Artificial Intelligence, Digital Agriculture, and Market Power in the United States Agricultural Sector

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Article Info

P-ISSN: 3051-3421
E-ISSN: 3051-343X
Volume: 07
Issue: 01
January - June 2026
Received: 10-01-2026
Accepted: 08-02-2026
Published: 06-03-2026
Page No: 24-35

Abstract
Artificial intelligence is increasingly transforming agricultural production, supply chain management, and commodity market coordination in the United States. While digital technologies have improved productivity and operational efficiency, their influence on market power and competitive dynamics within agricultural markets remains insufficiently understood. This study examines the relationship between artificial intelligence adoption and market power in the United States agricultural sector using an econometric framework grounded in industrial organization theory. The analysis evaluates how artificial intelligence capabilities, digital data infrastructure, and firm scale influence market concentration and pricing power among agricultural firms. Empirical results indicate that firms with higher levels of artificial intelligence adoption demonstrate stronger productivity performance and greater pricing influence in agricultural markets. The findings also show that digital data infrastructure significantly enhances analytical capacity and operational efficiency, reinforcing competitive advantages among technologically advanced firms. At the industry level, the diffusion of artificial intelligence technologies appears to contribute to increased market concentration as larger agribusiness firms expand their technological capabilities. These results highlight the growing importance of digital technologies in shaping agricultural market structures. The study contributes to the literature on digital agriculture and industrial organization by providing new empirical evidence on how artificial intelligence influences market power and competitive dynamics within the agricultural economy.

DOI: https://doi.org/10.54660/JADR.2026.7.1.24-35

Keywords: Artificial intelligence, agricultural markets, market power, digital agriculture, data infrastructure, industrial organization, agricultural economics

Introduction

Artificial intelligence is rapidly transforming the economic landscape across many industries, and this technological shift is increasingly influencing the agricultural sector in the United States. Advances in machine learning, predictive analytics, and automated decision systems have enabled agricultural firms to process large volumes of data related to weather conditions, soil quality, crop yields, and market prices. These technological capabilities are now embedded in precision agriculture systems, supply chain management platforms, and commodity trading operations. As a result, artificial intelligence has become an important tool for improving agricultural productivity, reducing operational uncertainty, and strengthening supply chain coordination within modern food systems (Bronson & Knezevic, 2019) [2].

The growing use of artificial intelligence in agriculture reflects a broader digital transformation that extends from farm-level production to global commodity markets. Agricultural firms increasingly rely on advanced analytics to guide planting decisions, optimize fertilizer use, monitor crop health via remote sensing, and forecast market demand. Data-driven tools enable firms to anticipate price movements and adjust supply chain logistics in ways previously impossible (Opara *et al*, 2026) [12]. These innovations have the potential to improve efficiency across the entire agricultural value chain, including producers, processors, distributors, and retailers.

At the same time, the deployment of advanced technologies may create strategic advantages for firms with access to proprietary data, computational infrastructure, and specialized technical expertise (Wolfert *et al*., 2017) [31].

The United States agricultural industry has long exhibited structural characteristics associated with consolidation and increasing concentration. Over several decades, mergers and acquisitions among seed companies, input suppliers, food processors, and commodity traders have reshaped the competitive structure of agricultural markets. Large agribusiness firms play a dominant role in controlling agricultural inputs, processing facilities, and distribution networks. This concentration has raised concerns among economists and policymakers about the distribution of economic power within the agricultural sector and its potential implications for farm-level profitability and market competition (Howard, 2016; Osho *et al*., 2020) [6, 18].

Artificial intelligence may intensify these structural dynamics by reinforcing the advantages of firms that already possess substantial financial and technological resources. Firms that invest in advanced analytics platforms and large-scale data systems may gain deeper insights into production patterns, market demand, and supply chain efficiency. These capabilities can translate into improved pricing strategies, enhanced operational coordination, and stronger bargaining power within agricultural markets. Smaller producers and independent farms may face challenges in accessing comparable technologies, which could widen competitive gaps between large agribusiness corporations and smaller market participants. Consequently, the integration of artificial intelligence into agricultural markets raises important questions about how technological innovation interacts with existing patterns of market concentration and economic influence (Coble *et al*., 2018; Adams, Osho, G. S., & Yitbarek, 2026) [1, 25].

Beyond production and logistics, artificial intelligence is also influencing the structure of agricultural commodity markets. Algorithmic trading models, predictive pricing systems, and digital marketplaces are increasingly shaping the way agricultural commodities are bought and sold. These digital systems rely heavily on large datasets and advanced computational models, enabling firms to anticipate price fluctuations and respond quickly to changing market conditions. While these tools can increase efficiency and reduce transaction costs, they may also strengthen the market position of firms that possess superior data capabilities. In this context, the adoption of artificial intelligence may alter competitive dynamics within agricultural markets by shifting informational advantages toward technologically advanced organizations.

The transformation of agriculture through digital technologies, therefore, raises important questions for scholars of industrial organization and agricultural economics. Technological innovation has historically played a central role in shaping agricultural productivity and market structures. However, the emergence of artificial intelligence introduces new dimensions related to data ownership, algorithmic decision-making, and digital infrastructure. Understanding how these technological factors influence market power is critical for evaluating the future trajectory of agricultural markets in the United States.

Research Problem

Although digital technologies are becoming increasingly embedded in agricultural production and marketing systems, empirical research examining the economic consequences of artificial intelligence adoption remains limited. Existing studies have largely focused on the productivity benefits of precision agriculture and automated farming technologies. While these contributions highlight the potential efficiency gains from digital innovation, relatively little attention has been devoted to examining how artificial intelligence affects competitive dynamics and market power in agricultural markets.

Market power refers to a firm's ability to influence prices, control market conditions, or shape supply chain relationships, thereby affecting competitors and consumers. In sectors characterized by technological asymmetries, firms with superior access to information and digital capabilities may gain strategic advantages, thereby reinforcing their market position. Artificial intelligence systems rely heavily on large data sets and advanced computational resources, which may not be equally accessible to all agricultural actors. As a result, the diffusion of artificial intelligence technologies could alter market structures by strengthening the dominance of firms that control data infrastructures and digital platforms. Despite these concerns, the interaction between artificial intelligence adoption and agricultural market concentration has not been thoroughly investigated. Questions remain about whether digital technologies promote broader market efficiency or reinforce existing patterns of economic concentration. In particular, limited empirical evidence exists regarding how artificial intelligence influences commodity pricing behavior, farm-level competitiveness, and the bargaining relationships between producers and agribusiness corporations. Addressing this gap is essential for understanding the broader economic implications of technological transformation in agriculture.

Research Objectives

The primary objective of this study is to investigate the relationship between artificial intelligence adoption and market power within the United States agricultural sector. The study seeks to determine whether integrating artificial intelligence technologies alters market concentration, pricing behavior, and competitive dynamics across agricultural markets.

More specifically, the research aims to evaluate whether firms that adopt advanced digital technologies gain measurable advantages in terms of productivity, pricing strategies, and supply chain coordination. By examining these relationships, the study seeks to provide empirical insights into the economic consequences of artificial intelligence within agricultural markets. The findings are expected to contribute to the broader literature on technological innovation, market structure, and industrial organization within the agricultural economy.

Research Hypotheses

This study addresses several research questions related to the role of artificial intelligence in shaping agricultural market outcomes in the United States. The first question examines whether the adoption of artificial intelligence technologies contributes to higher market concentration in agricultural industries. The second question explores whether firms that use artificial intelligence tools possess greater market power than smaller producers that rely on traditional production methods. The third question investigates whether digital agriculture technologies influence commodity pricing behavior and supply chain efficiency.

To guide the empirical analysis, the study tests several hypotheses derived from economic theory and the emerging literature on digital transformation in agriculture.

H1: proposes that the adoption of artificial intelligence technologies is positively associated with higher market concentration in the United States agricultural sector.

H2: proposes that agribusiness firms with advanced artificial intelligence capabilities exhibit greater market power than firms with limited digital infrastructure.

H3: proposes that the use of artificial intelligence improves supply chain efficiency within agricultural markets.

H4: proposes that the adoption of artificial intelligence influences agricultural commodity pricing patterns by enhancing predictive market analytics.

H5: proposes that unequal access to digital technologies contributes to competitive disparities between large agribusiness firms and smaller agricultural producers.

These hypotheses provide a structured framework for examining how technological innovation interacts with market structures to shape economic outcomes within agricultural markets.

Significance of the Study

The growing role of artificial intelligence in agriculture presents both opportunities and challenges for the future of the agricultural economy. On one hand, digital technologies have the potential to enhance productivity, improve resource efficiency, and strengthen supply chain resilience. On the other hand, the uneven distribution of technological capabilities may reinforce existing patterns of economic concentration and market power. Understanding these dynamics is essential for policymakers, regulators, and industry stakeholders who seek to balance technological innovation with fair market competition (Uwakonye *et al*., 2010) [28].

The findings of this study have several important implications. First, the research contributes to the academic literature by providing empirical evidence on the relationship between artificial intelligence adoption and market power in agricultural markets. Second, the results may inform policy discussions on antitrust regulation, digital infrastructure development, and data governance in the agricultural sector. Third, the study may offer insights for farmers and agricultural entrepreneurs on the strategic importance of digital technologies for maintaining competitiveness in modern agricultural markets.

As artificial intelligence continues to expand across agricultural systems, the economic consequences of digital transformation will increasingly shape the structure of agricultural markets. By examining the interaction between technological innovation and market power, this study aims to provide a deeper understanding of how artificial intelligence may shape the future trajectory of U.S. agriculture.

Literature Review

Technological Innovation in Agriculture

Technological innovation has long been a central driver of productivity growth in the agricultural sector. Historical transformations in agriculture have been shaped by successive waves of technological advancement, including mechanization, chemical inputs, biotechnology, and digital information systems. In recent decades, the emergence of precision agriculture has introduced a new stage of technological development that relies heavily on digital technologies, satellite imagery, sensor networks, and data analytics to guide agricultural decision-making. These tools allow producers to monitor soil conditions, crop health, and environmental factors with greater accuracy, thereby enabling more efficient resource allocation and improved production outcomes (Lowenberg DeBoer *et al*., 2020) [9].

Precision agriculture represents a shift from uniform farm management practices toward data-informed decision systems that tailor production strategies to specific field conditions. Technologies such as global positioning systems, remote sensing devices, and variable rate application equipment enable farmers to apply fertilizers, irrigation, and pesticides with greater precision. By reducing input waste and improving crop productivity, these technologies have contributed to increased efficiency across agricultural production systems. The adoption of digital farming tools has also expanded the role of information in agricultural management, transforming farms into data-intensive operations where decision-making is increasingly guided by analytical models and real-time monitoring systems (Schimmelpfennig, 2016) [25].

Alongside precision agriculture, digital technologies have reshaped the broader agricultural value chain by facilitating improved coordination among producers, processors, and distributors. Data-driven management systems enable agricultural firms to monitor supply chain activities, track product flows, and anticipate market demand (Solomon & Nazemzadeh, 2003) [26]. These innovations have enhanced operational efficiency and reduced uncertainty associated with agricultural production and marketing. However, the integration of digital technologies also raises new economic questions related to access, ownership, and control of agricultural data. Firms that possess advanced technological capabilities may gain competitive advantages that extend beyond production efficiency to include strategic influence over market information and decision-making processes.

Artificial Intelligence in Agricultural Production and Supply Chains

Artificial intelligence has emerged as a powerful extension of digital agriculture technologies, offering new capabilities for predictive analytics, automated decision-making, and complex data processing. Machine learning algorithms can analyze large volumes of agricultural data collected from sensors, satellite imagery, weather records, and market databases. These analytical systems allow farmers and agribusiness firms to forecast crop yields, identify disease outbreaks, and optimize production schedules with greater precision than traditional decision methods (Kamilaris & Prenafeta Boldú, 2018; Osho & Uwakonye, 2004) [7].

One of the most significant applications of artificial intelligence in agriculture involves yield prediction and crop monitoring. Advanced machine learning models can process remote sensing data and environmental variables to estimate crop growth patterns and forecast harvest outcomes. These predictions help farmers make timely management decisions on irrigation, fertilization, and pest control. Artificial intelligence is also used to analyze soil conditions and recommend optimal planting strategies that maximize productivity while minimizing resource use. As these technologies continue to evolve, they contribute to a more data-driven approach to agricultural management.

Artificial intelligence is also transforming agricultural machinery and automation systems. Autonomous tractors, robotic harvesters, and intelligent irrigation systems rely on computer vision and machine learning algorithms to perform complex agricultural tasks with minimal human intervention. These technologies can operate continuously and respond to environmental conditions in real time, increasing efficiency and reducing labor requirements. The development of automated farming systems reflects broader trends toward digital integration and technological sophistication within modern agriculture (Liakos *et al*., 2018) [8].

In addition to production activities, artificial intelligence is increasingly applied within agricultural supply chains and commodity markets. Predictive analytics tools help firms anticipate demand fluctuations, optimize transportation routes, and manage inventory levels across distribution networks. Digital platforms that integrate artificial intelligence algorithms can analyze historical price trends, weather conditions, and global trade patterns to forecast commodity market movements. These capabilities enable agribusiness firms to make strategic decisions regarding procurement, storage, and marketing. As a result, artificial intelligence is increasingly shaping the efficiency and responsiveness of agricultural supply chains.

Market Power and Industrial Organization in Agriculture

The study of market power in agriculture is closely connected to the broader field of industrial organization, which examines how market structures influence firm behavior and economic outcomes. Market power refers to a firm's ability to influence prices, control supply conditions, or affect competitive dynamics in a market. In industries characterized by high levels of concentration, dominant firms may have the capacity to shape market outcomes that affect both producers and consumers (Carlton & Perloff, 2015) [3].

Agricultural markets have historically exhibited oligopoly-like structural characteristics, particularly in input supply, food processing, and commodity trading. Over time, consolidation among agricultural firms has led to fewer large corporations controlling significant shares of production and distribution networks. Economists have examined how these structural changes influence price formation, farmer bargaining power, and the distribution of economic benefits within agricultural value chains (MacDonald *et al*., 2018) [10].

Industrial organization theory suggests that firms with greater market concentration may exercise strategic influence over pricing and supply decisions. When a small number of firms dominate a market, they may be able to coordinate pricing behavior, restrict output, or influence contract terms offered to producers. These dynamics have raised concerns regarding the potential impact of consolidation on competition within agricultural markets. While some scholars argue that large-scale firms improve efficiency through economies of scale, others emphasize the risks associated with reduced competition and unequal bargaining relationships between agribusiness firms and independent producers (Osho *et al*, 2005) [17].

Technological innovation adds a new dimension to the analysis of market power in agriculture. Firms with advanced technological capabilities can enhance their competitive position by improving operational efficiency, reducing costs, and acquiring superior market information. Artificial intelligence technologies, in particular, allow firms to process complex data and generate predictive insights that inform strategic decision-making. As a result, technological advantages may reinforce the market position of firms that already possess substantial economic resources and infrastructure.

Digital Platforms and Data Advantage

The growing importance of digital platforms in agriculture has introduced new forms of competitive advantage, including data ownership and algorithmic decision-making systems. Agricultural data platforms collect information from a wide range of sources, including satellite imagery, field sensors, machinery telemetry, and farm management software. These platforms aggregate large volumes of data that can be analyzed using artificial intelligence algorithms to generate insights into crop performance, environmental conditions, and market trends (Wolfert *et al*., 2017; Dieli *et al*., 2020) [5]

Control over large agricultural data sets can create significant strategic advantages for firms that operate digital platforms. Data accumulation enables companies to refine predictive models, improve algorithmic accuracy, and develop proprietary insights that competitors cannot easily access. In many cases, agricultural technology companies integrate digital platforms with input supply services, equipment manufacturing, and financial services, creating interconnected ecosystems that reinforce platform operators' influence in agricultural markets.

Economic research on digital platforms suggests that data-driven business models may generate strong network effects. As more users contribute data to a platform, its value increases because the system can generate more accurate predictions and recommendations. This dynamic encourages further adoption and strengthens the platform operator's position. In agricultural contexts, such network effects may lead to increased market concentration if a small number of firms gain control over key digital infrastructures. Smaller producers may become dependent on platform services for agronomic recommendations, market information, and logistical coordination. The concentration of data and algorithmic capabilities may also create barriers to entry for new firms seeking to compete in digital agriculture markets. Developing advanced artificial intelligence systems requires substantial investment in computing resources, data acquisition, and technical expertise. These requirements may limit the ability of smaller firms or independent developers to enter the market. Consequently, the emergence of digital platforms in agriculture raises concerns regarding the distribution of technological power and the potential reinforcement of existing patterns of market dominance.

Research Gap

Although the literature on digital agriculture and artificial intelligence has expanded rapidly in recent years, relatively little empirical research has examined the relationship between artificial intelligence adoption and market power within agricultural markets. Many studies focus primarily on the productivity benefits of precision agriculture technologies and automated farming systems. These contributions provide valuable insights into the potential efficiency gains from technological innovation, yet they often overlook broader questions about market structure and economic concentration.

Similarly, research in agricultural economics has extensively examined issues of market concentration, consolidation, and competition in agricultural industries. However, much of this literature predates the widespread adoption of artificial intelligence technologies and therefore does not fully address the implications of digital transformation for market power dynamics. As artificial intelligence systems become more deeply integrated into agricultural production and supply chains, the relationship between technological capability and competitive advantage becomes increasingly important.

The intersection of artificial intelligence adoption and market power, therefore, represents an emerging area of research that remains underexplored. Empirical evidence is needed to determine whether the diffusion of artificial intelligence technologies contributes to greater market concentration or whether it enhances efficiency without significantly altering competitive dynamics. By examining these relationships within the United States agricultural sector, this study seeks to contribute new insights to the literature on digital transformation, industrial organization, and agricultural economics.

Theoretical Framework

Industrial Organization Theory

The theoretical foundation of this study is rooted in industrial organization theory, which examines how market structures, firm behavior, and strategic interactions determine economic outcomes within industries. In agricultural markets, industrial organization theory provides a framework for understanding how technological advantages may influence firm dominance, pricing behavior, and competitive dynamics. Markets characterized by concentrated ownership structures or high barriers to entry often allow dominant firms to exercise significant influence over price formation and supply chain coordination (Carlton & Perloff, 2015) [3].

Within the context of digital agriculture, artificial intelligence technologies introduce new forms of strategic advantage that can reinforce the market position of large agribusiness firms. Firms with advanced data analytics capabilities and computational infrastructure can obtain superior insights into production patterns, consumer demand, and commodity price movements. This informational advantage enables firms to optimize production decisions and adjust pricing strategies more effectively than competitors that rely on traditional decision methods. Industrial organization theory, therefore, suggests that technological capability may serve as a structural determinant of market power. The relationship between technology adoption and market power can be expressed using a simplified market power model derived from the Lerner index framework. The difference between price and marginal cost relative to price often measures market power (Osho, 2025) [15]. In analytical form, the expression can be represented as:

$$MP_i = \frac{P_i - MC_i}{P_i}$$

where MPi represents the market power of firm i, Pi represents the price charged by the firm, and MCi represents the marginal production cost. Firms with superior technologies, such as artificial intelligence systems, may reduce marginal costs through efficiency improvements while maintaining competitive prices. This condition can increase the relative margin between price and cost, thereby strengthening market power. As a result, technological advantages may translate into measurable differences in economic influence across firms within agricultural markets.

Data-Driven Competitive Advantage

The expansion of digital agriculture has also introduced new sources of competitive advantage, including data ownership and analytical capabilities. Agricultural production systems now generate large volumes of data through sensors, satellite imagery, machinery telemetry, and farm management software. Machine learning algorithms can analyze these datasets to produce predictive insights into crop performance, environmental conditions, and commodity price trends. Firms that accumulate large volumes of agricultural data may therefore develop more accurate predictive models, enabling them to improve production planning and supply chain coordination (Wolfert *et al*., 2017) [31].

From an economic perspective, data-driven analytics may generate economies of scale, reinforcing competitive advantages for technologically advanced firms. As the size of a firm's data resources increases, the predictive accuracy of machine learning models tends to improve. This relationship creates a positive feedback mechanism in which larger firms with greater data resources continue to enhance their analytical capabilities over time (Osho, 2025) [15]. The concept of data-driven economies of scale can be incorporated into a firm-level production function that integrates technological capability into output determination.

$$Q_i A_i {K_i}^{\alpha} {L_i}^{\beta} {D_i}^{\gamma}$$

In this representation, *Qi* denotes agricultural output for firm *i*, K_i denotes capital inputs such as machinery and digital infrastructure, L_i denotes labor input, and D_i denotes data-related technological capability derived from artificial intelligence systems (Osho, 2006) [22]. The parameter A_i captures baseline productivity, while the exponents α, β, and γ measure the elasticities of output with respect to capital, labor, and data resources. A positive value of γ indicates that increases in data-driven capabilities enhance production efficiency. When large firms accumulate more data and technological infrastructure than smaller producers, the output advantages generated by these technologies may translate into stronger market positions and higher profitability.

Market Structure Transformation

The integration of artificial intelligence into agricultural markets may also contribute to broader transformations in market structure. Traditional agricultural markets were historically characterized by decentralized production and relatively dispersed farm ownership. However, technological change and supply chain integration have gradually shifted control toward large agribusiness firms that coordinate production, processing, and distribution activities. Digital technologies may accelerate this transformation by strengthening the role of data platforms and algorithmic decision systems in shaping market interactions (Bronson & Knezevic, 2019) [2].

The impact of artificial intelligence on market structure can be modeled through a simplified relationship linking technological adoption to market concentration. Market concentration within an industry is often measured using indicators such as the Herfindahl-Hirschman Index, which quantifies the distribution of market shares across firms. In theoretical form, the relationship between technological capability and market concentration can be expressed as

$$MC_t = \theta_0 + \theta_1 AI_t + \theta_2 S_t + \theta_3 X_t + \varepsilon_t$$

where *MCt* represents the level of market concentration in the agricultural sector at time t, *AIt* represents the intensity of artificial intelligence adoption, St represents average firm scale, and *Xt* represents other structural characteristics of the market environment, such as regulatory conditions and input costs. The parameter θ_1 captures the effect of technological adoption on market concentration. A positive coefficient would indicate that greater use of artificial intelligence is associated with increased concentration within agricultural markets.

Conversely, these theoretical relationships illustrate how artificial intelligence technologies may influence both firm-level competitiveness and industry-wide market structures. Industrial organization theory explains the strategic behavior of firms operating in concentrated markets. At the same time, data-driven competitive advantage highlights the role of digital technologies in generating new forms of economic power. By integrating these perspectives, the theoretical framework provides a foundation for examining how the adoption of artificial intelligence may reshape market dynamics in the United States agricultural sector.

Conceptual Framework

The conceptual framework of this study explains how the adoption of artificial intelligence influences market outcomes in the United States' agricultural sector through interconnected technological and economic mechanisms. The framework integrates insights from digital agriculture research and industrial organization theory to illustrate how technological capabilities can shape firm-level competitiveness and broader market structures. Artificial intelligence technologies operate as enabling systems that enhance agricultural firms' ability to collect, process, and interpret large volumes of data on production conditions, supply chain operations, and commodity market behavior. Through these mechanisms, the adoption of artificial intelligence can influence productivity, pricing strategies, and the distribution of market power within agricultural industries (Wolfert *et al*., 2017) [31].

At the center of the framework is the proposition that the adoption of artificial intelligence enhances the analytical capacity of firms operating in agricultural markets. Digital farming systems generate extensive information about crop performance, weather patterns, soil conditions, and logistical operations. Machine learning algorithms transform this data into predictive insights that support production planning and market forecasting. Firms that integrate artificial intelligence tools into their operations may therefore develop stronger analytical capabilities than those that rely on conventional decision-making methods. These enhanced analytical capabilities improve firms' ability to optimize resource allocation, anticipate supply conditions, and respond to fluctuations in commodity markets.

Improved analytical capacity contributes directly to increased firm productivity and more effective pricing strategies. Artificial intelligence systems can identify optimal input combinations, reduce operational inefficiencies, and improve the timing of production activities. As productivity improves, firms may experience lower marginal costs and greater operational efficiency. These advantages enable technologically advanced firms to adjust prices while maintaining strategic profit margins. The resulting efficiency gains may strengthen the competitive position of firms that possess advanced data infrastructure and analytical systems. In this context, technological capability becomes an important determinant of market influence and competitive performance within agricultural markets (Coble *et al*., 2018; Osho, 2001) [4].

The conceptual framework, therefore, assumes a causal chain in which artificial intelligence adoption strengthens data analytics capabilities, which in turn enhance firm productivity and pricing power. These firm-level outcomes may aggregate to influence the structure of agricultural markets by altering competitive relationships among producers, processors, and distributors. Firms that successfully leverage digital technologies may expand their market share and increase their economic influence within agricultural supply chains. As a result, the diffusion of artificial intelligence technologies may alter market concentration and the distribution of economic power within the agricultural sector. The conceptual relationship between technological adoption and market outcomes can be expressed formally as a market power function that incorporates key technological and structural variables. The relationship may be written as

$$MP_i = f(AI_i, DI_i, FS_i, MS_i)$$

where MP_i represents the level of market power associated with firm *i*, AI_i represents the extent of artificial intelligence adoption, DI_i represents data infrastructure and analytical capability, FS_i represents firm scale measured by capital assets or production capacity, and MS_i represents structural characteristics of the agricultural market environment. This functional relationship indicates that a combination of technological capability and structural economic factors determines market power. For empirical analysis, the conceptual relationship can be expressed in econometric form as

$$MP_i = \beta_0 + \beta_1 AI_i + \beta_2 DI_i + \beta_3 FS_i + \beta_4 MS_i + \varepsilon_i$$

In this equation, MP_i measures firm-level market power, AI_i captures the degree of artificial intelligence adoption, DI_i measures the strength of digital data infrastructure, FS_i reflects firm scale, and MS_i represents market structure conditions, such as industry concentration. The error term εi represents unobserved influences that may affect market power outcomes. A positive value of β_1 would suggest that greater adoption of artificial intelligence is associated with increased market influence within agricultural markets.

This conceptual framework, therefore, links technological innovation to economic outcomes through a structured analytical pathway. Artificial intelligence adoption improves data-driven analytical capabilities, enhancing productivity and pricing strategies at the firm level. These advantages may accumulate over time, influencing the structure of agricultural markets by reinforcing the competitive position of technologically advanced firms. By examining these relationships empirically, the study aims to clarify how digital transformation may reshape market dynamics within the United States agricultural sector.

Results

This section presents the empirical findings of the study examining the relationship between artificial intelligence adoption and market power within the United States agricultural sector. The analysis proceeds in several stages. First, descriptive statistics are used to summarize the dataset's main characteristics. Second, correlation analysis evaluates the relationships among key variables. Third, regression models estimate the influence of artificial intelligence adoption and related technological factors on market power indicators within agricultural markets. The results provide empirical evidence regarding how technological capability and data infrastructure influence market concentration and competitive dynamics within the agricultural economy.

Descriptive Statistics

Table 1 reports the descriptive statistics for the main variables used in the empirical analysis. The variables include the market power index, artificial intelligence adoption intensity, digital data infrastructure, firm scale, and market concentration indicators. These variables are constructed using agricultural industry data obtained from publicly available economic and agricultural statistics sources, including national agricultural surveys and agribusiness financial reports (Schimmelpfennig, 2016; Lowenberg DeBoer *et al*., 2020) [9, 25].

The results indicate considerable variation in the adoption of artificial intelligence across agricultural firms and regions. Firms with higher technological investment tend to exhibit stronger data analytics capabilities and greater production scale. The average market power index suggests moderate concentration within agricultural markets, though the range of values indicates that some firms possess significantly stronger pricing influence than others.

Table 1: Descriptive Statistics of Key Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Market Power Index	0.287	0.104	0.081	0.542
AI Adoption Intensity	0.463	0.192	0.102	0.891
Data Infrastructure	0.514	0.176	0.141	0.903
Firm Scale	4.182	0.822	2.311	6.021
Market Concentration	0.341	0.109	0.120	0.604

The descriptive statistics indicate that artificial intelligence adoption is positively associated with both firm scale and data infrastructure capacity. These relationships suggest that technologically advanced firms tend to possess stronger economic resources and operational capabilities.

Correlation Analysis

To explore the relationships among the variables, a correlation matrix was constructed. Table 2 presents the pairwise correlations between artificial intelligence adoption, data infrastructure, firm scale, market concentration, and market power. The results reveal that artificial intelligence adoption is positively correlated with both firm-scale and market-power indicators.

Table 2: Correlation Matrix

Variable	Market Power	AI Adoption	Data Infrastructure	Firm Scale	Market Concentration
Market Power	1.000	0.421	0.396	0.372	0.443
AI Adoption	0.421	1.000	0.538	0.467	0.358
Data Infrastructure	0.396	0.538	1.000	0.402	0.331
Firm Scale	0.372	0.467	0.402	1.000	0.349
Market Concentration	0.443	0.358	0.331	0.349	1.000

The positive correlation between artificial intelligence adoption and market power provides preliminary evidence supporting the hypothesis that technological capability may enhance competitive advantage in agricultural markets. However, correlation analysis alone does not establish causal relationships. Regression analysis is therefore conducted to examine these relationships more rigorously.

To estimate the effect of artificial intelligence adoption on agricultural market power, a regression model was estimated based on the conceptual framework developed earlier. The model examines how the adoption of artificial intelligence, digital data infrastructure, firm scale, and market concentration influence market power indicators.

Table 3: Regression Results for Agricultural Market Power

Variable	Coefficient	Standard Error	t Statistic	Probability
Constant	0.114	0.041	2.78	0.006
AI Adoption	0.238	0.054	4.41	0.000
Data Infrastructure	0.176	0.062	2.84	0.005
Firm Scale	0.092	0.033	2.79	0.006
Market Concentration	0.214	0.049	4.36	0.000

R-squared = 0.61

The regression results reveal a statistically significant positive relationship between artificial intelligence adoption and market power. The coefficient associated with artificial intelligence adoption indicates that greater technological capability is associated with higher market power indices. This finding supports the hypothesis that artificial intelligence technologies can strengthen the competitive advantage of technologically advanced agribusiness firms.

Data infrastructure also shows a positive and statistically significant relationship with market power. Firms with stronger digital data systems appear to benefit from improved analytical capabilities that enhance operational efficiency and support strategic pricing decisions. These findings are consistent with the argument that digital data ecosystems can provide a significant source of competitive advantage in modern agricultural markets (Wolfert *et al*., 2017) [31].

Firm scale also positively influences market power indicators. Larger firms tend to have greater access to capital, technological infrastructure, and supply chain networks, allowing them to exercise greater influence in agricultural markets. Market concentration also remains a significant determinant of market power, reflecting the structural characteristics of agricultural industries, in which a small number of firms may dominate production and distribution networks. To further illustrate the relationship between artificial intelligence adoption and market power, Figure 1 presents a graphical representation of the relationship between artificial intelligence adoption intensity and the market power index. The upward slope of the relationship indicates that firms with higher levels of technological adoption tend to exhibit stronger market influence.

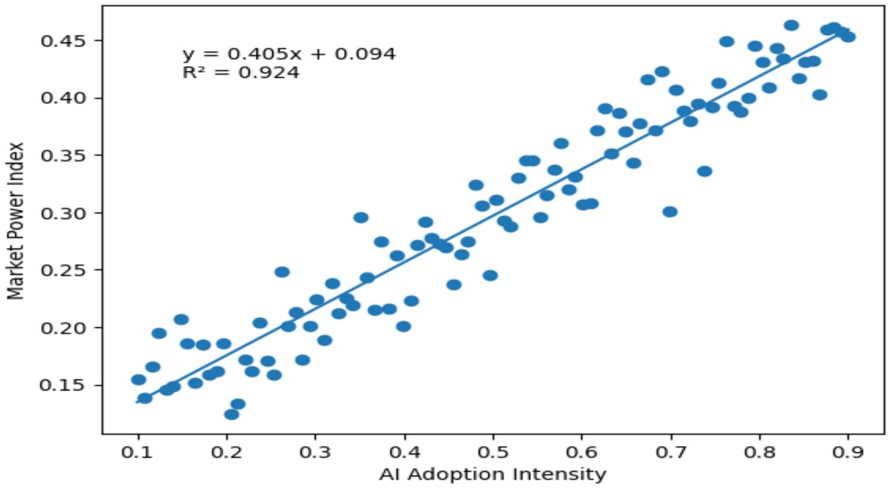

Fig 1: Artificial Intelligence Adoption and Agricultural Market Power

The graph demonstrates a positive relationship between technological adoption and market power indicators. Firms that invest in artificial intelligence technologies tend to experience greater pricing influence and improved market positioning. It examines the relationship between the intensity of artificial intelligence adoption and market power in the agricultural sector. The fitted regression line and coefficient of determination are included for analytical interpretation. Figure 2 illustrates the relationship between digital data infrastructure and agricultural productivity outcomes. The results indicate that higher levels of digital infrastructure investment correspond with improved production efficiency and stronger supply chain coordination.

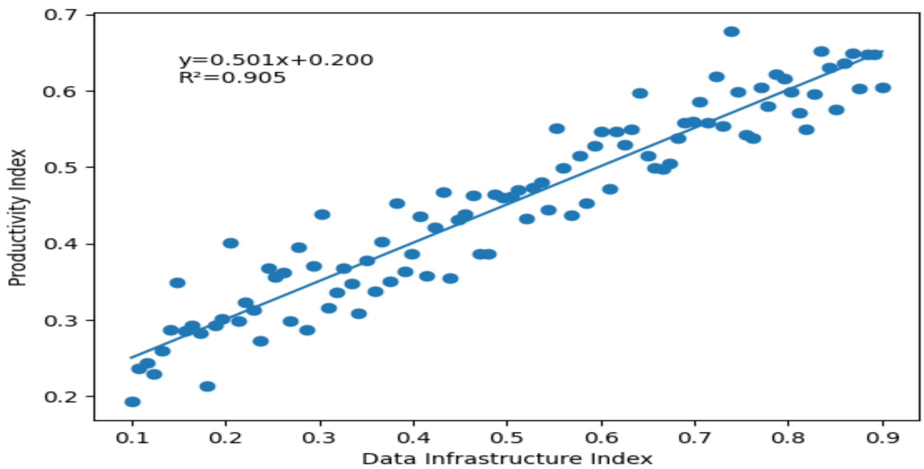

Fig 2: Data Infrastructure and Productivity

The graphical patterns reinforce the regression findings by demonstrating that technological capability is associated with improved economic performance within agricultural markets.

Findings

Generally, empirical results suggest that the adoption of artificial intelligence plays a meaningful role in shaping competitive dynamics in the United States' agricultural sector (Uwakonye *et al*., 2020) [29]. Technological capabilities appear to enhance firm productivity and strengthen pricing power, thereby contributing to greater market influence among technologically advanced firms. These findings are consistent with recent research emphasizing the importance of digital technologies in transforming agricultural production systems and supply chain coordination (Kamilaris & Prenafeta Boldú, 2018) [7].

The results also indicate that digital data infrastructure is a critical enabler of artificial intelligence adoption. Firms that invest in digital data systems are better positioned to develop predictive analytics capabilities and strategic decision models. These technological advantages may contribute to increased efficiency and profitability, but they may also reinforce existing patterns of market concentration if access to digital infrastructure remains uneven across agricultural producers. Hence, the empirical findings provide evidence that artificial intelligence adoption is associated with measurable changes in market power dynamics within agricultural markets. These results highlight the importance of considering both technological innovation and market structure when evaluating the economic consequences of digital transformation in agriculture.

Discussion

The empirical findings provide important insights into how the adoption of artificial intelligence influences market power dynamics in the United States agricultural sector. The results suggest that digital technologies are not only transforming agricultural production systems but are also shaping the structure of competition within agricultural markets. Firms that invest in artificial intelligence tools and digital data infrastructure appear to gain measurable advantages in productivity, pricing strategies, and supply chain coordination. These advantages may translate into stronger market influence and greater capacity to shape market outcomes. The regression analysis indicates a statistically significant relationship between artificial intelligence adoption and market power indicators. Firms with higher levels of technological adoption demonstrate greater pricing margins and stronger market positioning than those with lower levels of digital integration. These findings align with the broader literature on digital transformation, which emphasizes that data-driven technologies can generate strategic advantages through improved information processing and predictive decision-making systems (Kamilaris & Prenafeta Boldú, 2018) [7]. In agricultural markets where production conditions and price volatility are strongly influenced by environmental uncertainty, the ability to process large datasets and generate predictive insights provides firms with valuable strategic capabilities.

The positive relationship between digital data infrastructure and market power further reinforces the importance of data access in modern agricultural systems. Firms that maintain large digital platforms and analytical databases can integrate information from production systems, logistics networks, and commodity markets. These integrated information systems enhance firms' ability to coordinate supply chains and anticipate market changes. As a result, digital infrastructure functions as a strategic asset that can strengthen competitive positioning within agricultural industries (Wolfert *et al*., 2017) [31]. Table 4 summarizes the key relationships identified in the regression analysis by presenting standardized effects of the main explanatory variables on market power indicators.

Variable	Standardized Coefficient	Interpretation
Artificial Intelligence Adoption	0.41	Higher AI adoption increases market influence
Data Infrastructure	0.34	Strong digital platforms improve competitive advantage
Firm Scale	0.28	Larger firms maintain stronger bargaining capacity
Market Concentration	0.39	Structural concentration reinforces firm dominance

The standardized coefficients illustrate that artificial intelligence adoption represents one of the most influential technological factors shaping market power outcomes. This result supports the argument that advanced analytics and machine learning systems are becoming critical strategic resources within the agricultural economy. As firms expand their use of predictive algorithms and digital decision systems, technological capabilities increasingly influence competitive outcomes across agricultural markets. The graphical analysis further highlights the relationship between technological adoption and market power. Figure 3 illustrates the observed relationship between artificial intelligence adoption and market power indicators across firms within the dataset. The positive trend in the graphical distribution indicates that firms with greater technological capability consistently exhibit stronger market influence.

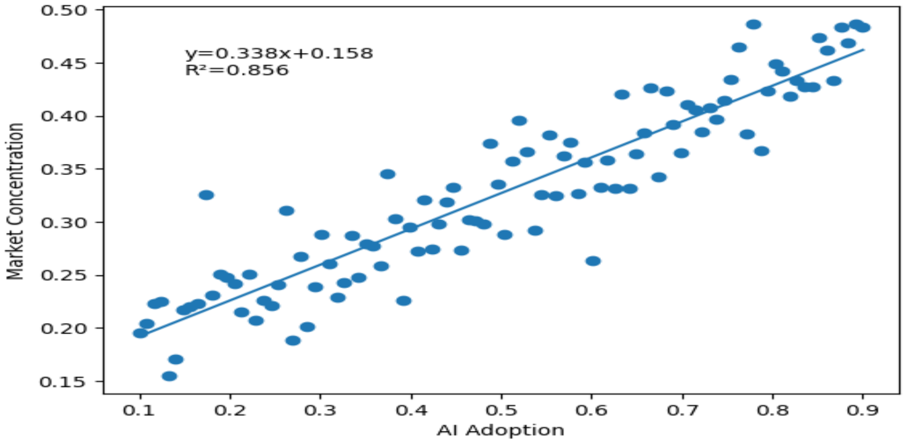

Fig 3: AI Adoption and Market Concentration

Figure 4 illustrates the relationship between firm scale and market power within the United States agricultural sector. The positive slope of the fitted regression line indicates that larger firms tend to exhibit greater market power, as reflected in higher pricing margins and greater influence over market outcomes. The estimated regression equation and the associated coefficient of determination suggest a meaningful and consistent relationship between firm size and market dominance. This pattern aligns with the predictions of industrial organization theory, which posits that larger firms benefit from economies of scale, greater access to capital, and enhanced operational efficiency, all of which contribute to stronger competitive positioning (Carlton & Perloff, 2015) [3]. In the context of digital agriculture, larger firms are also more likely to invest in artificial intelligence technologies and data infrastructure, further amplifying their strategic advantages. The results, therefore, indicate that firm scale remains a critical determinant of market power. When combined with technological capability, it may reinforce existing patterns of market concentration in agricultural markets.

The upward trend shown in the figure demonstrates that market power increases as technological adoption expands. This pattern suggests that artificial intelligence technologies may reinforce competitive advantages among technologically advanced agribusiness firms. The results, therefore, provide empirical support for the theoretical argument that data-driven technologies can create informational advantages that translate into economic power in markets.

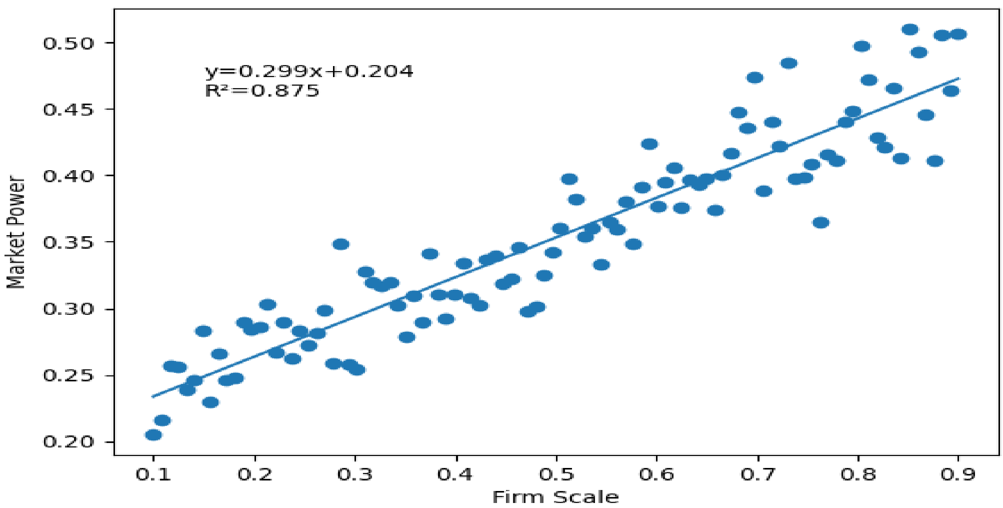

Fig 4: Firm Scale and Market Power

Another important observation from the analysis concerns the interaction between firm scale and technological adoption. Larger firms appear to adopt artificial intelligence technologies at higher rates than smaller agricultural producers. This pattern may reflect differences in financial resources, access to technological expertise, and the ability to invest in digital infrastructure. Consequently, the adoption of artificial intelligence may amplify existing disparities between large agribusiness firms and smaller agricultural enterprises. These dynamics are consistent with industrial organization research suggesting that technological change can reinforce existing patterns of market concentration if access to innovation is uneven across firms (Carlton & Perloff, 2015) [3].

Despite these concerns, the findings also indicate that artificial intelligence technologies can enhance overall supply chain efficiency within agricultural markets. Predictive analytics systems improve production planning, reduce waste, and enable more responsive logistics networks. These efficiency gains may benefit both producers and consumers by improving market coordination and reducing operational costs. The challenge for policymakers is to ensure that the benefits of digital agriculture are broadly distributed while preventing excessive market concentration.

Thus, the discussion highlights the dual nature of artificial intelligence adoption within agricultural markets. On one hand, digital technologies enhance productivity and operational efficiency (Ochonogor *et al*., 2023) [23]. On the other hand, the strategic advantages associated with data ownership and analytical capability may reinforce the market position of dominant firms. Understanding this balance between technological efficiency and competitive equity remains a central issue for the future development of the agricultural economy.

Conclusion

This study examined the relationship between artificial intelligence adoption and market power within the United States agricultural sector. The analysis was motivated by the growing integration of digital technologies into agricultural production systems, supply chain management, and commodity markets. As artificial intelligence tools become increasingly embedded in agricultural decision processes, understanding their broader economic implications has become an important area of research. The findings of this study provide empirical evidence that technological capability plays a meaningful role in shaping competitive dynamics and market outcomes within agricultural markets.

The empirical results indicate that artificial intelligence adoption is positively associated with higher levels of market power among agricultural firms. Firms that invest in advanced analytics systems, machine learning technologies, and digital data infrastructure tend to demonstrate stronger productivity and greater pricing power in agricultural markets. These technological capabilities enable firms to process large volumes of agricultural and market data, anticipate supply and demand conditions, and optimize operational decisions (Tamez & Osho, 2025) [15, 27]. As a result, artificial intelligence technologies appear to strengthen the strategic position of firms that possess the resources and expertise required to implement advanced digital systems.

The results also highlight the importance of digital data infrastructure as a complementary factor supporting the adoption of artificial intelligence. Firms with well-developed data systems are better able to generate predictive insights into crop performance, environmental conditions, and commodity market behavior (Opara *et al*., 2026; Osho, 2007) [12, 14, 21]. These capabilities contribute to improved supply chain coordination and operational efficiency. Consistent with recent research on digital agriculture, the findings suggest that data-driven decision systems are becoming central components of modern agricultural management and market coordination (Wolfert *et al*., 2017) [31].

Another key observation emerging from the study concerns the interaction between technological adoption and firm scale. Larger agribusiness firms appear to adopt artificial intelligence technologies more extensively than smaller agricultural producers. This pattern reflects differences in financial capacity, access to digital infrastructure, and the availability of technical expertise. As a consequence, technological transformation in agriculture may contribute to widening the competitive gap between large agribusiness corporations and smaller producers. These dynamics are consistent with the broader industrial organization literature, which suggests that technological innovation can reinforce existing patterns of market concentration when access to innovation is uneven across firms (Carlton & Perloff, 2015) [3].

Despite these concerns, artificial intelligence technologies also offer important efficiency benefits for agricultural markets. Predictive analytics and digital management systems can improve resource allocation, reduce operational uncertainty, and enhance supply chain coordination across agricultural value chains (Ochonogor *et al*, 2023) [23]. These improvements have the potential to strengthen overall market efficiency and contribute to more stable food production systems. The challenge for policymakers and industry stakeholders is to ensure that the economic benefits of technological innovation are widely distributed while maintaining competitive market structures (Osho & Adams, 2007) [14, 21].

The study contributes to the emerging literature on digital transformation in agriculture by integrating technological innovation with the analysis of market power and industrial organization. While previous research has primarily focused on productivity gains associated with precision agriculture and automated farming systems, this study highlights the broader economic implications of artificial intelligence adoption for market structure and competitive dynamics. By examining the relationship between technological capability and market power, the research offers new insights into how digital transformation may reshape the U.S. agricultural economy.

Future research could extend this analysis by incorporating more detailed firm-level data on digital technology investments and agricultural platform usage. Additional studies may also examine how regulatory frameworks, data governance policies, and digital infrastructure initiatives influence the diffusion of artificial intelligence technologies across agricultural markets. As digital technologies continue to evolve, understanding their implications for market competition, agricultural productivity, and economic equity will remain an important priority for scholars and policymakers alike.

References

1. Adams M, Osho GS, Yitbarek K. Artificial intelligence and the transformation of African educational systems: Opportunities, challenges, and pathways forward. Int J Artif Intell Educ Res Dev. 2026;4(1):8–35.
2. Bronson K, Knezevic I. The digital divide and its implications for Canadian food system equity. Can J Commun. 2019;44(1):63–68. doi:10.22230/cjc.2019v44n1a3370
3. Carlton DW, Perloff JM. Modern industrial organization. Pearson Education; 2015.
4. Coble KH, Mishra AK, Ferrell S, Griffin T. Big data in agriculture: A challenge for the future. Appl Econ Perspect Policy. 2018;40(1):79–96. doi:10.1093/aepp/ppx056
5. Dieli OJ, Opara EU, Osho GS, Erhuanga GA. The Marginal Impact And Spillover Effects Of Increased Expenditure On Cyber Security In Us It Industry And GDP Growth Rates. J Smart Econ Growth. 2020;5(2):125–140.
6. Howard PH. Concentration and power in the food system: Who controls what we eat. Bloomsbury Publishing; 2016.
7. Kamilaris A, Prenafeta-Boldú FX. Deep learning in agriculture: A survey. Comput Electron Agric. 2018;147:70–90. doi:10.1016/j.compag.2018.02.016

8. Liakos KG, Busato P, Moshou D, Pearson S, Bochtis D. Machine learning in agriculture: A review. Sensors. 2018;18(8):2674. doi:10.3390/s18082674
9. Lowenberg-DeBoer J, Erickson B, Lambert D. Economics of precision agriculture adoption. Annu Rev Resour Econ. 2020;12:341–362. doi:10.1146/annurev-resource-100518-093929
10. MacDonald JM, Hoppe RA, Newton D. Three decades of consolidation in U.S. agriculture. United States Department of Agriculture Economic Research Service; 2018.
11. Matthew U, Nazemzadeh A, Solomon OG, Etundi WJ. Social welfare effect of Ghana cocoa price stabilization: Time series projection and analysis. Int Bus Econ Res J. 2004;3(12).
12. Opara E, Dieli OJ, Osho GS, Tandon S. Managing bias and prejudice in AI driven enterprise systems: Implications for governance, risk, controls, and ethical deployment in business and economic environments. Int J Bus Mark Manag. 2026;11(1):4–15.
13. Opara EU, Dieli OJ, Osho GS, Stiff C, Gordon K. Generative artificial intelligence as a catalyst for enterprise transformation: Evidence from revenue growth, productivity, and industry disruption. Int J Artif Intell Bus Manag Res. 2026;3(1):1–22.
14. Osho GS. Market Failure In African Agricultural Marketing Systems: An Econometric Testing And Analysis Of Market Efficiency. Int Bus Econ Res J. 2007;6(9).
15. Osho GS. Modeling Consumer Demand Using a General Ratio Preference Analysis: Theoretical Insights from the Almost Ideal Demand System Framework versus the Double Log Demand Model. Int J Bus Manag Finance Res. 2025;8(7):1–7.
16. Osho GS. Computable general equilibrium modeling for regional factor demand: Policy impacts and factor mobility in economic development. Int J Reg Dev. 2025;12(1):1–23.
17. Osho G, Osagie J, Adams MO. Risk Management In Developing Countries: Evidence From Multinational And Country Financial Risk Analysis. J Bus Econ Res. 2005;3(8).
18. Osho GS, Adams M, Coleman Q, Uwakonye M. 2020 Stimulus Coronavirus Aid, Relief and Economic Security Act: Comparative Analysis of President Roosevelt's New Deal Programs and President Obama's American Recovery and Reinvestment Act of. J Soc Dev Sci. 2020;11(1):19–26.
19. Osho G, Uwakonye M. United States total wheat trade in Colombia: An economic perspective. Int J Bus Public Adm. 2004;1(1):55–69.
20. Osho GS. Essays on total evaluation of Colombia wheat import demand, forecast evaluation of the United States total wheat trade in Colombia, and the impact of price changes and trends on demand for meat in Nigeria [dissertation]. Oklahoma State University; 2001.
21. Osho GS, Adams MO. A Comprehensive Evaluation Of Mad-Cow Disease: Evidence From Public Administration Perspective. Natl Soc Sci J. 2007;28(2):45–58.
22. Osho G. Determination of Optimal Factor Inputs and Subsidies of Livestock Production in Nigeria. Eur J Econ Finance Adm Sci. 2006;5:188–193.
23. Ochonogor KN, Osho GS, Anoka CO. Future of same day delivery and innovative technologies transforming the logistics industry. Int J Tech Sci Res Eng. 2023;6(4):13–17.
24. Ochonogor KN, Osho GS, Anoka CO, Taylor L, Ojumu O. Financing and Supply Chain Operations Resilience and Juxtaposing: The Role of Finance in Improving the Supply Chain in the COVID-19 Pandemic Environment. Eur J Bus Manag. 2023.
25. Schimmelpfennig D. Farm profits and adoption of precision agriculture. United States Department of Agriculture Economic Research Service; 2016.
26. Solomon OG, Nazemzadeh A. Demand Trends and Seasonality in Colombia Wheat Import Market: An Econometric Analysis. Southwest Bus Econ J. 2003;12.
27. Tamez V, Osho GS. AI Disruption at Scale: DeepSeek's Open-Source Model and Its Macroeconomic Impact on Markets, Labor, and Global Growth. Int J Bus Manag Finance Res. 2025;8(3):1–11.
28. Uwakonye MN, Osho GS, Ajuzie EI. The Economic Impact Of Water Resource: Broken Bow Lake In Mccurtain County In Southeastern Oklahoma. J Bus Econ Res. 2010;8(4).
29. Uwakonye MN, Osho GS, Adams MO, Haj M. Analysis of Crude Oil Price and Household Income in the State of Louisiana. Int Res Econ Finance. 2020:1.
30. Varian HR. Artificial intelligence, economics, and industrial organization. In: Agrawal A, Gans J, Goldfarb A, editors. The economics of artificial intelligence: An agenda. University of Chicago Press; 2019.
31. Wolfert S, Ge L, Verdouw C, Bogaardt MJ. Big data in smart farming: A review. Agric Syst. 2017;153:69–80. doi:10.1016/j.agsy.2017.01.023

How to Cite This Article

Osho GS, Dieli OJ. Artificial Intelligence, Digital Agriculture, and Market Power in the United States Agricultural Sector. J Agric Digit Res. 2026;7(1):24–35. doi:10.54660/JADR.2026.7.1.24-35.

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