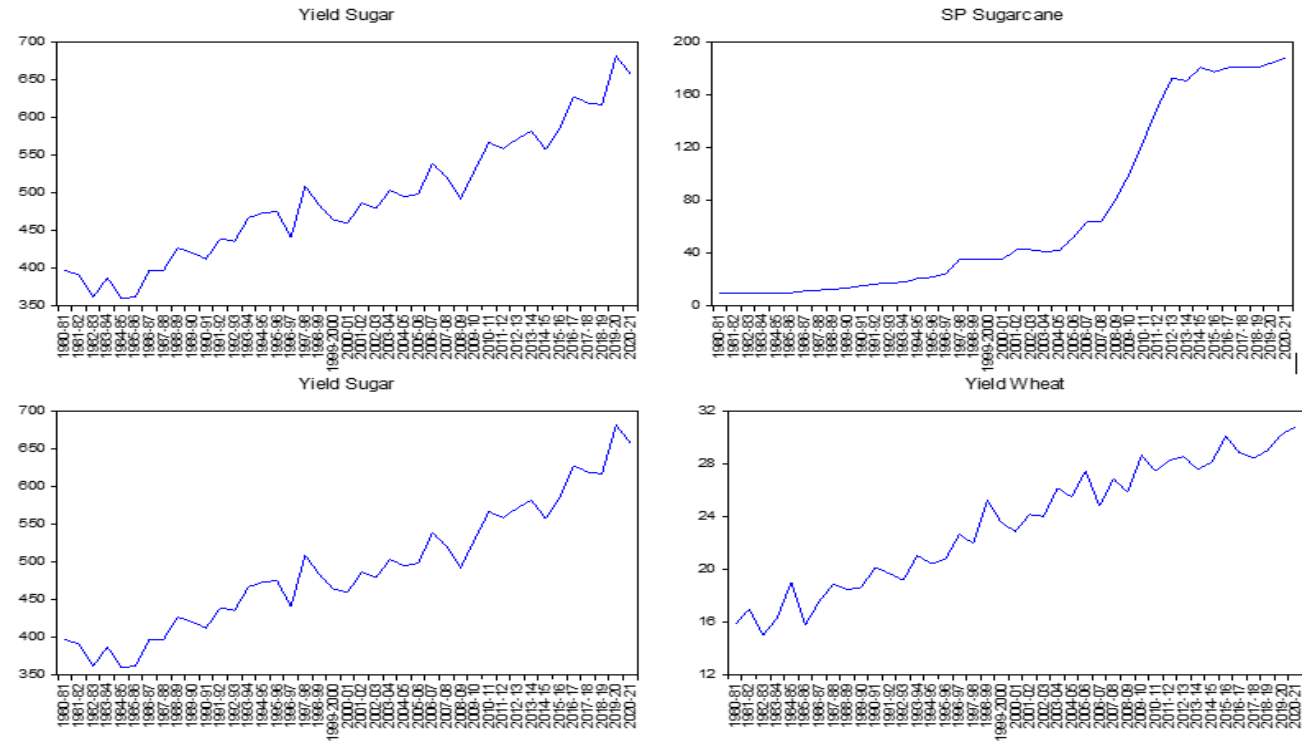
The present study aims at conducting a time-series econometric investigation around the short-run and long-run effects of support prices on two major food crops yields in Pakistan. Such an empirical exploration necessitates sufficiently longer sample data around the yield of two crops and their associated support prices, since majority of the time-series econometric estimators are asymptotically efficient. The data sets for this purpose are sourced from the database of Agricultural Marketing Information Service (AIMS), Punjab, Pakistan. Time-series data observations ranging from year 1980-81 to 2020-21 on annual frequency are obtained for wheat and sugarcane crop yields and their associated support prices regulated and implemented by Pakistan Agricultural Storage and Services Cooperation Limited (PASSCO). The precise definitions and measurement units of two types of time-series involved in the forthcoming empirical exercise are given below:

(i) Crop Yield: The series serves as the model regressand in our study. The annual yield for two major food crops of Pakistan is taken into account that is wheat and sugarcane. The average yield for each of the two types of crops is measured as 40 kg per acre. In results section of the paper, the yield series for two crops is symbolized as yield_wheat and yield_sugarcane. (ii) Support Price: This is the only model regressor. The support price for wheat, sugarcane and other various crops (cotton and rice in particular) in Pakistan is determined as Rs per 40 kg. Therefore, for our analysis, the support price series is expressed in the similar manner.

5. Results and Discussion

This section of the paper reports results for estimation procedures performed for investigating the short- and the long-run causal association between wheat and sugarcane yields with their support prices. Before conducting the econometric tests formally, we first shall hold a visual analysis of two series to have some informal evidence around their plausible features. The preliminary examination of the data is important as it allows the detection of data errors, and helps to identify structural breaks as well as the plausible long-run co-movement between model time-series.

Figure 4: Support Prices and Crop Yield of Wheat and Sugarcane (1980-81 to 2020-21)



This section of the paper reports results for estimation procedures performed for investigating the short- and the long-run causal association between wheat and sugarcane yields with their support prices. Before conducting the econometric tests formally, we first shall hold a visual analysis of two series to have some informal evidence around their plausible features. The preliminary examination of the data is important as it allows the detection of data errors, and helps to identify structural breaks as well as the plausible long-run co-movement between model time-series. The time-plots of support prices and the yield for the crops of wheat and sugarcane are given in Figure 4. It is clear from the figure that both types of series contain a definite time trend and, the unit root testing of model series should include both an intercept and a time trend in the testing (regression) specification. Further, at the outset, the presence of structural breaks seems quite plausible, particularly for two support price series. Also, it is noticeable that for almost entire sample period, the two series are trending in similar directions, for both wheat and sugarcane. Such a trending pattern of support prices and yield points towards a positive/direct nature of association between two series in longer-run.

However, nothing can be said with certainty unless formal econometric tests are performed. Prior to performing any sort of short- or long-run analysis, it is customary to determine the order of integration of model variables before subjecting them to formal testing procedures. It is common to see that a large majority of time-series pertaining to agricultural sector or natural resources are characterized by structural breaks. Keeping in view the said possibility, the present study employs Dickey-Fuller minimisation of 't' statistics (Dickey-Fuller min-t test) which is popularly employed for detecting unit root into time-series with breaks. The traditional unit root testing methods fail to realize the true order of integration of time-series in the event of a stationary noise component with a break in the slope. Such a presence leaves permanent effects, which ultimately leads to unnecessary or undue non-rejection for the null hypothesis of traditional unit root tests (Perron, 1989). This legitimizes the use of Dickey-Fuller min-t test, allowing for break points and the incorporation of dummy variables in intercept and trend to adjust the standard unit root regression equations or time-series with structural breaks. For both wheat and sugarcane, the unit root testing results favour the presence of one unit root in both support price and the yield series. The two series turn out to be first-differenced stationary (integrated of order one), with high statistical significance. This proves them to be eligible candidates for any sort of cointegration modelling. Now, after having determined the order of integration of model time-series, we are in a position to perform our short- and long-run analysis formally.

Table 3: Estimating the Short-Run Causal Relationship between Yield and SP Using Error Correction Model (ECM)

Dependent Variable	Error Correction (EC) Coefficient	Does Significant Speed of Adjustment Hold?
$yield\_wheat$	-0.52 (0.23) [-2.25]	Yes
$yield\_sugarcane$	-0.41 (0.14) [-2.89]	Yes

Table 3 reports the ECM results, for the two test regressions of yield_wheat and yield_sugarcane. For both crop yields, valid error correction process is yielded. Interpreting the test results for yield_wheat, the ECM generates statistically significant error correction coefficients of value -0.52. This implies that the two model series make sufficient adjustments in short-run, so that 52 percent of the deviations from long-run equilibrium is "corrected" in each period (year). The economic meaning of these results strongly suggests valid and statistically significant short-run causal relationship between wheat support price and the annual yield of the crop. However, the process of periodic adjustments of wheat yield towards long-run equilibrium is significantly driven by the differenced lagged term of yield_wheat and the differenced term of sp. The EC coefficient holds an intuitively correct sign (negative) with a t-value of -2.25 implying a valid error correction process with better than five percent statistical significance. Similar findings are obtained for the case of sugarcane, though, with an EC coefficient of relatively smaller magnitude. The EC term generates a value of -0.41 with a statistical significance of better than five percent, indicating that 41 percent of the misalignments/deviations are (significantly) corrected in each period towards achieving long-run equilibrium. Here, the differenced term and the lagged differenced term of sp are significantly driving the adjustment or the correction process, with almost negligible contribution from differenced lagged term of yield_sugarcane. After having determined valid and statistically significant short-run association between yields of two crops and their support price, we now investigate this relationship in long-run. The long-run elasticities of wheat and sugarcane crop yield against their respective support prices are estimated through employing FMOLS cointegration regression estimator. The test results are reported in Table 4 given below.

Table 4: Estimating the Long-Run Coefficients through Fully Modified Ordinary Least Squares (FMOLS) Cointegration Regression Estimator

Dependent Variable	Long-Run BS Coefficient (β)	Does Cointegrating Relationship Hold?
	FMOLS	
$yield\_wheat$	0.18 (0.01) [16.30]	Yes
$yield\_sugarcane$	0.15 (0.01) [13.52]	Yes

The results yielded through FMOLS cointegration regression estimator indicate the presence of valid and statistically significant long-run association between two crop yields and their support prices. Intuitively speaking, the long-run coefficient of the relationship is expected to hold a positive sign implying the positive or direct effects of changes in support price on crop yields. For both types of crop yields, intuitively correct association is obtained, thus, advocating the existence of a valid long-run relationship between crop yield and their support price. The long-run coefficient for both wheat and sugarcane yield is positive, holding a coefficient value of 0.18 and 0.15, respectively. The magnitude of two coefficients is of considerable value and can be interpreted economically as a percentage change (increase or decrease) in support prices of wheat and sugarcane may cause a change (increase or decrease) of 18 percent and 15 percent in two types of yields, respectively. Not only the magnitude but the statistical strength of the relationship is also of vital importance. The t-ratios associated with two long-run coefficients are revealing statistically highly significant association between model series. For both types of crops, the hypothesized relationship between yield and support prices receives acceptance at better than one percent statistical significance level.

On the whole, the results acquired from establishing long-run relationships and the short-run dynamics between wheat and sugarcane crop yield and their respective support prices strongly advocate the presence of unavoidable association between two series. The proposed relationship holds valid in long-run with high statistical significance and is characterized by temporary deviations from its equilibrium path in the short-run. Any policy change with respect to wheat and sugarcane support prices therefore should be enacted with great caution, the support price being holder of proven significance to yield performance of two major crops of the country.

6. Conclusion

In agrarian economies, the government polices devised for incentivizing farmers are needed to be very well thought and premeditated. Wheat and sugarcane being the strategic crops of the country, the cultivators of these two crops are receiving government support in the form support prices since long. However, the growth performance of annual yield of these crops has been highly turbulent, despite the fact that both wheat and sugarcane had been prioritized above by government relative to the other food and non-food crops of the country. Such a claim is much supported by the wheat and sugar support price policy enacted by government and the wheat procurement system established and run under the institution of PASSCO. Nevertheless, the volatile yield rates of two crops raises important questions on the efficacy and usefulness of such government provisions extended towards the wheat and sugarcane producers. Thorough investigation of support price policy for two crops is of greater significance, the one being responsible for taking away hefty amounts of government funds in the name of facilitating and motivating farmers on their cultivation behaviour.

The present study has attempted to seek empirical evidence on the causal linkage between support prices and the yield rates of wheat and sugarcane crops in Pakistan. Using annual time-series data set for a sample period of 41 years, the study has taken a deep econometric insight into the long-run co-movement between support prices and yield rates, in addition to analysing their short-run dynamics. Taking structural breaks into account, valid statistical evidence is acquired in support of hypothesized association of yield rates of both wheat and sugarcane against their respective support prices with transient (short term) deviations from the equilibrium path. Each year, these temporary misalignments of wheat and sugarcane yield from their long-run equilibrium path are corrected with their self-adjustments at a speed of 52 percent and 41 percent for wheat and sugarcane, respectively. This linkage is seen evidently existinbg in long-run also and with better statistical power. The magnitude of this relationship is of considerable value and can be interpreted economically as a percentage increase (decrease) in support prices of wheat and sugarcane may cause an increase (decrease) of 18 percent and 15 percent in wheat and sugarcane yields, respectively.

The analysis presented in this research holds strong policy implications for federal and local government institutions of agriculture and food security in Pakistan. As emphasized in the endogenous growth theory, support price as public policy tool may ensure rising per capita income and consumption growth in the long run. Therefore, at the outset, the federal government's decision of brining rise to support prices of wheat and sugarcane crops may serve as a big incentive for farmers and cultivators to give boost to their cultivation behaviour. Such a policy action will not only help to grow the profitability of farmers but will also improve their per capita incomes, rather, the incomes of entire rural population besides improving the real consumption at country level. However, one should not overlook the dark side of the story as there exist grave concerns regarding the equity and distribution of support price effects. On one hand, the said effects can be seriously disproportional across various crops and regions of the country and on the other it becomes very difficult to keep cultivators motivated to continue the production of those crops which are equally important but are not backed by support policy. Since all the crops are not backed by support policy, such a provision serves as a motivation to farmers to invest more into the cultivation of certain crops. As a result, it is seen repeatedly that every year, wheat and sugarcane are produced in right quantities in the country but are hoarded by wheat and sugar mill owners and private stockists. Every year, close to the announcement of new and higher support price, the market supplies of two crops are held back artificially which further pushes up their retail price. Ultimately, mill owners and stockists receive overwhelming profits through such malpractice since they receive dual benefits of hoarding; one from the higher support price offered by government and the other from increased retail price of their product caused by artificial demand and supply imbalance. Also, keeping in view the inter-regional

differences in soil quality and its fertility in the country, the specific soil type being viable for specific crops, support price may become a serious cause of regional disparity production and distribution of those crops which come under support price net. Highlighting all such discounted aspects of support price policy are meant to convince our policy making institutions to review and reassess the welfare consequences of support policies in a society like Pakistan which is largely characterized by horrific levels of corruption and innumerable bottlenecks. It is therefore of vital importance to plan and manage the implementation of support price policy and the procurement of wheat crop by government in a very cautious and thoughtful way, so that the massive corruption and stocking of wheat crops and sugar in the country could be prevented from occurring in the future.

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