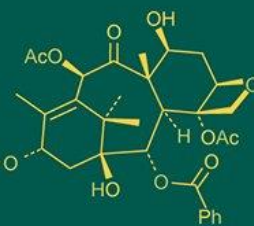
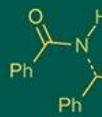


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RA Thombare
Ph.D. Research Scholar,
Department of Agricultural
Economics, Vasantrao Naik
Marathwada Krishi
Vidyapeeth Parbhani,
Maharashtra, India

RV Chavan
Associate Professor,
Department of Argil.
Economics, VNMKV,
Parbhani, Maharashtra, India

SS More
Professor & Head Department
of Argil. Economics, VNMKV,
Parbhani, Maharashtra, India

DS Perke
Associate Dean & Principal,
College of Agriculture,
Dharashiv, Maharashtra, India

SV Bharati
Assistant Professor,
Department of Argil.
Economics, VNMKV,
Parbhani, Maharashtra, India

TB Munde
Assistant Professor,
Department of Argil.
Economics, VNMKV,
Parbhani, Maharashtra, India

Corresponding Author:
RA Thombare
Ph.D. Research Scholar,
Department of Agricultural
Economics, Vasantrao Naik
Marathwada Krishi
Vidyapeeth Parbhani,
Maharashtra, India

Determinants of onion price volatility in major APMC markets of Maharashtra: An empirical assessment of policy, climatic and market factors

RA Thombare, RV Chavan, SS More, DS Perke, SV Bharati and TB Munde

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Abstract

Onion is one of the most important commercial vegetable crops in India and plays a significant role in farm income, consumer expenditure, and export earnings. Despite its economic importance, onion prices frequently experience substantial fluctuations, creating uncertainty for producers, traders, consumers, and policymakers. The present study investigates the determinants of onion price volatility in selected Agricultural Produce Market Committee (APMC) markets of Maharashtra, namely Lasalgaon, Solapur, and Satara. The study is based on secondary data collected from the Directorate of Marketing, APEDA, Indian Meteorological Department (IMD), and Mission for Integrated Development of Horticulture (MIDH) for the period 2010-2024. Price volatility was measured using unconditional variance, while Multiple Linear Regression Analysis was employed to identify the influence of market arrivals, Minimum Export Price (MEP), rainfall, and storage infrastructure on onion price volatility.

The results reveal that MEP and rainfall significantly influence onion price volatility across all selected markets. The positive and significant coefficients of MEP indicate that frequent export policy interventions contribute to market uncertainty and amplify price fluctuations. Rainfall variability also exerts a significant positive effect on volatility by affecting production, storage losses, and market arrivals. Market arrivals were found to have a stabilizing effect only in the relatively smaller Satara market, whereas their impact remained insignificant in larger markets such as Lasalgaon and Solapur. Storage infrastructure exhibited statistically insignificant effects in all markets, suggesting limited effectiveness of existing storage facilities in mitigating volatility. The findings highlight the need for stable export policies, climate-resilient production systems, and modernization of onion storage infrastructure to enhance market stability and reduce price fluctuations in Maharashtra.

Keywords: Onion, price volatility, multiple regression analysis, minimum export price, rainfall variability, APMC markets, Maharashtra

Introduction

Onion (*Allium cepa* L.) is one of the most important vegetable crops in India, contributing significantly to agricultural income, employment generation, domestic consumption, and export earnings. India is the second-largest producer of onions in the world, with Maharashtra being the leading onion-producing state and contributing a major share of national production and exports. Major onion markets such as Lasalgaon, Solapur, and Satara play a critical role in price discovery and distribution of onions across domestic and international markets.

The onion market is characterized by frequent and severe price fluctuations arising from the crop's seasonal production pattern, perishability, inadequate storage facilities, weather uncertainties, and policy interventions. These fluctuations adversely affect producers through unstable farm income and consumers through inflationary pressure. Price volatility has become a major concern for policymakers because onion prices often influence food inflation and public perception of agricultural market performance (Chand *et al.*, 2017) [2].

Several studies have reported that market arrivals, weather conditions, storage infrastructure, and export policies significantly affect onion prices (Jha & Srinivasan, 2004; Birthal *et al.*, 2019) [4, 1]. Among policy measures, Minimum Export Price (MEP) has frequently been used by the Government of India to regulate onion exports and protect domestic consumers.

However, abrupt changes in export policy may create uncertainty and contribute to price instability. Similarly, rainfall variability affects production, post-harvest losses, storage quality, and transportation, thereby influencing market supply and price behaviour.

Research Gap

Previous studies on onion markets have largely focused on price behaviour, market integration, seasonal variation, and volatility analysis. However, empirical evidence examining the determinants of onion price volatility at the market level remains limited, particularly for Maharashtra's major APMC markets. Furthermore, earlier studies have rarely incorporated policy variables such as MEP alongside climatic and infrastructural factors within a unified analytical framework.

Contribution of the Study

The present study addresses this gap by examining the combined effects of market arrivals, rainfall variability, storage infrastructure, and Minimum Export Price on onion price volatility across three representative onion markets of Maharashtra. By comparing a large reference market (Lasalgaon), a major trading hub (Solapur), and a relatively smaller market (Satara), the study provides market-specific insights into the drivers of volatility. The findings contribute to evidence-based policymaking aimed at improving market stability, enhancing farmer welfare, and strengthening onion supply chain management in Maharashtra.

Materials and Methods

Data Period

To identify price determinants of onion, the relevant data of districts wise rainfall, Minimum Export price (MEP) Arrivals Data and storage unit of onion, were collected for the period 2010 to 2024, covering 15 years.

Nature and Source of Data

The study relied entirely on secondary data. Indian Meteorological Department (IMD), APEDA, India Stat and MIDH.

The determinants for onion price volatility.

Multiple Linear Regression Analysis was employed because onion price volatility is influenced by several interrelated factors simultaneously. Unlike simple regression, multiple regression enables the estimation of the independent effect of each explanatory variable while controlling for the influence of other variables. Therefore, the technique is appropriate for identifying the relative contribution of policy, climatic, market, and infrastructural factors affecting onion price volatility (Gujarati & Porter, 2009) [3].

The dependent variable was measured using unconditional variance of annual onion prices. Unconditional variance was preferred because the study aimed to capture the overall variability in prices over the entire study period rather than short-term conditional fluctuations. It provides a comprehensive measure of long-run price instability and is widely used in agricultural price volatility studies. equation as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + e_i$$

Where:

Y = Price volatility (Unconditional Variance of prices)

X_1 = Arrivals (Qt)

X_2 = MEP (Minimum Export Price-USD)

X_3 = Rainfall (mm)

X_4 = Storage unit (No. of storage structure)

$\beta_0, \beta_1, \dots, \beta_n$ = Regression coefficients

e_i = Random error term

Results

The determinants of onion price volatility in selected markets of Maharashtra

To examine the determinants of onion price volatility, three representative markets in Maharashtra were selected based on market size, trade orientation, and supply characteristics. Among them, Solapur APMC was purposively selected due to its strategic importance in the onion marketing system. Solapur acts as a major assembling and redistribution centre, supplying onions to southern states and indirectly contributing to export channels, supported by relatively better road connectivity and trading infrastructure. The market handles large volumes of onion arrivals, placing it among the major onion trading centres in Maharashtra and Asia. In contrast, Satara market represents a low-arrival market, enabling comparison across structurally different markets and improving the robustness of price determinant analysis.

Determinants of onion price volatility in Solapur market

The estimated regression results presented in Table 01 highlight that price volatility in the Solapur onion market is influenced by both policy-related and climatic factors, while certain physical market variables remain statistically insignificant.

Minimum Export Price (MEP)

The coefficient of MEP (X_1) is positive (965.339) and statistically significant at the 1 percent level ($p = 0.0015$), indicating a strong influence of export policy on price volatility. Frequent changes in MEP directly affect export competitiveness, leading to sudden diversion of onion supply between domestic and international markets. Given Solapur's close integration with inter-state and export-oriented trade, such policy interventions introduce uncertainty among traders and exporters, thereby intensifying price fluctuations. Similar findings have been reported by Chand, Raju and Pandey (2017) [2], who observed that export restrictions and policy volatility significantly amplify onion price instability in major markets.

Market Arrivals

The coefficient for arrivals (X_2) is positive but very small (0.023) and statistically non-significant ($p = 0.5700$), suggesting that variations in arrivals do not exert a meaningful influence on price volatility in Solapur. This reflects the large size and high absorptive capacity of the market, where fluctuations in arrivals are smoothly managed through inter-market movement, trader networks, and short-term holding. In large, well-integrated markets, arrivals often influence price levels rather than volatility, a pattern consistent with earlier studies (Birthal *et al.*, 2019) [1].

Rainfall

Rainfall (X_3) shows a positive coefficient (1021.491) and is statistically significant at the 5 percent level ($p = 0.0313$), highlighting the importance of climatic factors in explaining onion price volatility. Rainfall variability affects onion prices indirectly by influencing crop maturity, harvest timing, post-harvest losses, storage quality, and transportation efficiency. Unseasonal or excess rainfall increases spoilage and supply uncertainty in a highly perishable crop like onion, thereby contributing to greater price fluctuations. The significant role of rainfall in price instability has also been documented by Sarker and Pal (2014)^[5] and Vasanthi *et al.* (2024)^[6].

Storage Units

The coefficient of storage units (X_4) is positive (11.246) but statistically non-significant ($p = 0.8416$), indicating that storage infrastructure has not played a decisive role in stabilising onion prices in the Solapur market. This may be attributed to the limited penetration of scientific onion storage structures and continued reliance on traditional storage methods, which are less effective in reducing post-harvest losses under adverse climatic conditions. Similar observations were made by Birthal *et al.* (2019)^[1], who reported that storage infrastructure contributes to price stabilisation only when modern facilities are widely adopted.

Table 1: Determinants for price volatility of onion in Solapur market.

Sr. No	Variables	Regression Coefficients	Standard error	P-value
1	MEP (X_1)	965.339***	272973.214	0.0015
2	Arrivals (X_2)	0.023	224.738	0.5700
3	Rainfall (X_3)	1021.491**	0.040	0.0313
4	Storage unit (X_4)	11.246	408.237	0.8416

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

Determinants of Onion Price Volatility in Lasalgaon Market

Table 02 presents the regression estimates identifying the determinants of onion price volatility in Lasalgaon, which is widely recognised as the largest onion market in India and Asia and often acts as a price leader for other domestic markets. Due to its central role in price discovery, volatility in Lasalgaon reflects both policy shocks and supply-side disturbances.

Minimum Export Price (MEP)

The coefficient of MEP (X_1) is positive (1621.744) and statistically significant at the 5 percent level ($p = 0.0370$), indicating that export policy interventions significantly influence price volatility in Lasalgaon. Changes in MEP directly alter export incentives, causing abrupt shifts between domestic retention and export diversion of onion supplies. Given Lasalgaon's dominance in price formation, such policy-induced demand shocks tend to amplify price fluctuations rather than stabilise them. Earlier studies have similarly reported that frequent export policy changes intensify onion price volatility in major reference markets (Jha, S., & Srinivasan, P. V. 2004, Chand *et al.*, 2017)^[4, 2].

Market Arrivals

The coefficient for arrivals (X_2) is negative (-0.0523) but statistically non-significant ($p = 0.7017$), implying that variations in arrivals do not significantly affect price volatility in Lasalgaon. This reflects the large trading volume, efficient market integration, and strong trader networks in the market, which absorb short-term supply fluctuations smoothly. In such dominant markets, arrivals influence average price levels rather than volatility, a finding consistent with Birthal *et al.* (2019)^[1].

Rainfall

Rainfall (X_3) shows a positive coefficient (2103.118) and is statistically significant at the 5 percent level ($p = 0.0382$), highlighting the strong role of climatic variability in explaining onion price volatility. Rainfall affects onion prices indirectly through its impact on crop damage, harvest delays, post-harvest losses, storage deterioration, and transport disruptions. Unseasonal or excess rainfall creates uncertainty in effective market arrivals and quality, thereby intensifying price instability in a highly perishable commodity like onion. The significant influence of rainfall corroborates earlier findings by Sarker and Pal (2014)^[5] and Vasanthi *et al.* (2024)^[6].

Storage Units

The coefficient of storage units (X_4) is negative (-111.190) but statistically non-significant ($p = 0.4682$), suggesting that existing storage infrastructure has not been effective in reducing price volatility in the Lasalgaon market. Despite the presence of storage facilities, limited adoption of scientific onion storage structures and continued reliance on traditional storage methods restrict their stabilising role. Similar conclusions were drawn by Birthal *et al.* (2019)^[1], who observed that storage infrastructure contributes meaningfully to price stability only when modern, large-scale facilities are widely used.

Table 2: Determinants for price volatility of onion in Lasalgaon market.

Sr. No	Variables	Regression Coefficients	Standard error	P-value
1	MEP (X_1)	1621.744**	674.47186	0.0370
2	Arrivals (X_2)	-0.0523	0.1327803	0.7017
3	Rainfall (X_3)	2103.118**	881.7125	0.0382
4	Storage unit (X_4)	-111.190	147.48792	0.4682

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

Determinants of Onion Price Volatility in Satara Market

Table 03 presents the regression estimates for factors influencing onion price volatility in Satara APMC, which represents a relatively low-arrival onion market compared to Solapur and Lasalgaon. Owing to its smaller market size and limited market integration, price behaviour in Satara is more sensitive to policy shocks and local supply variations.

Minimum Export Price (MEP)

The coefficient of MEP (X_1) is positive (1944.381) and highly significant at the 1 percent level ($p = 0.0011$), indicating a strong influence of export policy on onion price volatility in the Satara market. Even though Satara is not a major export-oriented market, changes in MEP indirectly affect local prices through spillover effects from larger reference markets, particularly Lasalgaon and Solapur.

Frequent export policy interventions reduce market predictability and transmit volatility across interconnected markets. Similar transmission effects of export policy shocks on smaller domestic markets have been documented by Chand *et al.* (2017)^[2].

Market Arrivals

The coefficient for arrivals (X_2) is negative (-28.5422) and statistically significant at the 10 percent level ($p = 0.0973$), suggesting that increased arrivals tend to reduce price volatility in the Satara market. Unlike large markets, Satara has lower and irregular arrivals, and periods of higher inflow improve supply consistency, thereby stabilising prices. This result highlights the importance of physical supply in smaller markets, where even moderate increases in arrivals can dampen price fluctuations. Similar findings for small and semi-regulated markets were reported by Birthal *et al.* (2019)^[1].

Rainfall

Rainfall (X_3) exhibits a positive coefficient (1454.571) and is statistically significant at the 5 percent level ($p = 0.0189$),

indicating that climatic variability plays an important role in driving onion price volatility in Satara. Rainfall affects production conditions, harvest timing, and post-harvest losses, especially in regions with limited storage and handling infrastructure. Unseasonal rainfall increases supply uncertainty and quality deterioration, thereby amplifying price instability. The significant role of rainfall in onion price volatility has also been highlighted by Sarker and Pal (2014)^[5] and Vasanthi *et al.* (2024)^[6].

Storage Units

The coefficient of storage units (X_4) is negative (-1.1317) but statistically non-significant ($p = 0.9914$), indicating that storage infrastructure has not contributed meaningfully to price stabilisation in the Satara market. This may be due to the limited availability and adoption of scientific onion storage facilities, coupled with lower market throughput, which restricts the effective utilisation of storage units. Earlier studies have similarly observed that storage infrastructure alone is insufficient to stabilise prices unless supported by scale and modern technology (Birthal *et al.*, 2019)^[1].

Table 3: Determinants for price volatility of onion in Satara market.

Sr. No	Variables	Regression Coefficients	Standard error	P-value
1	MEP (X_1)	1944.381***	433.603	0.0011
2	Arrivals (X_2)	-28.5422*	15.605	0.0973
3	Rainfall (X_3)	1454.571**	520.629	0.0189
4	Storage unit (X_4)	-1.1317	103.379	0.9914

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

Conclusion

The study examined the determinants of onion price volatility in selected APMC markets of Maharashtra using Multiple Linear Regression Analysis. The findings indicate that Minimum Export Price (MEP) and rainfall variability are the most significant determinants of onion price volatility across the selected markets. The positive and significant impact of MEP suggests that frequent export policy interventions increase market uncertainty and contribute to price fluctuations. Similarly, rainfall variability significantly influences volatility through its effects on production, storage losses, crop quality, and market arrivals. Market arrivals exhibited mixed effects across markets. In the smaller Satara market, higher arrivals significantly reduced price volatility, whereas arrivals were statistically insignificant in the larger and more integrated markets of Lasalgaon and Solapur. Storage infrastructure did not exhibit a statistically significant effect on price volatility, indicating that existing storage facilities may be inadequate or insufficiently modernized to effectively stabilize onion markets.

Overall, the results suggest that policy-related and climatic factors exert a greater influence on onion price volatility than physical market factors. Therefore, improving policy consistency, strengthening climate resilience, and expanding scientific storage infrastructure are essential for enhancing price stability in Maharashtra's onion marketing system.

Policy Implications

1. Ensure Stability in Export Policy: Frequent revisions in MEP should be minimized. A predictable export policy framework can reduce uncertainty and market volatility.

- 2. Expand Scientific Onion Storage Infrastructure:** Increase investment in modern onion storage structures under MIDH and state horticulture schemes. Encourage farmer groups and FPOs to adopt scientific storage practices.
- 3. Develop Climate-Resilient Onion Production Systems:** Promote weather-based advisories, drought-tolerant varieties, and improved drainage systems to reduce rainfall-related risks.
- 4. Strengthen Market Intelligence Systems:** Real-time dissemination of price, arrivals, Rainfall and export information can improve farmer decision-making and reduce panic selling.
- 5. Promote Decentralized Storage and Aggregation Centres:** Establish village-level storage and aggregation facilities in major onion-producing districts.

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