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Are Agricultural Markets in Haryana Integrated?

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Abstract

In this paper, we analyze prices of seven major agricultural commodities produced in the state of Haryana, viz. paddy, wheat, maize, bajra, mustard, cotton and potato and test if markets are integrated. Using Philips and Sul (2007) method to test market integration, we find that markets for four of these crops, paddy, maize, mustard and potato are completely integrated with one another. For wheat and cotton, our results show that there is one standalone market and all other markets are well integrated. Bajra is the only crop where markets are not integrated. Comparing markets in Haryana with rest of India, our results show that in Haryana, markets are much more well integrated compared to other states for all crops except bajra. One consistent pattern we note across almost all crops (except paddy and wheat) is that they are sold at prices much below announced MSPs. Our results point towards the need for interventions targeting market infrastructure like warehousing and cold storages for crops and markets which are not integrated or receive prices below announced MSPs.

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Introduction

The significance of integrated agricultural markets is well established in academic literature (Fackler and Goodwin (2002) and Kabbiri et al (2016) offer an exhaustive review) and is one of key objectives in agricultural policy making. The concept of market integration is based on the notion of Law of one price (LOP) which states that after controlling for transaction costs, regional markets that are linked by trade and arbitrage will have a common and unique price (Fackler and Goodwin, 2001). Integrated markets are critical for both farmers and consumers. Farmers get competitive prices, there is reduction in price volatility and resources are efficiently allocated. From the perspective of consumers, it supports food security and reduces regional inequality. Integrated markets support broader rural development and economic growth.

In this paper, we study market integration for the major crops produced in Haryana. Haryana is one of India's most agriculturally advanced states, with 45% of total workforce employed in the sector (PLFS-2024-25). Despite accounting for roughly 2.5-3% in India's gross cropped area, it contributes almost 14-15% of India's agricultural GDP (epwrfits database). Compared to the all-India average, Haryana has higher productivity, higher agricultural income and greater irrigation coverage. It is one of the few states in India with a robust procurement mechanism where paddy and wheat are procured by government at minimum support prices (MSP). Given the significance of agriculture in the state and its contribution to national agricultural growth, it is critical to explore whether markets in Haryana are integrated and if the extent of integration is different across all crops. To understand the relative status of Haryana vis-à-vis rest of India, we also test and compare market integration for these crops in markets outside the state.

Several existing studies have explored the extent of market integration across India[2] and Haryana in particular. Studies focussing on Haryana find that overall, markets are integrated but results are heterogeneous across crops. Kumar and Sharma (2002) analyses market integration for paddy using cointegration tests find markets to be integrated. Mahesh et al (2018) examined market integration of selected cotton markets in Haryana. By applying the Augmented Dickey-Fuller (ADF) unit root test, the Johansen cointegration test, and the

[2] Since this paper focusses on Haryana, this section discusses studies which have looked at market integration in the state. For those interested in market integration across major markets in India, can refer to studies like Jha et al (2005), Sekhar (2012), Beag and Singla (2014), Katoch and Singh (2020), Bhattacharya and Chowdhury (2021) among others

Granger causality test, the study found that the cotton price series in the selected markets were integrated of order one (I(1)) and that long-run equilibrium relationships existed among the markets. For potato markets in Haryana, both Bhatia et al. (2023) and Goyal (2026) using time series techniques like cointegration, Granger causality and Augmented Dickey- Fuller (ADF) unit root test and found strong inter market price association across Haryana. Bhatia et al. (2022) studied the arrival and price behaviour of mustard across major markets in Haryana using time series techniques and found integration for major markets. Ghoshray and Ghosh (2011) deployed the Engle and Granger (1987) two-step method to test for cointegration and to see how integrated Indian wheat markets are especially in Haryana, Panjab, Rajasthan and Uttar Pradesh. In Haryana at market centres such as Ambala, Rohtak, Karnal and Sonepat results showed that prices are highly integrated and in general for each state the wheat prices forms strong robust long run relationship. Mallory et al. (2012) using vector error correction model and Johansen tests for cointegration found Haryana's paddy and wheat markets integrated and lack of integration in less regulated markets like pearl millet (bajra) and corn markets (maize).

In this paper, we first study price pattern using daily mandi (APMC) prices for the harvest months for the seven major crops (paddy, wheat, bajra, maize, mustard, cotton and potato) produced in Haryana. The analysis has been done for the harvest months[3] from 2021 to 2025. These seven crops are the most commonly grown in the state[4] and the choice of crops ensures heterogeneity in terms of nature of crops (cereals, cash crops, vegetables), extent of government intervention (procurement and MSP), crop season (rabi/kharif), perishability and shelf life. The preliminary descriptive analysis points towards interesting pattern in prices. First with regards to MSP, we find that except for paddy and wheat, almost all other crops are sold at prices much below MSP. Second, in terms of variation across markets, we find that crops like paddy, maize, potato have relatively higher Coefficient of variation (CV) while crops like bajra, cotton, mustard and wheat have relatively low CV. However, we also note that despite high CV for certain crops, over time there has been a decline in CV levels indicating potential market integration. On the other hand, crops like bajra despite having relatively much lower CV, the pattern shows that the levels of CV has fluctuated a lot over the years indicating a possible lack of market integration. On the other hand, we also note that crops like wheat and

[3] Harvest months are discussed in Section 2 where we discuss our data in detail
[4] Source- NSS REPORT NO. 587: Situation Assessment of Agricultural Households and Land and Livestock Holdings of Households in Rural India, 2019 (JANUARY – DECMEBER 2019)

mustard which have a lower CV and also do not show much fluctuation. This pattern points towards heterogeneity across crops in terms of market integration which we analyze next.

For our evaluation on the extent of market integration in Haryana for these crops, we use Philips and Sul cluster method (2007) (from now on PS-method). It is an endogenous cluster identification method that allows us to test integration across large number of markets taken together. Time series methods used to study market integration (as those cited above) generally do not handle large number of markets and often do not give clear policy implications (issues discussed in detail in Minten,1999, Chatterjee and Ganesh-Kumar, 2025). PS-method, as we show later allows us to ask if the price level in markets across space are integrated and converge to one steady state over time or form multiple clusters/clubs of markets or do not converge with any other markets. Markets which do not integrate with any other market in the state are standalone markets. The results from PS-method allow us to rank spatial units in terms of cluster membership, i.e., PS method will allow us to identify spatial units which are members of the highest price cluster, second highest price cluster and so on. This allows us to compare and contrast the extent of market integration across markets in Haryana. In order to compare the quality of market integration vis-à-vis other states, we use the same method to test market integration across markets in rest of India.

Our results point towards highly integrated markets for most of the major crops produced in the state. We find complete market integration for paddy, mustard, potato and maize. For wheat and cotton, we find that one market is standalone and rest all other markets are well integrated. However, bajra was the only crop in Haryana with no integration across the markets. On comparing the extent of integration with rest of India, we find that markets in Haryana are relatively much more integrated. For example, for paddy while Haryana markets converge to one cluster, markets outside Haryana converge to four clusters. For both maize and potato, once again markets in Haryana converge to one cluster and markets outside converge to 2 clusters. For cotton, rest of India converges to two clusters and all markets in Haryana converge to one cluster and one market remains standalone. Only for wheat we find that markets in rest of India are fully integrated and converge to one cluster while for Haryana, 15 markets converge to one cluster and one market remains standalone. For mustard, both markets within Haryana and outside are well integrated and all markets converge to one cluster. Bajra is the only commodity where markets are not integrated both within Haryana and outside. Bajra, outside Haryana converges to 6 clusters while within Haryana, all the markets are standalone and do not converge with each other. We discuss these in detail in Section 4.

The rest of the paper is organized as follows- We discuss data and methodology in Section 2. Section 3 explores the pattern followed by market prices in Haryana. We discuss the results of Philips and Sul (2007) cluster identification method in Section 4 and conclude in Section 5.

Data and methodology

We compile data on prices and arrivals from Government of India *AGMARKNET* portal on agricultural marketing[5]. It covers 350 commodities, with prices being reported from approximately 4000 mandis spread across the country. The volume of arrivals of each agri-commodity, along with prices (maximum, minimum, and modal), is reported by each mandi and uploaded to the portal on a daily basis. Our dataset includes daily data on arrivals and modal prices for paddy, wheat, bajra, maize, mustard, cotton and potato for the harvest months from 2021 to 2025. Harvest months for paddy are September, October and November and for wheat the months are April and May. respectively. Harvest months for bajra are September, October and November. Harvest months for Maize are June, July and August. Harvest months for cotton are October, November and December and for Mustard, months are March and April respectively. For potato, harvest months are December, January, February and March.

PS-method requires balanced panel data for analysis. Therefore, we restrict our analysis to those markets which have the most frequently available data. Following Mallory et al. (2012), we drop all markets from our analysis which report 50 percent missing data in our period of analysis. For markets with fewer missing observations, we replace the missing variable with average of two days before and after the missing date. Post this data cleaning, we are able to use daily modal prices for the harvest months of each crop for the years 2023, 2024 and 2025. Table 1 reports the number of markets and market arrival share covered for the crops analyzed in this paper.

Table 1 Crops covered in the analysis

	#Markets	Arrival share (%)
Paddy Haryana	18	36
Paddy Rest of India	126	45
Wheat Haryana	16	26
Wheat Rest of India	377	44
Maize Haryana	4	71
Maize Rest of India	70	53
Bajra Haryana	4	26
Bajra Rest of India	58	35

[5] https://agmarknet.gov.in/

Mustard Haryana	4	24
Mustard Rest of India	129	50
Cotton Haryana	5	71
Cotton Rest of India	27	36
Potato Haryana	24	79
Potato Rest of India	242	70

Source: Authors' calculation using data from agmarknet.in

As mentioned in Section 1, PS-method is an endogenous cluster identification method that allows us to test integration among large number of markets taken together. The test procedure allows for a wide variety of possible transition paths, i.e., (1) it allows for a scenario of full market integration where all markets converge to the same steady state/cluster, (2) it also allows for a scenario where some markets converge to one cluster while others to a different cluster and so on and (3) the possibility of standalone markets which do not converge with any other market. The test statistic is based on relative transition path i.e., ratio of price in each market to cross-sectional average price and the same statistic is used to test for overall convergence and cluster identification, which gives empirically more robust results than other cluster identification methodologies (Fritsche and Kuzin (2011), Bartkowska and Reidl (2012) among others.

According to PS-method, a time varying common factor representation of logarithm of market prices for market, *'i'* at time, *'t'*, $log(p_{it})$, can be decomposed into a common trend/component, μ_t and an individual element, δ_{it} which varies over time. δ_{it} helps us to capture the deviation of each market from the common component (μ_t).

$$\log(p_{it}) = \delta_{it}\mu_t \qquad (1)$$

The relative transition path (h_{it} in Equation 2) can be derived from δ_{it} and captures the transition path relative to the common average.

$$h_{it} = \log(p_{it})/\{N^{-1}\sum_{i=1}^{N}\log(p_{it})\} = \delta_{it}/\{N^{-1}\sum_{i=1}^{N}\delta_{it}\} \qquad (2)$$

Hence, h_{it} measures the individual market behaviour in relation to other markets. Equation (2) implies that the cross-sectional mean of h_{it} is one and the cross-sectional variance of h_{it} satisfies the following condition:

$$V_t^2 = \frac{1}{N}\sum_{i=1}^{N}(h_{it}-1)^2 \to 0 \; if \; \lim_{t\to\infty}\delta_{it} = \delta, for \; all \; i \qquad (3)$$

PS explain that relative convergence implies, $\lim_{t\to\infty} \delta_{it} = \delta$ for all *'i'* values (i=1,2…N). Also, they assume $\delta_{it} = \delta_i + (\sigma_i \varepsilon_{it}/L(t)t^{\alpha})$, where δ_i is fixed over time across markets, σ_i is an idiosyncratic scale parameter, ε_{it} is iid (0, 1), $L(t)$ is a slowly varying function ($L(t) \to \infty$ when t$\to \infty$) and α is the decay rate. PS developed a log t regression model (Equation 4) to test the null hypothesis of convergence, $H_O: \delta_i = \delta$ and $\alpha \geq 0$ against the alternative, $H_A: \delta_i \neq \delta$ or $\alpha < 0$.

$$log(V_1^2/V_t^2) - 2logL(t) = a + \beta logt + u_t \qquad (4)$$

for t= [rT],[rT]+1……T , r Є (0,1) and L(t) is a slowly varying function. The procedure depends on the choice of L (t) and 'r'. PS suggest that r=0.2 and $L(t) = logt$ seems to be a preferable choice when sample size is greater than T= 50 as is the case in this study.

PS show that $\beta = 2\alpha$. The null hypothesis of convergence is constructed as a one-sided test of $\beta > 0$ against the alternate hypothesis of $\beta < 0$. The null hypothesis of convergence is rejected at the 5% level of significance when the value of the *t*-statistic is below −1.65. PS-method states that in case null of convergence is rejected, many possibilities exist for example possible existence of convergence clusters or cases where there may be possibility of coexistence of both convergent clusters and divergent members.

For that the PS-method suggests that the markets are first ordered by final observation in descending order and then the core group is identified. To identify the core group, PS-method is applied on the first two markets. In case they converge, one by one other markets are included, and PS-method is applied. In case the first two markets do not converge, the third market is tested with the first to test for convergence. Once the first core group is identified, all other markets are iteratively tested for convergence with the first core group. All markets which form part of the first core group form the first cluster. Similarly, other cluster members are identified. If there are no two units for which we find convergence, it can be concluded that there is neither convergence nor cluster formation among the markets. If there are markets which do not converge with any of the other identified clusters, it can be concluded they are standalone. This way all the markets are tested for convergence/divergence and cluster formation. We use STATA (2017) commands: *pfilter, logtreg*, *psecta*, *scheckmerge*, and *imergeclub* developed by Du (2017) for the PS method here.

Agricultural markets in Haryana

In this section, we explore trends and patterns followed by daily modal prices and arrivals for the seven crops we study in this paper. In addition to exploring trend and pattern

in arrivals and prices, we explore whether market prices are influenced by arrivals. For that first, we compute correlation coefficient and second estimate Ordinary Least Square regression models for daily modal prices on market shares after controlling for market and month-year fixed effects. We estimate these regression models separately for each crop. In this section, we first discuss crop wise trends. We discuss crops grown in Kharif season first (paddy, maize, bajra, cotton,) and then crops grown in rabi season (wheat, mustard and potato) and then later in this section we discuss results of the correlation between prices and arrivals and the regression models.

Paddy

As expected, paddy markets in Haryana exhibit strong MSP support and relatively stable prices. A total of 74 APMC mandis reported paddy sales during harvest months (September–November) between 2021 and 2025. Table 2 shows aggregate summary statistics for modal prices, deviation of modal prices for paddy from MSP and arrivals across all APMC markets. Across 2021–2025, the average modal price of paddy was ₹2512 per quintal, approximately ₹266 above MSP, implying an average positive deviation of 12.1 percent. This indicates that MSP functioned effectively as a price floor. The minimum observed price was ₹1500 per quintal and the maximum was ₹4900. The coefficient of variation (CV) for prices was about 20 percent. Average daily arrivals were around 3916 MT with a much higher CV of 260%.

Table 2 : Descriptive Statistics of Paddy Prices and Arrivals in Haryana (All Markets, 2021–2025 Harvest season)-

	N	Mean	SD	CV (%)	Min	Max
Modal Price (₹/qtl)	4220	2512.26	510.12	20.31	1500.00	4900.00
Price Deviation from MSP(₹/qtl)	4220	265.81	515.97	194.11	-869.00	2717.00
% Deviation from MSP	4220	12.10	23.81	196.85	-36.68	124.46
Arrival Qty (MT)	4220	3915.88	10218.69	260.96	0.01	96399.00

MSP IN 2021-22 was Rs. 1940, 2022-23 was Rs. 2040, in 2023-24 was Rs. 2183, in 2024-25 was Rs. 2300, and in 2025-26 was Rs. 2369.

Source and Notes: Agmarknet; MSP: CACP, GOI; Price Deviation = Modal Price – MSP; CV (%) = (Standard Deviation / Mean) × 100.

Table 3 reports deviation of average daily modal prices from MSP for all the districts. Except for Palwal, all other districts report prices on an average above MSP. Highest price deviation was observed in Gurgaon (53%) and Sonipat (35%). Nearly 96 percent of markets arrivals were traded at or above MSP. Only three markets reported prices below MSP on average. Consistency in sale at or above MSP highlights the effectiveness of the state in ensuring MSP.

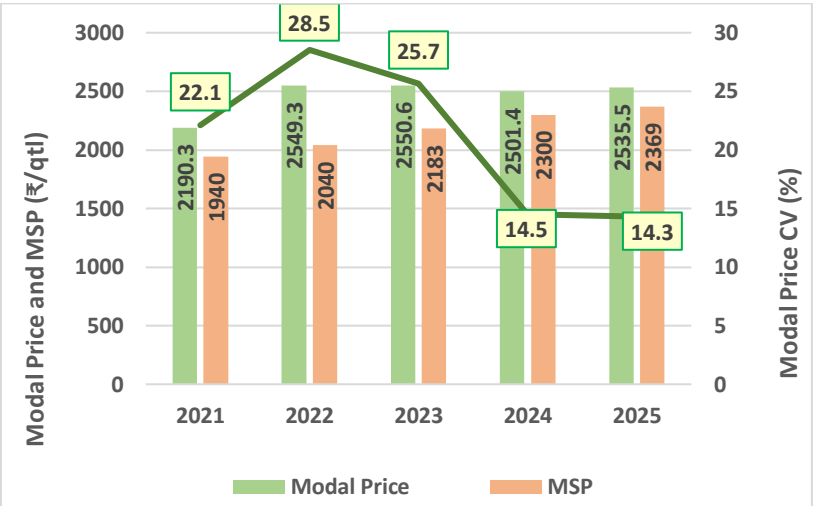
Table 3: District-wise Absolute and Percentage Average Price Deviation from MSP

Districts	**Average Price Deviation from MSP**	**% price deviation from MSP**
Ambala	20.12	0.92
Fatehabad	24.41	1.06
Gurgaon	1149.51	52.86
Hissar	567.41	25.27
Jhajar	20.00	0.87
Jind	196.79	9.25
Kaithal	40.28	1.75
Karnal	130.17	5.52
Kurukshetra	400.18	18.63
Mewat	249.97	11.06
Palwal	-207.48	-8.76
Panchkula	18.66	0.79
Panipat	333.74	14.37
Rohtak	72.75	3.07
Sirsa	685.43	31.22
Sonipat	791.29	34.64
Yamuna Nagar	17.81	0.79
Average	265.81	12.10
Markets	**Prices Above and at MSP**	**Prices Below MSP**
Number of markets	71	3
Share of market arrival (%)	96	4

Source and Note: Agmarknet

Figure 1 presents year-wise average modal prices and MSP at the state level with variation in average modal prices. Average modal prices increased sharply from 2021 to 2022 and stabilized around ₹2500–2550 in later years. Although prices remained above MSP throughout the period, the extent of positive deviation gradually declined. Price variation across markets also reduced over time indicating increasing convergence in paddy prices across markets.

Figure 1 :Year-wise Trends in Modal Prices, MSP and variation in Modal Prices (2021–2025)



Source and Note: Agmarknet; Number of observations were 242 (2021), 401 (2022), 1,113 (2023), 1,078 (2024), and 1,386 (2025). The analysis covers 74 markets annually.

Maize

Maize presents a contrasting picture to paddy, both in terms of number of markets where sale happened in the period of our analysis and deviation from MSP. Only 22 markets reported maize sales during June–August, and MSP realization was weak. Table 4 report the summary statistics for daily modal prices and market arrivals for the harvest months of June, July and August for the years 2021 to 2025.

Table 4: Descriptive Statistics (Harvest month season, 2021-2025)

	N	Mean	SD	CV (%)	Min	Max
Modal Price (₹/qtl)	1379	1762.60	364.40	20.67	500.00	4900.00
Price Deviation from MSP(₹/qtl)	1379	-361.39	354.65	-98.14	-1590.00	2810.00
% Deviation from MSP	1379	-16.94	16.82	-99.34	-76.08	134.45
Arrival Qty (MT)	1379	197.52	358.08	181.29	0.20	3000.00

MSP IN 2021-22 was Rs. 1870, 2022-23 was Rs. 1962, in 2023-24 was Rs. 2090, in 2024-25 was Rs. 2225, and in 2025-26 was Rs. 2400.

Source: Agmarknet.

The average modal price was ₹1763 per quintal, approximately ₹361 below MSP, implying a negative deviation of nearly 17 percent. CV for modal price was 21%, while arrivals showed very high variation (CV around 181%). The minimum price recorded was ₹500 per quintal, indicating severe distress sales in some markets. Table 5 brings out the heterogeneity across districts and markets in terms of deviation of prices from MSP. Out of 11 districts, 8 districts

reported prices very low compared to MSP. Sirsa (64%) and Jhajar (46%) Of the 22 APMC markets, 18 (82%) traded below the MSP on average, 4 (18%) traded above or at MSP. This shows that unlike paddy, where almost all sale happens at or above MSP, maize farmers do not get the support of MSP.

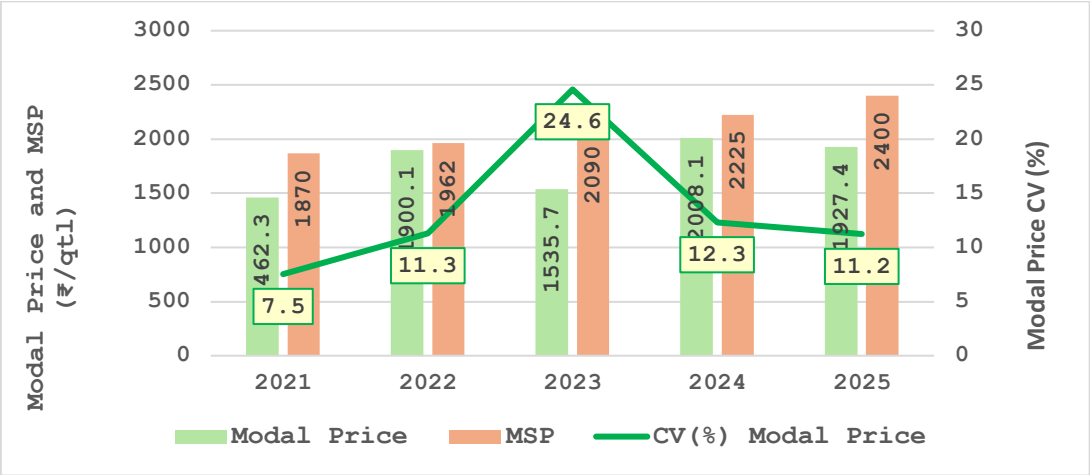
Table 5: District-wise Average Absolute and Percentage Average Price Deviation from MSP –

Districts	Average Price Deviation from MSP	Average % price deviation from MSP
Ambala	-318.47	-14.86
Bhiwani	74.64	3.70
Fatehabad	-1.29	0.36
Jhajar	-967.78	-46.31
Jind	0.00	0.00
Kurukshetra	-557.08	-26.19
Palwal	-1073.75	-50.85
Panchkula	-194.75	-9.42
Sirsa	-1340.00	-64.11
Yamuna Nagar	-130.53	-5.87
Average	-361.39	-16.94
Markets	**Above and at MSP**	**Below MSP**
Number of markets	4	18
Market arrivals (%)	18	82

Source: Agmarknet.

Figure 2 presents the year wise trend of average prices and MSP with variation in modal prices. Price fluctuated considerably with lowest price dispersion in 2021 and highest in 2023. Although variation declined in later years, average prices remained below MSP.

Figure 2 : Year-wise Trends in Modal Prices, MSP and variation in Modal Prices (2021–2025)



Source and Note: Agmarknet. Number of observations were 63 (2021), 270 (2022), 554 (2023), 327 (2024), and 165 (2025). The analysis covers 22 markets annually.

Bajra

43 markets in Haryana report sale of bajra during harvest months from 2021 to 2025. Table 6 reports the summary statistics for harvest seasons across 43 markets over 5 years. Bajra markets also experienced persistent below-MSP trading. Average modal price was ₹2189 per quintal, approximately ₹432 below MSP, representing a negative deviation of over 16 percent. Price variation was relatively low (CV about 14%), but arrivals displayed very high variability (CV about 247%).

Table 6: Descriptive Statistics for bajra (Harvest month season, 2021-2025)

	N	Mean	SD	CV (%)	Min	Max
Modal Price (₹/qtl)	2402	2189.22	305.95	13.98	1225.00	3914.00
Price Deviation from MSP(₹/qtl)	2402	-431.80	320.56	-74.24	-1275.00	1139.00
% Deviation from MSP	2402	-16.32	11.83	-72.51	-45.95	41.05
Arrival Qty (MT)	2402	220.82	546.24	247.37	0.01	9350.00
MSP for 2021-22 was Rs. 2250, for 2022-23 was 2350, for 2023-24 was 2500, 2024-25 was 2625 and 2025-26 was 2775						

Source and Note:: Agmarknet; Harvest season = Sept, Oct, Nov only

Table 7 reports the variation in prices across districts and we find that although there was a huge variation in prices, none of the districts sold at prices above MSP. Since all markets report average prices much below MSP, we do not report it separately in Table 7. Like maize, modal

prices lower than MSP once again reflects the ineffectiveness of MSP as a price floor owing to a lack of procurement mechanism.

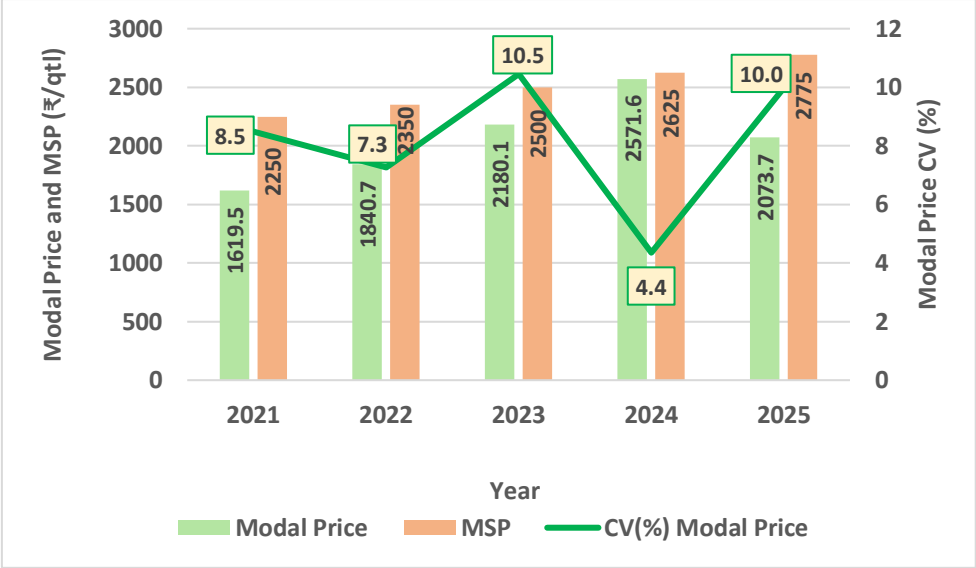
Table 7: District-wise Average Absolute and Percentage Average Price Deviation from MSP

Districts	Average Price Deviation from MSP	Average % price deviation from MSP
Bhiwani	-242.31	-9.11
Faridabad	-9.38	-0.34
Fatehabad	-628.69	-23.05
Gurgaon	-529.30	-20.67
Hissar	-412.20	-15.03
Jhajar	-437.50	-15.77
Jind	-490.86	-19.31
Mahendragarh	-390.10	-14.96
Mewat	-575.52	-21.37
Palwal	-779.88	-28.27
Rewari	-421.88	-15.20
Rohtak	-875.00	-31.53
Sirsa	-426.61	-15.67
Sonipat	-622.50	-22.44
Average	-431.80	-16.32

Source: Agmarknet; Note: Data (2021-2025; Harvest season: Sept/Oct/Nov)

Figure 3 shows average prices with variation and MSP by year. Prices improved gradually between 2021 and 2024 but fell sharply in 2025. Price variability fluctuated substantially across years with low variation in 2022, increased in 2023, once again very low in 2024 and much higher variation in 2025. This could point towards a lack of convergence or a lack of integration across markets in Haryana. We will explore this later in Section 4 of the paper.

Figure 3: Year-wise Trends in Modal Prices, MSP and variation in Modal Prices (2021–2025)



Cotton

Table 8 presents summary statistics for harvest seasons across 38 markets over 5 years. Cotton differs from maize and bajra because average prices were generally above MSP, although large regional disparities persisted.

Table 8: Descriptive Statistics (Harvest month season, 2021-2025)

	N	Mean	SD	CV (%)	Min	Max
Modal Price (₹/qtl)	3500	7156.11	757.26	10.58	2203.00	9650.00
Price Deviation from MSP(₹/qtl)	3500	191.44	1152.59	602.07	-4417.00	3570.00
% Deviation from MSP	3500	3.98	17.71	445.49	-66.72	58.92
Arrival Qty (MT)	3500	127.04	236.98	186.54	0.10	5442.00
MSP IN 2021-22 was Rs. 5726, 2022-23 was Rs. 6080, in 2023-24 was Rs. 6620, in 2024-25 was Rs. 7121 and in 2025-26 was Rs.7710.						

Source: Agmarknet. Note: Harvest season = Oct, Nov, Dec months only

Table 9 shows that there were several districts like Fatehabad, Hissar, Jhajar, Kaithal, Mewat, Palwal, Rewari and Rohtak which report prices below MSP. Among 16 below MSP markets five markets such as Beri (Jhajar), Khanina (Mahendragarh–Narnaul), Meham (Rohtak), Narnaul (Mahendragarh–Narnaul), and Sirsa (Sirsa) reported prices below MSP only once during the study period. Rest 11 markets were repeatedly below MSP. Out of 16 markets reporting price below MSP and on an average 8 districts out of 13 reported prices lower than MSP.

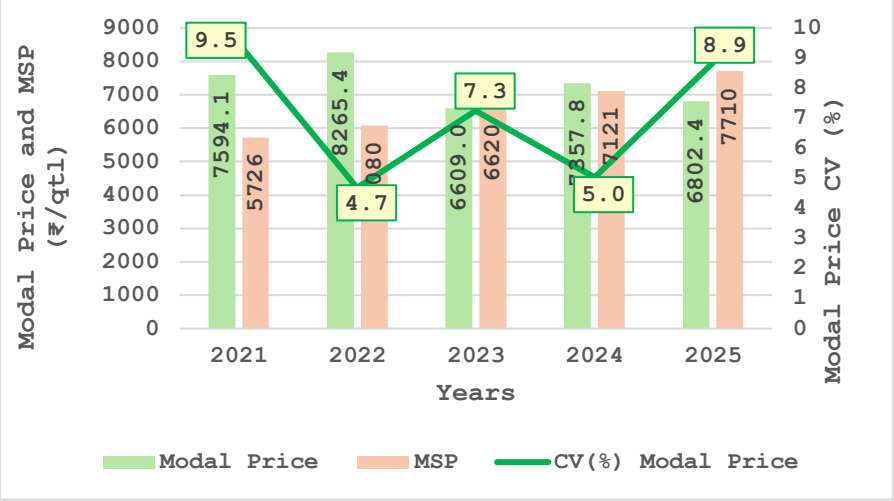
Table 9: District-wise Average Absolute and Percentage Average Price Deviation from MSP

Districts	Average Price Deviation from MSP	Average % price deviation from MSP
Bhiwani	677.45	11.68
Faridabad	591.69	10.20
Fatehabad	-353.85	-4.60
Hissar	-101.29	-0.86
Jhajar	-421.00	-5.91
Jind	494.26	8.71
Kaithal	-1540.53	-19.98
Mahendragarh-Nar	930.22	15.15
Mewat	-569.34	-7.51
Palwal	-1114.59	-14.35
Rewari	-1257.27	-16.31
Rohtak	-524.50	-8.00
Sirsa	296.51	5.59
Total average	191.44	3.98
Markets	**At or above MSP**	**Below MSP**
Number of markets	22	16
Share arrivals (%)	58	42

Source: Agmarknet; Note: Data (2021-2025; Harvest season: Oct/Nov/Dec)

Figure 4 shows the average price with price variation and MSP offered by year. Cotton prices displayed strong cyclical movement with very high positive deviations from MSP in 2021 and 2022, near parity with MSP in 2023, moderate positive deviation in 2024 and prices below MSP in 2025 and price variability remained comparatively low over the years.

Figure 4: Year-wise Trends in Modal Prices, MSP and variation in Modal Prices (2021–2025)



Source and Note: Agmarknet; Number of observations were 63 (2021), 591 (2022), 909 (2023), 899 (2024), and 1038 (2025). The analysis covers 38 markets annually.

Mustard

Mustard markets showed relatively stable prices and moderate MSP effectiveness. A total of 72 markets reported mustard sales during March–April. Table 10 reports the descriptive statistics for Mustard. Average modal price was ₹5730 per quintal, approximately 4 percent above MSP. Price variability was low (CV around 10%), while arrivals displayed substantial variation.

Table 10: Descriptive Statistics (Harvest month season : March & April, 2021-2025)

	N	Mean	SD	CV (%)	Min	Max
Modal Price (₹/qtl)	3881	5730.01	577.06	10.07	3501.00	9333.00
Price Deviation from MSP(₹/qtl)	3881	184.57	760.03	411.78	-1949.00	4283.00
% Deviation from MSP	3881	4.01	14.65	365.42	-35.76	84.81
Arrival Qty (MT)	3881	271.23	585.26	215.79	0.05	8952.00
MSP IN 2021-22 was Rs. 4650, 2022-23 was Rs. 5050, in 2023-24 was Rs. 5450 , in 2024-25 was Rs. 5650 and in 2025-26 was Rs. 5950 .						

Source: Agmarknet.

Of the 20 districts, we find that mustard was sold below MSP in 7 markets (Table 11). This presents a much better scenario compared to other crops discussed above. Out of the 72 APMC markets, 21 (29 per cent) traded below the MSP on average; 10 (14 per cent) traded at MSP; and 41 APMCs (57 per cent) traded at Above MSP. Many markets repeatedly recorded below-MSP prices despite overall positive state averages.

Table 11: District-wise Average Absolute and Percentage Average Price Deviation from MSP

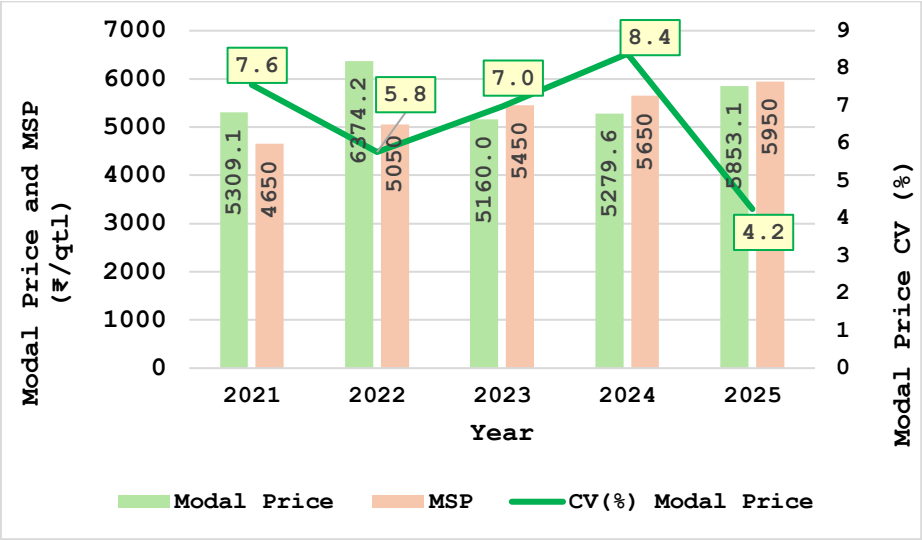
Districts	Average Price Deviation from MSP	Average % price deviation from MSP
Ambala	240.71	5.10
Bhiwani	386.67	7.68
Faridabad	323.00	6.44
Fatehabad	-209.23	-3.65
Gurgaon	-146.14	-2.00
Hissar	126.02	2.87
Jind	345.41	7.07
Kaithal	-13.06	-0.22
Karnal	-214.19	-3.60
Kurukshetra	39.17	1.35
Mahendragarh-Nar	315.19	6.50
Mewat	-319.05	-5.25
Palwal	-466.27	-7.92

Panchkula	4.55	0.07
Panipat	363.50	7.20
Rewari	648.84	13.01
Rohtak	-7.95	-0.14
Sirsa	156.06	3.46
Sonipat	383.29	7.71
Yamuna Nagar	73.68	1.46
Average	**184.57**	**4.01**
	At or above MSP	**Below MSP**
No of markets	51	21
Market share arrival (%)	71	29

Source: Agmarknet

Figure 5 reports year wise trend of modal prices with variation and MSP over five years. Prices remained well above MSP in 2021 and 2022. Prices fell below MSP from 2023 onward. Negative deviations narrowed by 2025. Despite these shifts, price variability remained relatively low throughout indicating stronger market integration compared to several other crops.

Figure 5: Year-wise Trends in Modal Prices, MSP and variation in Modal Prices (2021–2025)



Source and Note: Agmarknet; Number of observations were 87 (2021), 965 (2022), 730 (2023), 745 (2024), and 1354 (2025). The analysis covers 38 markets annually.

Wheat

Table 12 presents summary statistics for wheat for the harvest months across 99 markets over 5 years. The mean modal price is ₹ 2234 per quintal. On an average, prices were slightly higher than MSP (0.19%) and the coefficient of variation was 7%.

Table 12: Descriptive Statistics (Harvest month season, 2021-2025)

	N	Mean	SD	CV (%)	Min	Max
Modal Price (₹/qtl)	4912	2234.44	160.40	7.18	1975.00	2845.00
Price Deviation from MSP(₹/qtl)	4912	3.88	27.36	705.44	-315.00	720.00
% Deviation from MSP	4912	0.19	1.30	699.18	-12.99	33.88
Arrival Qty (MT)	4912	2322.66	5297.26	228.07	0.04	78413.00
MSP in 2021-22 was Rs. 1975, 2022-23 was Rs. 2015, in 2023-24 was Rs. 2125, in 2024-25 was Rs. 2275 and in 2025-26 was Rs. 2425						

Source: Agmarknet. Note: Harvest season = April & May months only

District level and market level heterogeneity in price realization is reported in Table 13. Out of 21 districts reporting sale of wheat only two districts Mewat and Palwal report average prices below MSP. However, district level summary hides within district variations. Of the 99 APMC markets, 10 (10 per cent) traded below the MSP on average; 21(21 per cent) traded at MSP; and 68 APMCs (69 per cent) traded at Above MSP (Table 32). The 68 Above-MSP markets averaged ₹ 2250 against an average MSP of ₹ 2244 i.e, marginally 0.27 per cent above MSP.

Table 13: District-wise Average Absolute and Percentage Average Price Deviation from MSP

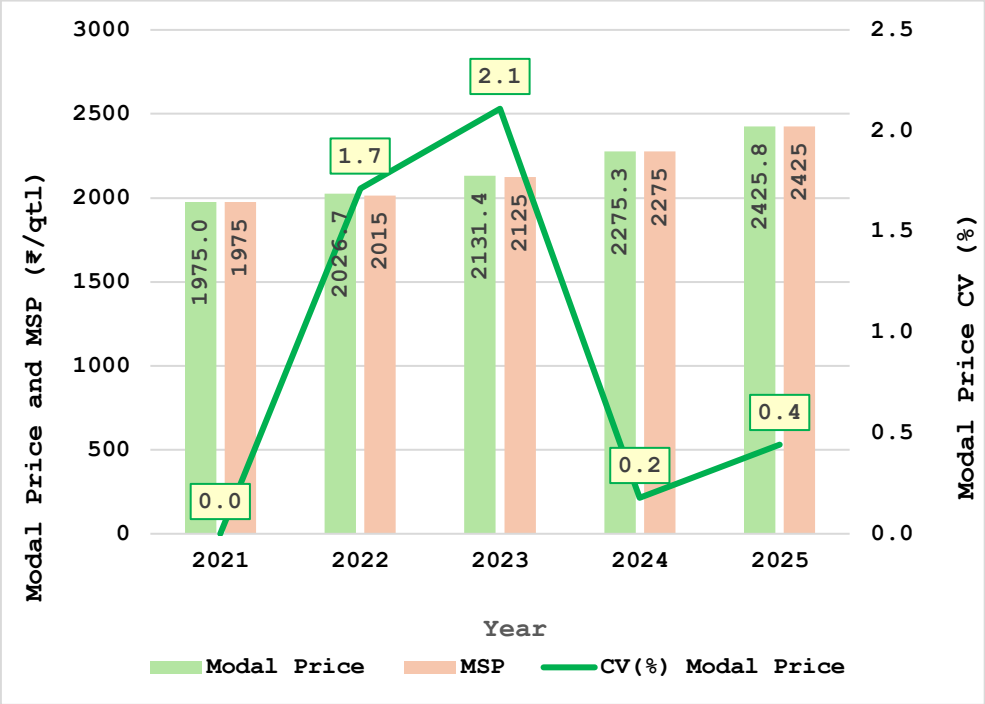
Districts	Average Price Deviation from MSP	Average % price deviation from MSP
Ambala	6.82	0.32
Bhiwani	1.88	0.10
Faridabad	5.68	0.24
Fatehabad	0.79	0.03
Gurgaon	3.90	0.19
Hissar	3.52	0.16
Jhajar	0.00	0.00
Jind	2.61	0.13
Kaithal	1.33	0.06
Karnal	0.30	0.01
Kurukshetra	0.42	0.02
Mahendragarh-Nar	23.40	1.13
Mewat	-1.46	-0.07
Palwal	-2.74	-0.12

Panchkula	0.00	0.00
Panipat	0.16	0.01
Rewari	59.56	2.94
Rohtak	0.56	0.03
Sirsa	1.71	0.09
Sonipat	1.69	0.08
Yamuna Nagar	0.30	0.01
Total	**3.88**	**0.19**
Markets	**At and above MSP**	**Below MSP**
No of markets	89	10
Market arrival share (%)	90	10

Source: Agmarknet; Note: Data (2021-2025; Harvest season months: April and May)

Figure 6 shows average modal prices with variation and MSP by year. On an average, the deviation from MSP has been negligible compared to paddy which is also regularly procured at MSP by the government. We find that the CV has been much lower compared to most of the other crops we study in this paper. This could point towards greater market integration which we explore in detail in Section 4.

Figure 6: Year-wise Trends in Modal Prices, MSP and variation in Modal Prices (2021–2025)



Source and Note: *Agmarknet;* Number of observations were 194 (2021), 865 (2022), 1159 (2023), 1103 (2024), and 1591 (2025). The analysis covers 99 markets annually.

Potato

Table 14 reports the descriptive statistics for Potato during the harvest months (December to March). The mean modal price is ₹ 885.5 per quintal with a CV of about 53 per cent, indicating significant price variability across markets. Arrival quantities exhibit very high dispersion (CV of 429 per cent), with a mean of 53 MT.

Table 14: Descriptive Statistics (Harvest month season: Dec, Jan, Feb, March, 2021-2025)

	N	Mean	SD	CV (%)	Min	Max
Modal Price (₹/qtl)	25626	885.55	468.22	52.87	175.00	20000.00
Arrival Qty (MT)	25626	53.14	227.95	428.96	0.01	9960.00

Source: Agmarknet.

Table 15 reports inter-district variation in average prices during our study period. Since, there are no MSPs announced for potato, we are unable to calculate deviations from MSP. To understand heterogeneity across districts, we compute deviations from average price. We find Districts Hissar and Panchkula fetches higher average modal prices while Ambala and Kurukshetra has the lowest average price.

Table15: District wise average modal prices and variation in Prices

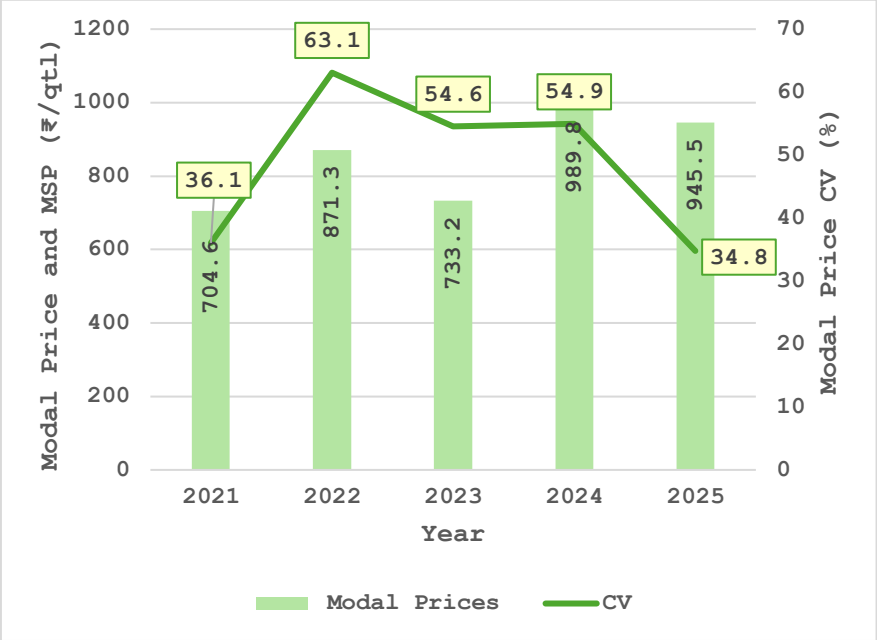
District	Average Modal Price(₹/qtl)	deviation from average (Rs)	% deviation from average
Ambala	652.28	-255	-39
Bhiwani	997.48	90	9
Faridabad	836.59	-71	-8
Fatehabad	839.79	-68	-8
Gurgaon	1016.87	109	11
Hissar	1143.55	236	21
Jhajar	886.67	-21	-2
Jind	807.29	-100	-12
Kaithal	881.42	-26	-3
Karnal	917.21	10	1
Kurukshetra	701.64	-206	-29
Mahendragarh-Narnaul	905.88	-2	0
Mewat	924.3	17	2
Palwal	952.17	45	5
Panchkula	1250.07	342	27
Panipat	766.83	-141	-18
Rewari	1093.25	186	17
Rohtak	854.77	-53	-6
Sirsa	912.19	5	1
Sonipat	946.85	39	4

Yamuna Nagar	772.03	-136	-18
Average	907.58		

Source: Authors' calculations

Figure 7 presents average modal prices and variation over five years of our study period. Average modal prices ranges from Rs.705 per quintal in 2021 to 990 per quintal in 2024. High variability in prices observed ranging from 36 per cent in 2021 to 63 per cent in 2022. Compared to the other crops variability is much higher in Potato prices over the years. But we find that there is a downward trend in CV levels pointing towards higher market integration in recent years.

Figure 7:Year-wise Trends in Modal Prices and variation in Modal Prices (2021–2025)



Source and Note: Agmarknet; Number of observations were 1170 (2021), 6360 (2022), 4975 (2023), 6191 (2024), and 6930 (2025). The analysis covers 87 markets annually.

It is plausible that price levels are determined by market arrivals, specially for perishable crops like potato. Annexure Tables A-1 to A7 report a simple 2 X 2 matrix which classifies markets into four categories- (1) markets with high arrival share and high prices, (2) markets with high arrival share and low prices, (3) markets with low arrival share and high prices and (4) markets with low arrival share and low prices. To statistically assess whether arrivals drive modal prices, the analysis proceeds in two steps: a bivariate correlation between modal prices and arrival share and second we estimate an Ordinary Least Square regression model where we

regress market arrival share on modal prices with market and month-year fixed effects to control for unobservable market and time characteristics. Table 16 reports the results.

Our results show that the relationship between arrival share and prices is also heterogeneous across crops. For paddy and maize, we find that both the correlation coefficient and OLS regression models show that there is no association between arrivals and prices. For bajra, wheat and mustard we find that the correlation coefficient is statistically significant and positive at 5 percent level of significance, but the OLS models show that after controlling for market and month-year fixed effects, there is no statistically significant association between arrivals and prices. For cotton on the other hand, we find that although there is no statistically significant correlation between arrivals and prices, after controlling for month-year and market fixed effects, there is a positive association between arrivals and prices. This implies that markets with higher arrival share drives prices upward. On the other hand for potato, we find that both correlation coefficient and OLS regression models show that there is a negative and statistically significant. While correlation coefficient is statistically significant at 5 percent level, OLS regression coefficient is statistically significant at 1 percent level of significance. The negative relationship is not surprising given that potato is a perishable crop and given the warehousing and storage constraints, higher arrivals are sold at lower prices.

Table 16- regression of daily arrivals on daily modal prices

	Paddy	Maize	Bajra	Cotton	Wheat	Mustard	Potato
Corr coeff	-0.160**	−0.015	0.111**	0.019	0.084**	0.053**	-0.124**
				Regression results			
	Modal price	Modal price	Modal price	Modal price	Modal price	Modal price	Modal price
Arrival share	-21.05	41.05	-30.49	1041.77**	7.935	184.67	-918.73***
	(141.8)	(50.86)	(30.30)	(457.49)	(8.001)	(125.36)	(226.64)
N	4220	1,379	2402	3500	4912	3,881	25,626
R-sq	0.645	0.772	0.833	0.7458	0.9780	0.7847	0.5838
Mkt FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
M-yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at market level reported in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

To summarize, our first finding from the descriptive statistics analysis is consistent sale of all crops at prices much below MSP. Except for paddy and wheat, almost all crops are sold at huge

negative deviations from MSP. With regards to the impact of arrivals on prices, as expected, crops with low shelf life like potato have a negative and statistically significant association with prices.

In terms of variation across markets, we find that there are crops like paddy, maize, potato which have relatively higher Coefficient of variation and there are crops like bajra, cotton, mustard and wheat which have relatively low CV. However, we also note that for crops like paddy and maize despite high CV, the trend shows that over the years CV has fallen indicating that this could be a sign of a possible market integration and less variation in prices across markets in the state. On the other hand, crops like bajra despite having relatively much lower CV, the pattern shows that the levels of CV has fluctuated a lot over the years indicating a possible lack of market integration. For crops like wheat and mustard, we note that they have relatively lower CV and the levels of CV also do not show much fluctuation. Another interesting pattern to note which is common for all crops is that within the same district, there are markets with relatively much higher price and also markets with relatively much lower prices. We explore the extent of market integration next.

Market integration in Haryana

Table 17 reports the results of PS-method used to test market integration across markets in Haryana and rest of India. Table 1 in Section 2 gave the details of the number of markets and share of these markets in total arrivals. Our findings point towards a relatively well integrated market in Haryana, albeit with some heterogeneity across crops. We find that paddy, mustard, and potato markets are completely integrated in Haryana with all markets converging to one cluster. Wheat and cotton have almost integrated market with one market for each crop diverging from the rest which in turn are all completely integrated. Only bajra markets show no integration with all markets standalone, i.e., all the markets move towards different steady state and none of them are converging with one another.

In contrary, our results show that markets in rest of India are less integrated compared to those of Haryana. For example, while paddy markets in Haryana are all perfectly integrated, markets across rest of India have four clusters with 53 markets in cluster 1 which is the highest priced cluster, 48 markets in cluster 2 which is the second highest priced cluster, 22 markets are members of cluster 3 and 3 markets are members of cluster 4. Similarly, maize markets were perfectly integrated in Haryana but markets across rest of India converge to 2 clusters with 53 markets in cluster 1 and 17 in cluster 2. Once again, potato markets also bring out a very similar

picture. While they are perfectly integrated across markets in Haryana, there are two clusters in rest of India with 135 markets in cluster 1 or the highest priced cluster and 107 markets in cluster 2 or lowest price cluster. For cotton, we find that rest of India two clusters with 23 markets in cluster 1 and 4 markets in cluster 2. Haryana on the other hand, has one standalone market and rest all other markets are integrated to one cluster.

Only for wheat we find that markets across rest of India are all completely integrated to one cluster while for Haryana we find that there is one standalone market and rest are integrated to one cluster. Bajra offers a completely contrary picture with no market integration for both markets in Haryana and markets in rest of India. Bajra markets seem to be more poorly integrated in Haryana compared to rest of India since none of the markets in Haryana are integrated with each other, i.e., all of them are standalone markets. We find 6 clusters in bajra markets across rest of India.

Table 17- Extent of market integration

	# clusters	Cluster distribution	market integration
Paddy Haryana	1		complete
Paddy rest	4	53 in cluster 1, 48 in cluster 2, 22 in cluster 3 and 3 in cluster 4	no
Wheat Haryana	1 club and 1 standalone	15 markets in 1 club and 1 standalone	Almost
Wheat rest	1		complete
Maize Haryana	1		complete
Maize rest	2	53 in cluster 1 and 17 in cluster 2	No
Bajra Haryana	no convergence	all standalone	no
Bajra rest	6	9 in cluster 1, 8 in cluster 2, 12 in cluster 3, 15 in cluster 4, 9 in cluster 5 and 5 in cluster 6	no
Mustard Haryana	1		complete
Mustard rest	1		Complete
Cotton Haryana	1 club and 1 standalone	4 markets in 1 cluster and 1 standalone	almost
Cotton rest	2	23 in cluster 1 and 4 in cluster 2	almost
Potato Haryana	1		complete

Potato rest	2	135 markets in cluster 1 and 107 markets in cluster 2	no

Source: Authors' calculations

Although, reasons driving cluster membership is beyond the scope of this paper, we note a few patterns with regards to cluster membership in Haryana. First, none of the crop specific characteristics seem to be driving market integration. For example, our results do not show any link between procurement and market integration. While we do see higher market integration for crops which are regularly procured i.e., paddy and wheat, crops which are not procured like maize and mustard also show complete market integration for Haryana. However, bajra, a crop which is not procured does not have an integrated market.

Other factors like season of crop i.e., rabi or kharif does not determine market integration. Our results do not show any pattern in terms of difference between foodgrains and oilseeds in terms of market integration. Finally, perishability or shelf life of a crop also does not seem to have any impact on market integration. Potato which has relatively low shelf life has completely integrated markets in Haryana like that of paddy, mustard and maize among others which have relatively much longer shelf life.

Another pattern we note is that markets within a district could be part of different clusters or it is possible that a few markets are integrated and some are standalone. We find this in case of wheat and cotton in Haryana. Chatterjee and Ganesh-Kumar (2025) explore market integration using Philips and Sul (2007) method for several crops across India and once again find heterogeneity in extent of market integration across crops. On the same lines as our finding, they also find that markets in a district could be members of different clusters and the pattern is consistent across all crops with incomplete market integration.

One of the advantages of using PS-method in studying market integration is that it allows us to identify specific markets which are not integrated or are standalone. For example, PS-method shows that for cotton, Hissar APMC in Hissar district is standalone. However, there is another market in Hissar, Adampur APMC which is integrated with other markets in Haryana. For wheat, Safidon market in Jind district is standalone. There are other mandis in Jind district like Jullana APMC, Pillukhera APMC and Uchana APMC which are integrated with other markets in Haryana. Both Hissar APMC and Safidon APMC has the lowest average price for cotton and wheat respectively. Market arrival shares do not explain the lack of integration or price levels

since Safidon APMC has one of the highest markets share for wheat and Hissar APMC has one of the lowest market share for cotton.

To summarize, our results throw light on the extent of integration across markets in Haryana for all the major crops produced in the state. We find that except for bajra, markets for all other crops are either completely or mostly integrated. Compared to rest of India, markets in Haryana show higher degree of market integration reflecting robust marketing infrastructure in the state.

Conclusion

Market integration is key to both farmer and consumer welfare and therefore is integral in agricultural policy making. In this paper, we explore agricultural market integration in the state of Haryana in India and test whether the extent of integration is heterogeneous across crops. For that, we first compare the pattern followed by prices across markets in the state using descriptive statistics. Our findings show a lot of heterogeneity across crops. Analysis of price trend from 2021 to 2025 shows that prices for crops like paddy are much above MSPs announced for the years. Although wheat is also procured like paddy at MSPs, on an average, prices hover much more closely around MSPs compared to paddy. On an average paddy was sold at12.10% higher than MSP and wheat was sold at only 0.19% higher than MSP. Cotton which is procured in smaller quantities compared to other states has on an average positive deviation from MSP but with a lot of heterogeneity across markets with 22 out of 38 markets having prices higher than MSP and 16 markets with prices lower than MSP. Other crops which are not procured by the state like maize and bajra are sold at much lower prices compared to the MSPs announced every year. Mustard on the other hand, despite not procured reported on an average higher price than MSPs announced.

In terms of variation across markets, CV for paddy and maize was relatively higher but both show a decline over the years. CV for wheat is on an average is low but shows higher fluctuation than paddy. CV for mustard is relatively low and has somewhat medium fluctuation. CV of Cotton on the other hand, although low can be seen to be fluctuating much more over the years. Bajra had a relatively lower CV but shows a lot of variation over the years. Potato was the only crop in our study which does not have an MSP and therefore we are unable to compare it with deviations from MSP. In terms of variation, we find that potato had the highest CV but the levels of CV declined over the years. Our preliminary analysis points towards a pattern where irrespective of the levels, over the years CV shows a declining trend for all crops

except bajra. This indicates a higher likelihood of more integrated markets which we explore through PS-method.

In terms of whether market arrivals drive daily prices, our OLS regression models find statistically significant results only for potato and cotton. While we are unable to explain the positive coefficient for cotton, negative coefficient for potato could indicate a lack of cold storage and warehousing facilities. Given its low shelf life, it is plausible that lack of storage infrastructure hurts potato farmers the most. Policy intervention to improve warehousing and cold storage infrastructure could be critical in promoting farmer interests.

Our results from PS-method are broadly consistent with our findings from our preliminary descriptive analysis on crop prices. We find that markets for four out of seven crops, viz. paddy, maize, mustard and potato are completely integrated. For both wheat and cotton, we find that only one market is not integrated with the rest. Comparing the extent of market integration with rest of India, our results show that Haryana markets are relatively much more well integrated compared to rest of India for all crops except wheat. Even in case of wheat, it is only one market in Haryana which is standalone thereby preventing complete market integration. And for bajra, there is no market integration both for Haryana and markets in rest of India.

Our results point towards a broadly well-functioning market infrastructure for the state. Being one of the Green revolution states, agriculture has always been one of the primary focus areas for the state government over the years. However, our results also show that intervention must be targeted towards crops which are sold at prices below MSP and markets which are standalone (not integrated with other markets) and moving towards a low-price equilibrium over the years.

The key advantage of using PS-method for studying integration is that it allows us to identify which markets are not integrated or standalone and hence suitable policy interventions can be designed accordingly. Focussed analysis on these markets/districts could help identify the drivers of low market prices and can thereafter, focussed interventions can be accordingly designed. Further our results also highlight the lack of market integration for bajra and appropriate policy interventions are required to correct the same. Another significant finding from our analysis is consistent below MSP pricing for most of the crops we studied. Interventions targeting better pricing for farmers through investments in warehousing, cold storages could enable farmers to get higher prices. One of the limitations of the study is that we do not look at aspects driving low prices and lack of market integration. Given the

unavailability of long run data on these aspects at such granular level, future studies on primary field research would be beneficial. Despite this limitation, we believe our analysis has thrown light on key issues in Haryana markets and will help future studies to delve into these aspects at a deeper level.

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Annexure

Relation between daily modal prices and market arrivals

For all the seven crops, we study in this paper, we classify markets in Haryana into four groups based on their arrival share and average modal price, with each group above or below the median. Table A1 reports the results. We broadly classify markets into four categories- (1) markets with high arrival share and high prices, (2) markets with high arrival share and low prices, (3) markets with low arrival share and high prices and (4) markets with low arrival share and low prices. Higher concentration of markets in any of the sub-groups would point towards the direction of the relationship between daily prices and arrivals in the state.

Paddy

No systematic relationship between arrivals and prices was observed. Markets with high arrivals could record either high or low prices, and the same pattern existed for small markets. The findings imply that factors beyond market size influence price realization.

Table A1. Harvest-season classification of paddy markets based on arrival share and modal price

Modal Price / Arrival Share	Low Price (Below Median)	High Price (Above Median)
Low Arrival Share (Below Median)	**Small market – low price** Markets: 13 Districts: **11** Avg. arrival share: **0.11%** Avg. modal price: **₹2,275.91** Hissar, Jhajar, Palwal, Jind, Ambala, Panchkula, Karnal, Kaithal, Kurukshetra, Yamuna Nagar, and Panipat	**Small market – high price** Markets: 24 Districts: **13** Avg. arrival share: **0.07%** Avg. modal price: **₹2,636.96** Panipat, Panchkula, Sirsa, Hissar, Mewat, Fatehabad, Kaithal, Jind, Sonipat, Karnal, Palwal, Rohtak, and Gurgaon
High Arrival Share (Above Median)	**Large market – low price** Markets: 24 Districts: **8** Avg. arrival share: **3.37%** Avg. modal price: **₹2,264.63** Ambala, Fatehabad, Yamuna Nagar, Sirsa, and Kaithal. Karnal, Jind, Kurukshetra.	**Large market – high price** Markets:13 Districts: **6** Avg. arrival share: **1.23%** Avg. modal price: **₹2,821.05** Karnal, Kurukshetra, Hissar, Sirsa, Kaithal, and Jind

Source and Notes: Agmarknet; Note: For detailed market information, see annexure

Maize

We find that like the case of paddy, here as well there is no apparent relationship between market arrivals and modal prices in the market. We explore the relationship between market arrivals and prices through regression models later in the paper.

Table A2. Harvest-season classification of maize markets based on arrival share and modal price

Modal Price / Arrival Share	Low Price (Below Median)	High Price (Above Median)
Low Arrival Share (Below Median)	**Small market – low price** Markets: 4 Districts: 4 Avg. arrival share: 0.068% Avg. modal price: ₹1138.06 Jhajar, Panchkula, Palwal and Sirsa	**Small market – high price** Markets: 7 Districts: 6 Avg. arrival share: 0.066 % Avg. modal price: ₹2477.25 Ambala, Fatehabad, Kurukshetra, Jind, Panchkula and Yamuna Nagar
High Arrival Share (Above Median)	**Large market – low price** Markets: 7 Districts: 2 Avg. arrival share: 11.84% Avg. modal price: ₹1611.47 Ambala, Kurukshetra	**Large market – high price** Markets: 4 Districts: 3 Avg. arrival share: 4.09 % Avg. modal price: ₹1936.74 Ambala, Kurukshetra, Bhiwani

Source and Notes: Agmarknet; Note: For detailed market information, see annexure; Harvest season months (Jun/July/August)

Bajra

We find that there is no clear linear relationship between the scale of arrivals and price realisation across the markets. Markets with both high and low prices are found in categories with either high or low arrival shares pointing towards factors beyond arrival could shape the price outcomes. Also we find that the same district is a part of two or more categories. For instance, district Bhiwani appears across small market -high price, large market- low price and large market-high price category, while Gurgaon and Palwal appears in two categories of small and large markets fetching low price.

Table A3. Harvest-season classification of Bajra markets based on arrival share and modal price

Modal Price / Arrival Share	Low Price (Below Median)	High Price (Above Median)
Low Arrival Share (Below Median)	**Small market – low price** Markets: 14 Districts: 9 Avg. arrival share: 0.084 Avg. modal price: ₹ 1912.66 Fatehabad, Sirsa, Palwal, Jhajar, Jind, Rohtak, Ambala, Gurgaon, and Mewat.	**Small market – high price** Markets: 8 Districts: 6 Avg. arrival share: 0.11 Avg. modal price: ₹ 2446.93 Hissar, Faridabad, Bhiwani, Jhajar, Jind, and Sonipat

Modal Price / Arrival Share	Low Price (Below Median)	High Price (Above Median)
High Arrival Share (Above Median)	**Large market – low price** Markets: 7 Districts: 6 Avg. arrival share: 2.36 Avg. modal price: ₹ 2011.91 Mahendragarh, Gurgaon, Mewat, Bhiwani, Palwal and Jind.	**Large market – high price** Markets: 14 Districts: 5 Avg. arrival share: 5.82 Avg. modal price: ₹ 2324.98 Hissar, Bhiwani, Sirsa, Mahendragarh, and Rewari

Cotton

We find from Table A4 that large markets with high arrivals did not consistently receive better prices. Some high-arrival markets experienced lower prices, suggesting possible downward price pressure due to volume concentration. Small markets also exhibited both high and low prices. Hence, arrivals alone cannot explain cotton price outcomes.

Table A4. Harvest-season classification of Cotton markets based on arrival share and modal price

Modal Price / Arrival Share	Low Price (Below Median)	High Price (Above Median)
Low Arrival Share (Below Median)	**Small market – low price** Markets: 13 Districts: 10 Avg. arrival share: 0.065 Avg. modal price: ₹ 6544.07 Mahendragarh-Narnaul, Faridabad, Jhajar, Bhiwani, Fatehabad ,Mewat ,Palwal, Kaithal, Rohtak and Rewari	**Small market – high price** Markets: 6 Districts: 4 Avg. arrival share: 0.12 Avg. modal price: ₹ 7444.10 Bhiwani, Jind, Mahendragarh, and Hissar
High Arrival Share (Above Median)	**Large market – low price** Markets: 6 Districts: 3 Avg. arrival share: 6.00 Avg. modal price: ₹ 6925.32 Hissar, Fatehabad and Sirsa	**Large market – high price** Markets: 13 Districts: 5 Avg. arrival share: 4.80 Avg. modal price: ₹ 7437.18 Hissar, Bhiwani, Sirsa, Mahendragarh-Narnaul and Jind

Source and Notes: Agmarknet; Note: For detailed market information, see annexure; Harvest season months (Oct/Nov/Dec)

Mustard

Once again like other crops, both small and large markets appeared in high-price and low-price categories indicating market size was not a strong determinant of price realization.

Table A5. Harvest-season classification of Mustard markets based on arrival share and modal price

Modal Price / Arrival Share	Low Price (Below Median)	High Price (Above Median)
Low Arrival Share (Below Median)	**Small market – low price** Markets: 19 Districts: 11 Avg. arrival share: 0.07 Avg. modal price: ₹ 5393.69 Ambala, Kurukshetra, Faridabad, YamunaNagar, Bhiwani, Sirsa, Fatehabad, Palwal, Mewat, Karnal and Rohtak	**Small market – high price** Markets: 17 Districts: 11 Avg. arrival share: 0.13 Avg. modal price: ₹ 5963.17 Panipat, Panchkula, Hissar, Bhiwani Fatehabad, Sirsa, Karnal Kurukshetra, Yamuna Nagar, Jind, Kaithal
High Arrival Share (Above Median)	**Large market – low price** Markets: 17 Districts: 8 Avg. arrival share: 2.59 Avg. modal price: ₹ 5623.98 Hissar, Fatehabad, Sirsa, Gurgaon, Mahendragarh-Narnaul, Kurukshetra, Ambala, Jind	**Large market – high price** Markets: 19 Districts: 11 Avg. arrival share: 2.77 Avg. modal price: ₹ 5946.31 Hissar, Mahendragarh-Narnaul, Ambala, Bhiwani, Jind, Kaithal, Sonipat Panchkula, Rewari ,Rohtak Sirsa

Source and Notes: Agmarknet; Note: For detailed market information, see annexure; Harvest season months (March & April)

Wheat

We find that there is no clear relationship between arrivals and prices. Both small and large markets fetches lower and nearly same modal prices on average. Further we find that a district could both have markets with small share- low price and large markets-low price markets. For instance Ambala and Hissar districts are there in both these categories. Hissar, Yamuna Nagar, and Kaithal districts appear in every category pointing towards intra-district variation in market performance.

Table A6. Harvest-season classification of Wheat markets based on arrival share and modal price

Modal Price / Arrival Share	Low Price (Below Median)	High Price (Above Median)
Low Arrival Share (Below Median)	**Small market – low price** Markets: 24 Districts: 17 Avg. arrival share: 0.17 Avg. modal price: ₹ 2183.60 Hissar, Ambala, Faridabad, Sirsa, Gurgaon, Sonipat, Palwal, Bhiwani, Mahendragarh-Narnaul, Rohtak, Karnal, Panipat, Mewat, Yamuna Nagar, Panchkula, Rewari, Kaithal	**Small market – high price** Markets: 25 Districts: 13 Avg. arrival share: 0.17 Avg. modal price: ₹ 2367.06 Hissar, Ambala, Mahendragarh-Narnaul, Panchkula, Sirsa, Palwal, Panipat, Jhajar, Kaithal, Bhiwani, Rohtak, Yamuna Nagar, Karnal
High Arrival Share (Above Median)	**Large market – low price** Markets: 25 Districts: 9 Avg. arrival share: 2.44 Avg. modal price: ₹ 2186.09 Ambala, Yamuna Nagar, Kaithal, Sirsa, Jind, Karnal, Kurukshetra, Sonipat, Hissar	**Large market – high price** Markets: 25 Districts: 10 Avg. arrival share: 1.23 Avg. modal price: ₹ 2336.22 Karnal, Kurukshetra, Panipat, Hissar, Fatehabad, Yamuna Nagar, Mewat, Sirsa, Kaithal, Rohtak

Source and Notes: Agmarknet; Note: For detailed market information, see annexure; Harvest season months (April & May)

Potato

We find a very similar pattern as in other crops, i.e. market arrivals do not seem to have any significant relationship with prices.

Table A7. Harvest-season classification of Potato markets based on arrival share and modal price

Modal Price / Arrival Share	Low Price (Below Median)	High Price (Above Median)
Low Arrival Share (Below Median)	**Small market – low price** Markets: 23 Districts: 12 Avg. arrival share: 0.06 Avg. modal price: ₹ 729.79 Ambala, Karnal, Sirsa, Fatehabad, Kurukshetra, Jind, Panipat, Rohtak, Yamuna Nagar, Mewat, Panchkula, Kaithal	**Small market – high price** Markets: 21 Districts: 13 Avg. arrival share: 0.04 Avg. modal price: ₹ 1116.61 Yamuna Nagar, Kaithal, Gurgaon, Mewat, Karnal, Palwal, Rewari, Bhiwani, Panchkula, Sirsa, Rohtak, Fatehabad, Hissar

Modal Price / Arrival Share	Low Price (Below Median)	High Price (Above Median)
High Arrival Share (Above Median)	**Large market – low price** Markets: 20 Districts: 14 Avg. arrival share: 4.23 Avg. modal price: ₹ 716.64 Ambala, Kurukshetra, Jhajar, Panchkula, Sonipat, Yamuna Nagar, Mahendragarh-Narnaul, Faridabad, Karnal, Panipat, Fatehabad, Rohtak, Jind, Sirsa	**Large market – high price** Markets: 23 Districts: 14 Avg. arrival share: 0.57 Avg. modal price: ₹ 984.26 Faridabad, Hissar, Bhiwani, Kaithal, Fatehabad, Sonipat, Gurgaon, Jhajar, Jind, Mahendragarh-Narnaul, Palwal, Rewari, Mewat, Kurukshetra

*Source and Notes: Agmarknet; Note: For detailed market information, see annexure; Harvest season months (*Dec, Jan, Feb, March)