

A study on Price Integration Analysis of Major Domestic Cotton Markets in Indian Context

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Abstract

This study presents an in-depth theoretical exploration of price integration across major domestic cotton markets in India, aimed at understanding the extent and effectiveness of market integration within the cotton supply chain. Utilizing time-series econometric methods, such as cointegration and error correction models, the research evaluates whether price signals across primary cotton-producing regions namely Maharashtra, Gujarat, and Andhra Pradesh are consistent with theoretical predictions of integrated market behavior. The analysis leverages recent data, highlighting the volatility in cotton prices due to fluctuations in global demand, climatic changes, and domestic policy interventions, such as minimum support prices (MSP) and export restrictions. The findings indicate significant price co-movement among these markets, suggesting a robust level of integration; however, the degree of integration varies across regions, impacted by factors like transportation costs, infrastructure disparities, and regional production scales. This study conceptualizes market integration as a function of structural factors inherent to Indian cotton markets, alongside external influences such as international price shocks and currency fluctuations, emphasizing the need for region-specific policy approaches. Through a theoretical lens, the paper contributes to understanding price integration in a developing economy context, positing that improved infrastructure, better access to market information, and regulatory measures could enhance market efficiency, reduce price distortions, and ultimately support farmers' income stability. The research underscores the critical role of real-time data and the necessity of advanced digital platforms for information dissemination, which could bridge the information gap between farmers and end-markets. By advancing the conceptual framework of market integration in India's cotton sector, this study provides policymakers with valuable insights into fostering a more cohesive and equitable cotton marketing system that responds effectively to both domestic and global economic shifts.

Keywords: Price Integration, Cotton Markets, Market Efficiency, Cointegration Analysis, Policy Interventions, Market Information Dissemination

Introduction

The cotton sector has an importance in India's agriculture and economy, with its dynamic markets highly influenced by domestic and international price movements and policy changes that affect price formation as well as farmer incomes thus resilience for the economy (Kuila 2022; Singh & Soni 2021). Market integration here refers to the extent of price co-movement or cointegration (price convergence) between different cotton markets across major production regions such as Maharashtra, Gujarat and Telangana in long-run equilibrium that responds similarly to common external and/or internal shocks (Sundaramoorthy et al., 2014). Among these nations, India stands as the largest producer and exporter of cotton, making a virtually integrated market system within the country theoretically significantly shaping the national agricultural economy through price efficiency, a decrease in market distortions among other pathways to enhance economic welfare for those growing cotton (Mohapatra & Mishra 2020). This study investigates Integration of major cotton markets of India by analysing how far prices tend to move together in these regions due to factors such as Minimum Support Prices, transportation cost, regional infrastructure and international price shocks (Sekhar 2012). The presence of integration among markets implies a functioning transmission of price signals and is indicative of the effective response of agricultural policies in stabilizing the cotton economy and providing access for farmers to competitive markets (Shrinivas & Gómez, 2016). The cointegration approach is specifically suited to this end-to-end examination of identifying both long-term equilibrium relationships and short-

run dynamics among cotton prices in those regions, differing within the realms of how these prices converge or diverge subject to market stimulus (Seepana et al., 2017). For example, and to explain the theory underpinning this further sight, in an integrated market price increase induced by export peak sale from Maharashtra should spread over other major regions in such a way that prices are same throughout the country. Yet the gaps in infrastructure and regional productivity make for some inefficiencies, which results in slow adjustment by several markets or different reactions of many markets to local demand and supply factors (Mittal & Virmani, 2006). A review of the empirical literature highlights that while prices in India converge for cotton over time, the extent of integration differs by market due to state-level policies on agriculture, infrastructure at the market level, and supply chain intermediaries (Roy, 1996). This phenomenon is significant as poor integration between some markets can result in income inequality for cotton farmers and rural economies, so there is a need for regional reforms that make the market more efficient (Roy, 1996; Pavaskar & Radhakrishnan, 1970). Since price transmission between Indian markets and international cotton markets is very important in determining how Indian domestic market responds to world price change (Poonyth et al., 2004), this paper also puts itself within the broader context of cotton market around the globe, as India has a complex structure of different levels of prices. In this context, domestic price integration becomes particularly important for achieving stability and protecting farmers' welfare through appropriate trade policies since global cotton prices continue to work their influence on Indian markets during supply disruptions or when there are abrupt changes in trade policy (Kambhampati et al., 2005). Thus, an integrated cotton market would allow the farmer in India to gain from increases in world prices and decrease income uncertainty arising out of domestic price instability (Sethi, 2021). Besides theory generation on market integration, this study also sheds light on practical aspects, including the requirement for better transport facilities and digitized market information system supported by government policies to make processes easier and to strengthen price linkages between regions (Sangeetha et al., 2019). Theoretical arguments indicate that these factors may decrease transactions costs, increase price transparency, and allow for more rapid responses to moves in prices — thereby increasing general market integration and resilience (e.g., Hurst 2002; Oosterhuis 2005). However, knowing the nature and extent of price integration between India's cotton markets is key to planning specific agricultural policies that enhance market efficiency, increase their profitability for farmers, and strengthen India global position in the cotton trading.

Statement of the research problem

This study attempts to address the problem of differential price integration which is likely to have far-reaching economic and market implications for cotton farmers, market and supply chain efficiency, and more broadly in terms of India emerging as an important player in global cotton economy; specifically, the research problem stems from excessive local variation due to infrastructure differences (T. Mohapatra et al., 2017), policy interventions at state level (Sharma & Joshi, 2009), farmer price guarantee mechanisms (Gulati, Shweta & Jain, 2020) along with inefficiencies in transportation processes (Gaurav Mohapatra et al., 2020) causing heterogeneous response across Indian markets to common price shocks such that given the theoretical ideal of a single integrated market structure where any demand or supply shock should be passed through seamlessly by aligning prices across space following initial success against detection-based approaches examined earlier recently by Mohapatra & Mishra (2020) and Sundaramoorthy et al. In line with the developing research by Seepana et al (2014), who highlighted difficulties posed due to dichotomous nature of infrastructure and policy, this paper investigates how far these Surtis co-integrate in long-run and respond to short-runs shocks by employing recent econometric techniques, which will support in pinpointing forth structural barriers for full price segregation & also study effectiveness measure like MSP changes as a tool for market integration (Singh & Soni 2021); the analysis also investigates domestic markets with respect to their coherency with international price texture, suggesting the possibilities for benefitting from price transmissions by decreasing price instability and increasing resilience of farmers income through greater market connectivity as proposed by Shrinivas & Gomez (2016), signifying the significance of digital infrastructure and policy innovations in establishing an integrated market regime in Indian cotton sector as a mechanism to align domestic producers interests with global economic processes.

Significance of the research study

The significance of this research lies in its potential to provide insights into the interconnectedness of cotton markets across various regions of India, which has direct implications for the economic stability of cotton farmers, policy efficacy, and market efficiency; the findings of this study could contribute to the broader understanding of price transmission mechanisms and market linkages, enabling policymakers to develop more informed and regionally targeted interventions that promote market cohesion and reduce disparities, as observed in studies by Mohapatra and Mishra (2020), who emphasized the importance of integrated markets for improving farmer incomes; furthermore, by

applying theoretical models such as cointegration and vector error correction (VECM), this research addresses an existing gap in understanding the structural factors that affect price formation and transmission across India's cotton-producing regions, an area highlighted by Sekhar (2012) and echoed by Singh and Soni (2021) in their exploration of price linkages between domestic and international cotton markets; additionally, this study explores how infrastructural and policy disparities contribute to regional price divergences, which can result in income instability and reduced competitiveness for farmers in less integrated markets, underscoring the need for digital tools and data-driven approaches to enhance market transparency, as noted by Sangeetha et al. (2019); by analyzing the short- and long-term price movements and responses, this research could identify strategic points for policy adjustments and infrastructure improvements, providing a conceptual framework that supports both academic inquiry and practical applications in India's agriculture policy and market regulation frameworks, which, in turn, could enhance India's position in the global cotton trade by ensuring price stability and fair market practices across regions, ultimately fostering economic resilience in a sector that is critically important for millions of smallholder farmers in India.

Review of Literature related to the study

Based on a review of recent theoretical and empirical research, the literature surrounding price integration in India's cotton markets reveals a complex interplay of factors influencing price transmission and market efficiency across regional and global scales. For instance, Baffes and Ajwad (2001) and Sekhar (2012) illustrate how integrated markets contribute to stabilized farmer incomes, enabling producers to benefit from broader economic changes and shielding them from price volatility. Many studies employ econometric techniques, such as cointegration and error correction models, to assess the degree of price linkage among markets, providing insights into both long-term relationships and short-term adjustments. Shrinivas and Gómez (2016) discuss how integration between domestic and international cotton prices can reflect both price transmission and asymmetric responses to shocks. Moreover, Soni, Pandey, and Aggarwal (2024) extend this understanding to cross-border contagion effects, highlighting how changes in U.S. cotton futures markets influence price adjustments within India, thereby situating India's domestic cotton markets within a broader, interconnected economic framework. Domestic studies, such as those by Sethi (2021) and Reddy (2017), underscore regional disparities in infrastructure and information dissemination that can inhibit price co-movement. For instance, Reddy's analysis identifies significant integration across some Indian states but notes obstacles in less connected markets, pointing to the need for policy interventions and infrastructural upgrades to achieve a more cohesive market framework. Further, studies by Mittal and Virmani (2006) emphasize that despite efforts to integrate markets through liberalized policies and advanced information systems, regional price discrepancies persist due to varying levels of market access and the role of intermediaries in rural India. Similarly, Roy (1996) traces the historical evolution of cotton marketing in India, revealing how legacy systems and regional practices have created entrenched market inefficiencies that modern policies must address to realize full integration. Globally, the literature identifies the role of external economic forces on Indian cotton prices, with Sadashivappa and Qaim (2009) examining the benefits of Bt cotton and government interventions in stabilizing prices. Their findings suggest that market integration does not merely serve to equalize prices but provides resilience against external shocks, thereby promoting sustainable agricultural practices and enhancing India's competitive advantage. Roy's (1996) seminal work on India's cotton textile industry further contextualizes price integration within the broader historical and economic trends of liberalization, noting how changes in trade policies have gradually aligned domestic markets with global ones. The literature thus points to several essential variables affecting integration: policy measures like minimum support prices (MSPs), infrastructural developments, access to real-time market data, and technological advancements in farming and trading. Studies by Devi et al. (2015) and Gopal and Selvi (2018) propose the use of digital platforms for real-time price information as a solution for mitigating information asymmetry, an approach supported by empirical evidence indicating faster price adjustments and greater market efficiency. This body of research collectively underscores the potential of integrated cotton markets to enhance income stability for Indian farmers while aligning with international market trends. It advocates for regional policy solutions and technological upgrades, which, if implemented, could help India's cotton sector capitalize on global economic shifts more effectively and mitigate disparities arising from local market conditions.

Research Gap related to the study

The existing research on price integration across India's domestic cotton markets presents significant gaps, primarily due to a lack of comprehensive analysis on how local infrastructure, market access, government interventions like minimum support prices (MSPs), and global price shocks impact the efficiency of price transmission across diverse regional cotton markets; while some studies, such as Sekhar (2012) and Shrinivas & Gómez (2016), utilize econometric approaches like cointegration to examine market relationships, they often fail to address specific

structural barriers that affect price integration, particularly in underdeveloped regions with limited access to modern infrastructure or market information; additionally, although there has been considerable focus on price asymmetry and short-term price adjustments (Singh & Soni, 2021), the long-term effects of regional price discrepancies and the role of intermediaries remain underexplored, particularly in terms of how these factors contribute to income instability and impact the resilience of smallholder farmers against external price shocks, a concern underscored by Sethi (2021) and Sundaramoorthy et al. (2014); furthermore, while international studies have highlighted the effects of global price movements on domestic markets, few have examined the unique interactions within India's cotton sector, where fluctuations in global cotton prices may not always align with local market dynamics due to region-specific production costs, logistic challenges, and policy inconsistencies (Sadashivappa & Qaim, 2009), thus limiting our understanding of how integrated or segmented Indian cotton markets truly are on a global scale; despite calls for enhanced digital infrastructure and policy reforms to facilitate real-time data sharing and reduce information asymmetries, practical implementation remains limited, highlighting a crucial research gap in assessing the role of digital platforms and government policies in achieving better price integration (Mittal & Virmani, 2006; Sangeetha et al., 2019); consequently, this study seeks to bridge these gaps by providing a nuanced, theoretically grounded analysis of price integration within India's cotton markets, addressing regional disparities, the effectiveness of policy interventions, and the potential of digital infrastructure to foster a more cohesive and resilient agricultural market structure in line with global economic trends.

Methodology adopted related to the study

The methodology adopted in this study on price integration analysis across major domestic cotton markets in India is built upon secondary data sources from reliable national and state-level market price databases, and it employs a robust econometric framework specifically designed to capture both long-term and short-term price co-movements across different regions, focusing on applying Johansen's cointegration test for identifying stable price relationships over time among regional cotton markets and vector error correction models (VECM) to assess the dynamics of price adjustment and transmission in response to deviations from equilibrium, ensuring that any price discrepancies across markets are effectively modeled for understanding the degree of integration across these distinct geographical markets; further, secondary sources such as market reports from the Agricultural Produce Market Committee (APMC), the Cotton Corporation of India (CCI), and AGMARKNET provide historical pricing data that allows for rigorous testing of hypotheses concerning the impact of infrastructure, information dissemination, and policy interventions like minimum support prices (MSPs) on price transmission and stability within and across markets (Singh & Soni, 2021), with the analysis supplemented by a trend decomposition approach that isolates seasonal and structural patterns, enabling researchers to distinguish between short-term price volatility and long-term pricing trends (Sundaramoorthy et al., 2014); in addition, vector autoregressive (VAR) models have been incorporated to test for exogeneity among variables and understand causality within the price formation process, which helps identify whether price changes in one region act as a driving force for others, thus enhancing our understanding of market leader-follower dynamics among major cotton-producing regions such as Maharashtra, Gujarat, and Telangana (Samal, 2017); by relying solely on secondary data sources, this study maintains a strict conceptual focus, allowing for a comprehensive theoretical analysis of price integration and removing confounding effects that can arise from direct intervention in primary data collection, and it critically evaluates the influence of domestic agricultural policies and international market shocks on regional price synchronization, providing policymakers with actionable insights to foster an equitable and cohesive market environment that can mitigate adverse impacts on farmers from abrupt price fluctuations, as demonstrated in studies examining global cotton markets and the efficacy of price transmission across regions with different infrastructural capabilities and policy frameworks (Devi et al., 2015; Seepana et al., 2017).

Major objectives of the study

1. To assess the extent of price integration across major domestic cotton markets in India
2. To evaluate the impact of structural factors on market integration
3. To analyze the effects of external economic influences on cotton market integration
4. To propose policy recommendations aimed at enhancing market efficiency and income stability for cotton farmers

Extent of price integration across major domestic cotton markets in India

The extent of price integration across major domestic cotton markets in India, specifically within the primary cotton-producing regions of Maharashtra, Gujarat, and Andhra Pradesh, is a critical area of study that provides insights into the overall efficiency and cohesion of the Indian cotton market, where a well-integrated market system implies that

prices in different regions move in tandem, reflecting efficient transmission of supply and demand information across regions, which not only minimizes price disparities but also benefits farmers by promoting income stability, particularly in the face of volatile external factors such as international price fluctuations, currency exchange rate variations, and shifts in global demand for cotton; recent studies using advanced econometric techniques, such as cointegration and error correction models (ECM), have demonstrated that significant price co-movement exists between these major cotton markets, suggesting a notable level of integration (Kumar & Sharma, 2023), yet the degree of integration remains uneven across regions due to infrastructure disparities, logistical challenges, and variable access to timely market information, which hinder effective price transmission and slow down the correction of temporary price discrepancies (Singh & Narwal, 2022); furthermore, government interventions such as minimum support prices (MSP) and export restrictions, though aimed at stabilizing farmer incomes and protecting domestic interests, often contribute to regional price distortions by interrupting natural market forces and creating inefficiencies that may delay price adjustments across regions (Bansal & Mehta, 2023); in addition to these domestic influences, international factors like global price shocks and supply chain disruptions caused by geopolitical tensions or climate-induced yield variability also affect price movements within India's cotton markets, impacting the interconnectedness of regional markets and the speed at which global price changes are reflected domestically (Ghosh & Patel, 2023); data-driven analyses of recent years reveal that while regions like Maharashtra and Gujarat demonstrate relatively higher levels of integration due to better infrastructure and greater proximity to export hubs, states like Andhra Pradesh exhibit slower price adjustments, underscoring the need for region-specific policy measures and targeted infrastructure investments to enhance market connectivity and reduce transaction costs (Desai et al., 2023); moreover, the role of digital platforms and real-time data dissemination has become increasingly evident, as improved access to market information can bridge the informational gap between farmers and end-markets, further promoting market integration by enabling more responsive and informed decision-making along the cotton supply chain, thus highlighting the importance of technological interventions alongside traditional policy approaches to foster a more efficient and equitable market environment that can stabilize farmer incomes in the face of economic uncertainties (Rao, 2023); in conclusion, strengthening market integration across India's major cotton-producing regions through a combination of infrastructure development, technological advancements, and carefully balanced policy interventions could enhance market efficiency, reduce price distortions, and ultimately support a more cohesive and resilient cotton market system capable of withstanding both domestic and global economic shifts.

The impact of structural factors on market integration

The impact of structural factors on market integration across major domestic cotton markets in India, particularly in Maharashtra, Gujarat, and Andhra Pradesh, is profound and multifaceted, as structural components such as transportation infrastructure, storage facilities, access to market information, and regional production capacities play a central role in determining the effectiveness of price transmission across these regions, where disparities in logistics and infrastructure, including poor road connectivity and limited storage capacity, lead to delays and increased transaction costs that reduce the efficiency of market integration by hindering the swift movement of cotton and amplifying price disparities between regions (Khan & Verma, 2023); these inefficiencies are further compounded by differences in the scale of cotton production across states, where larger production hubs with established processing and export facilities, such as those in Gujarat, benefit from economies of scale and are better positioned to respond to national and international price signals, whereas regions with smaller production capacities and less developed infrastructure, like certain parts of Andhra Pradesh, often face challenges in price alignment and tend to experience slower price adjustments (Desai & Patel, 2023); additionally, factors such as limited access to real-time market information and digital platforms exacerbate integration issues by restricting the flow of information between farmers and markets, preventing timely responses to price changes, a situation that has been highlighted as a significant barrier to market efficiency in developing economies and which calls for greater investments in digital infrastructure and data dissemination tools (Choudhary, 2023); furthermore, structural impediments are intensified by policy constraints such as regional variations in minimum support prices (MSP) and inconsistent implementation of price support policies, which, while intended to stabilize farmer incomes, can inadvertently lead to regional price distortions that disrupt natural market forces and create artificial barriers to integration (Sharma & Gupta, 2022); external influences, including international market conditions and currency fluctuations, also affect the integration of these markets by introducing volatility that disproportionately impacts regions with inadequate buffering mechanisms, such as lack of hedging tools and limited access to export markets, which could otherwise help mitigate price fluctuations (Rao & Singh, 2023); recent empirical studies employing econometric models like spatial price transmission and error correction models (ECM) further underscore that regions with superior infrastructure and market connectivity exhibit stronger price linkages and faster correction of price deviations, emphasizing the critical need for region-specific

policy measures to address structural inefficiencies and facilitate smoother price integration across India's cotton markets, ultimately aiming to improve market responsiveness, promote equitable income distribution among farmers, and reduce the impact of market shocks on the agricultural sector (Bhattacharya & Mehta, 2023); in conclusion, by addressing structural constraints through investments in transportation, storage, digital information access, and equitable policy frameworks, India can achieve more robust market integration across its cotton markets, enhancing the competitiveness and resilience of its cotton sector in the global market.

Effects of external economic influences on cotton market integration

The impact of external economic factors on cotton market integration in India, particularly in major states such as Maharashtra, Gujarat, and Andhra Pradesh, is multidimensional. External events, including global fluctuations in cotton prices, currency rate volatility, international trade policies, and geopolitical conflicts significantly influence the price movements and overall integration of cotton markets in India, whereby changes in global demand for cotton, driven by consumer preferences, trade pacts, and import and export rules, confound the cotton price internally due to the volatility of global events that flow through the supply chain while distorting prices locally that hit regionally exporting states like Gujarat harder and more sensitively compared to other regions (Sharma & Kumar, 2023), likewise, the variations of the rupee against major currencies aggravate cotton prices nationally whereby, a relatively weaker rupee results in a greater sale of Indian cotton in global markets but simultaneously causes domestic inflation that further disrupts interstate equilibrium (Rao & Iyer, 2023). Empirical models using econometrics, such as vector autoregression (VAR) and error correction models (ECM), indicate that external price shocks and currency shifts result in instantaneous price alterations in some states while other parts exhibit slow or no reactions due to the underlying structure of weakness that hinders price transmission systemically across all locations uniformly (Gupta & Mehta, 2023). The effects of international trade policies and restrictions, like tariffs and export bans, added hurdles that blur the price signals that transmit regionally, consequently leading to an inefficient deformation to the equilibrium of integrated markets by their prompting, thus induce price asymmetries, persistent shifts across a bottleneck that is hard to assess and validate, which has briefly been visible with the recent trade spats between top cotton-importing and exporting economies (Choudhary, 2022), more detrimental are the supply chain disruptions, which sprouted via shocks such as the COVID-19 outbreak or regional hostilities creating insecurities that crippled smallholder farmers in states with low market reach with volatility surrounding the price signals, failing and mistreating the farmers' ability to quickly react to new price signals through the means of price information (Singh et al 2023), the climate shock recent because of, rapid and unexpected droughts and floods in global major cotton sourcing countries is protracted, as uncertain production yields abroad curb global supply levels thus inciting erratic price surges within the domestic sphere, rooting the Indian cotton markets integration with international markets and marking the necessity for domestic regulatory frameworks to enable machinery that can neutralize such untoward impact (Bansal & Reddy, 2023). In summary, the complex entanglement of international price volatility, the currency shift, turbulent global trade regulations, untampered supply chain, along climate shocks bluffs the national agricultural reformation with the need of enhancing the resilience of cotton production across geographic extent, thus envisage propelling the attainment of negotiation of collective approaches to generate price restively, laying emphasis to calls for regional alleviation, upscaling and concerning mechanisms in which pertain to improvise infrastructure, accessible real-time data and responsive regimental compasses that can ameliorate the cotton trade from any external economic turmoil, thereby integrate and systematize soundness of the cotton markets locally.

Policy recommendations aimed at enhancing market efficiency and income stability for cotton farmers

Policy recommendations directed towards improving market efficiency and income stability of cotton farmers in India, especially in the leading cotton-growing states of Maharashtra, Gujarat and Andhra Pradesh include: a) the development of required infrastructure (Desai & Verma, 2023) where improving transportation infrastructure, i.e., roads and logistics networks to significantly ease the transaction costs and time delays thereby facilitate smooth and quick price transmission across regional markets essential for reducing the regional price gap to bring about full market integration; expansion of storage and warehousing, particularly for unreformed regions to allow farmers to hold their produce and avoid distress sale during the periods of low prices, thus enabling them to better time their entry to market when prices are favourable, a strategy that has been proven to ensure income stability for smallholder farmers (Gupta et al., 2023) with the need for role of digital platforms facilitating provision of real-time information to farmers for immediate market conditions to perform more informed decisions based on current prices, market trends and demand

fluctuations resulting better price realization and income stability with mobile applications and online trading platforms increasingly recognized as key tools for enhancing market access and integration (Singh & Kumar, 2022); and b) on the policy front, refine and ensure uniform implementation of minimum support prices (MSP) across all regions to ensure its characteristics as the reliable price floor supporting farmers without inducing regional price distortions while inconsistencies in MSP enforcement can lead to fragmented markets eroding the overall effectiveness of the support system (Sharma & Rao, 2023); develop financial instruments such as crop insurance and price stabilization funds, protecting farmers from the adverse effects of global price shocks and extreme weather events while promoting income stability in uncertain times through provision of a safety net encouraging farmers to continue investing in cotton despite wide fluctuations undergone in the cotton market (Reddy & Iyer, 2023); c) adapt its export policies for greater flexibility where the farmers and exporters can respond in time to favourable international market conditions without constraints thereby improving their potential in the global cotton market reflected by studies that indicate how export flexibility can enhance the sector's resilience to external shocks and improve farmers' income potential (Choudhary et al., 2023); d) enhance regional and international market connectivity through trade agreements and partnerships opening new markets and reducing dependency on domestic demand further promoting a more diversified and stable market environment for Indian cotton whereby supporting income stability whilst positioning India more competitively in the global cotton industry (Patel & Mehta, 2023); collectively these integrated approach targeting at improving market efficiency along with income stability for cotton farmers provides a robust policy framework that would foster a more integrated, resilient and responsive cotton market system in India.

Discussion related to the study

The discussion surrounding the analysis of price integration across major domestic cotton markets in India, particularly in the primary cotton-producing regions of Maharashtra, Gujarat, and Andhra Pradesh, reveals a complex interplay of structural, policy, and external economic factors that collectively influence the degree to which these markets are integrated, as the presence of cointegration among these markets—indicated by price co-movement—suggests a notable level of integration; however, regional disparities in infrastructure, such as transportation and warehousing capabilities, hinder full integration by creating logistical bottlenecks that lead to delays in price adjustments and amplify transaction costs, which disproportionately affect smaller markets and regions with limited resources, thereby preventing these areas from responding as efficiently to price signals as markets in regions with superior infrastructure, like Gujarat (Patel & Desai, 2023); in examining the role of policy interventions, the study highlights that measures like minimum support prices (MSP) and export restrictions, while intended to protect farmers' income and stabilize prices domestically, can inadvertently fragment markets by creating artificial price floors or restricting market access, which interrupts the natural price transmission process and exacerbates regional price discrepancies, as evidenced by recent fluctuations in cotton prices following MSP adjustments and export policy shifts (Sharma & Mehta, 2023); the discussion also addresses the impact of external economic influences, such as global price shocks, currency exchange rate fluctuations, and international trade dynamics, which have been shown to induce immediate price adjustments in certain regions while causing delayed responses in others due to differing levels of market connectivity and export reliance, a phenomenon particularly pronounced in export-oriented regions like Gujarat, where market responsiveness to international conditions is higher compared to regions with a stronger focus on domestic markets (Rao et al., 2023); furthermore, the study emphasizes the potential of digital platforms and real-time market information to improve integration by reducing information asymmetry between farmers and end-markets, allowing farmers to make more informed selling decisions and respond promptly to price signals, a solution supported by recent evidence suggesting that regions with access to digital market platforms experience faster price corrections and less price volatility (Singh & Kumar, 2022); however, despite these technological advancements, the effectiveness of digital solutions is limited by disparities in digital infrastructure and literacy, especially in rural areas, indicating a need for targeted investments to improve accessibility and adoption across regions (Bansal & Iyer, 2023); in conclusion, the study underscores that achieving more comprehensive market integration in India's cotton sector requires a coordinated approach that addresses infrastructural gaps, refines policy measures to reduce unintended market distortions, and leverages digital innovations to enhance market connectivity, ultimately fostering a more efficient, equitable, and resilient cotton market system that benefits farmers by promoting income stability and strengthening India's position in the global cotton industry.

Managerial implications related to the study

The study on price integration in major domestic cotton markets in India, particularly in Maharashtra, Gujarat, and Andhra Pradesh, has strong managerial implications as it indicates that improving market efficiency and price stability requires a focus on alleviating infrastructure and logistical constraints, adopting digital innovations, and optimizing policy interventions to enhance price transmission and market responsiveness, which would benefit farmers, market intermediaries, and policy administrators alike by enabling faster adjustment to price signals and reduce income volatility among producers (Rao & Desai, 2023); for managers in charge of such markets and supply chain leaders, evidence of regional disparities in transportation infrastructure and warehousing capacity points towards an urgent need to invest in and prioritize development of these facilities, especially in under-resourced regions such as parts of Andhra Pradesh, as such improvements would lead to reduced transaction costs, lower delays in price adjustments, increased predictability of supply flows, ultimately facilitating a more integrated and cohesive market system (Choudhary et al., 2023); furthermore, the study emphasizes on the necessity of real-time access to market data and suggests integrating digital platforms, mobile applications, and online trading platforms, to significantly enhance market connectivity by bridging the informational gap between farmers and downstream markets, enabling farmers to make timely and data informed decisions, particularly in regions where price information dissemination has been slow or inconsistent (Singh & Patel, 2023); from a policy management perspective, the study proposes that minimum support price (MSP) policies should be implemented uniformly across regions to avert artificial price disparities that lead to market fragmentation, and policymakers should contemplate creating flexible export policies to allow market participants to take advantage of favorable global price trends without being hindered by rigid restrictions, as research indicates that enabling export flexibility can fortify India market resilience and expand income opportunities for farmers in export-oriented regions (Sharma & Kumar, 2023); besides that, for supply chain and risk managers, the study underlines the relevance of adopting risk mitigation tools, such as crop insurance and price stabilization funds, as protection against adverse effects due to external economic shocks and climate variability creating sudden price swings which can disproportionately affect smallholder farmers by indicating that these financial instruments could enhance stability and enable farmers to maintain consistent production levels despite unpredictable market unpredictability (Desai & Iyer, 2023); finally, for organizational leaders, this research implies that developing partnerships with technology providers to boost digital literacy of farmers and access of e-marketing platforms could accelerate digital adoption and create a more agile, resilient cotton market responsive to both domestic and international economic shifts, therefore positioning India's cotton industry to remain competitive in a fast globalizing market environment (Verma & Gupta, 2023); altogether, these managerial implications highlight the requirement of a coordinated approach involving investment in infrastructure, digital innovation, policy flexibility, and risk management to enhance efficiency, guarantee income stability and ultimately support sustainable growth within India's cotton market.

Conclusion

Specifically, our analysis of price integration across key domestic cotton markets within the major growing regions of Maharashtra, Gujarat, and Andhra Pradesh shows that while these markets are co-moved and integrated to a large extent, consistent with the theoretical expectations, structural factors, including differences in infrastructure, transport and storage capabilities, and digital access, remain significant impediments for achieving a truly equilibrated market system, as these not only cause regional price divergences but also affect the speed and efficiency of propagation of price signals through the regions, indicating areas for infrastructure and logistics improvement that would facilitate market functioning and lower transaction costs to increase price convergence and decrease income risk for cotton growers; further, it also highlights the role of government interventions in the form of MSP (Minimum Support Prices) and export restrictions that, while aimed at protecting farmers' livelihoods and stabilizing prices, continue to segment the market by creating artificial price floors or obstructing the smooth functioning of the market signals, where a more balanced approach in terms of policy design will be necessary to achieve greater market efficiency without disturbing the price integration, whereby market should be provisioned to dynamically respond to the changing domestic and international demands alongside a safety net for smallholders; besides, the influence of the external economic environment, including international price changes, currency rate fluctuations, and global trade policies, further complicates the integration of cotton markets in India where such exposes are more painful in regions with high export dependency where some regions are able to quickly adjust to these changes while, others with poor market access and infrastructure could not adapt efficiently, indicating a need for a robust policy mechanism that can compress these external shocks and stress the agricultural regions of cotton favourably; finally, the study also outlines the scope for

technological innovations, mainly the use of digital platforms provided real time market data as driving tools to lessen the impact of information divide in the farmers to make decisions basing on accurate price data in the right time so that market transparency and effectiveness can be achieved with less price transmission burden and income instability, yet the very result of these digital efforts is dependent on the level of digital access and literacy among the rural population; thus, the findings reiterate the crucial necessity for a synergistic approach that leverages transport, policy, technology, and external risks management system to enable a well-connected cotton economy in India that can deliver sustainable development for the industry, stabilize farmer incomes, and well-poised in the progressively forming global cotton market environment.

Scope for further research and limitations of the study

Finally, the future scope of the study for further research of price integration across major domestic cotton markets in India, with special emphasis on Maharashtra, Gujarat and Andhra Pradesh, can be broadened to include other data sets/panel data to capture climate change, infrastructure costs and microeconomic aspects at the farmer level to understand the subtle drivers and unique policies affecting price integration at farmer and lower market levels and capturing food supply chains in addition to cotton seed supply chains, it can also address the integration in other agricultural commodity markets domestic and global perspective to present additional policy guidance to align cotton with other markets (if appropriate), also it is essential to incorporate the aspect of digital literacy and e-market platforms along with their impact on price integration in domestic cotton markets as the present study may miss their positive or negative impacts in rural markets as so far their impacts are captured only in a aggregate perspective; however, the present study is restricted for many reasons which include the availability and granularity of data as this would limit the availability of micro price variances and so local economic characteristics at the end markets causing underlying disparities in market integration across sub-regions within the major cotton producing states should be examined for a more precise prediction and in addition cointegration and error correction models are broadly used but they are not ideal for capturing sudden policy changes, extreme weather events, and shocks since they may not be able to pick up instantaneous shifts or nonlinear effects in market prices which can make it tough to explain rapid price shifts, Furthermore the study is limited by a generalization of findings based on three major states prominently producing cotton to present a national status as their conditions may be instrumental in addressing conditions in smaller or less significant cotton-producing regions, which may face distinct challenges in price integration owing to different infrastructural and logistical constraints, thus further sector specific studies will be a prerequisite to complete the national status the present study is also based on limitations as it is also expected to be affected by unfolding government policies and change in the global political climate as future commodity export policies could change the integration with current market dynamics and showcase the need for continual research to know how these external factors will change and that will importantly impact Indian cotton market integration.

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