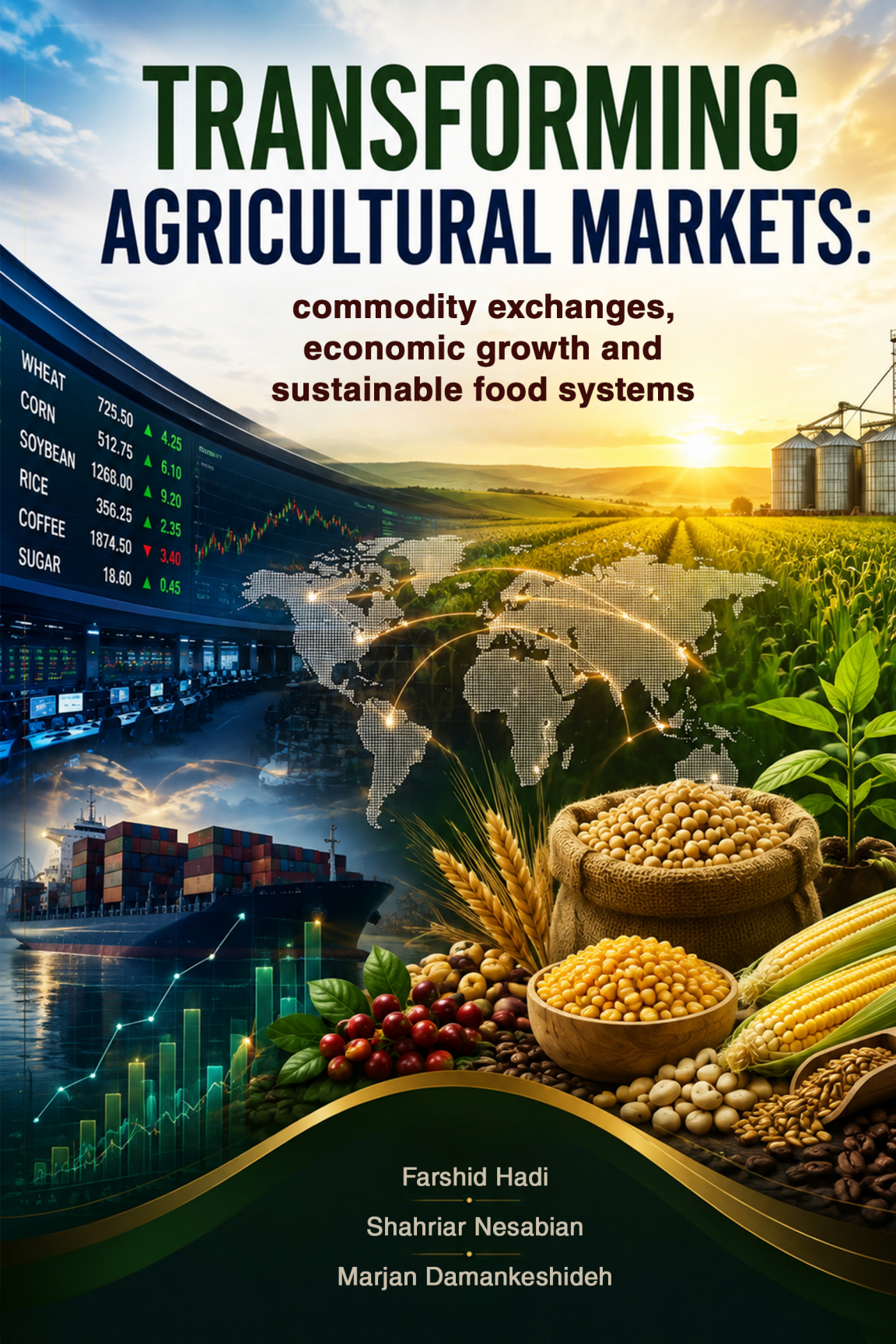
TRANSFORMING AGRICULTURAL MARKETS:

commodity exchanges, economic growth and sustainable food systems



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DEDICATION

Dedicated to our parents, whose love, guidance, and wisdom have shaped our lives and inspired everything we have learned.

To our families, whose unconditional support, encouragement, and presence give us strength, hope, and motivation to continue moving forward.

With our deepest gratitude and affection.

EDITORIAL COMMITTEE

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PREFACE

Agriculture has always occupied a position that extends far beyond the simple production of food. It is a foundation of human survival, a source of employment and income, a component of national economic stability, and an essential link between natural resources, markets, communities, and development. In countries where agriculture retains a strategic role in the productive structure, the organization of agricultural markets becomes particularly important. The ability to produce is only one part of the agricultural equation. Producers must also be able to reach markets, obtain reliable information, manage price uncertainty, commercialize their products under transparent conditions, and transform productive capacity into sustainable economic value.

This book emerges from precisely this intersection between agricultural production, market organization, economic development, and sustainability. Its central concern is the role that organized commodity exchanges can play in improving the functioning and performance of the agricultural sector, with particular attention to the experience of Iran. The subject is especially relevant because the Iranian agricultural sector occupies an important place in food supply, rural development, employment, national production, and trade, while simultaneously operating under considerable structural, environmental, and economic pressures.

Agricultural markets are characterized by conditions that distinguish them from many other areas of economic activity. Production is exposed to climatic uncertainty, biological cycles, seasonality, perishability, variations in quality, fluctuating demand, and considerable price risks. Producers frequently make decisions long before they know the final conditions under which their products will be sold. Small and geographically dispersed farms may face additional difficulties in obtaining information,

accessing formal markets, negotiating favorable prices, complying with quality standards, and reaching consumers without passing through multiple layers of intermediation. These characteristics make agricultural commercialization particularly sensitive to institutional quality and market organization.

Iran provides a valuable setting in which to examine these issues. Agriculture has historically played an important role in the country's productive structure and remains closely connected with employment, food security, rural livelihoods, non-oil trade, and the broader process of national development. At the same time, Iranian agriculture faces significant constraints related to land availability, water scarcity, climatic variability, production costs, inefficient commercialization structures, changing demographic conditions, and the need to increase the productivity of scarce resources. These pressures reinforce the importance of creating agricultural institutions capable of supporting not only production but also commercialization, value creation, and market access.

Within this context, the agricultural commodity exchange acquires particular significance. An organized commodity exchange is not merely a physical or electronic marketplace where products are bought and sold. Properly developed, it can become an institutional mechanism for organizing transactions, improving market information, facilitating price discovery, reducing information asymmetries, promoting standardization, strengthening transparency, and creating more predictable relationships among producers, traders, processors, exporters, and other market participants.

The importance of such an institution becomes clearer when contrasted with fragmented or predominantly traditional agricultural markets. Where market information is incomplete and bargaining power is unequally distributed, producers may have limited capacity to anticipate prices, plan production, or obtain returns that adequately reflect market conditions. Organized commodity markets can help reduce some of these deficiencies by establishing formal procedures, transparent transactions,

standardized product requirements, and more visible interactions between supply and demand.

The Iranian experience is particularly relevant in this regard. The development of organized agricultural commodity trading emerged from broader transformations in production and commercialization, increasing attention to consumer demand, globalization, export opportunities, product quality, and the need to reduce unnecessary intermediation. The Iranian Agricultural Commodity Exchange formally began its activities in 2004, creating an institutional platform through which agricultural products could increasingly be incorporated into organized trading mechanisms.

This institutional transformation also reflected a gradual shift in the way agricultural support and market regulation were conceived. Traditional mechanisms based on guaranteed purchasing were designed to protect producers and strategic crops, but they also generated financial and operational burdens for public institutions and did not always provide farmers with the most efficient commercialization conditions. The gradual introduction of guaranteed pricing through organized market mechanisms represented an effort to combine producer support with more transparent price formation and market participation.

These developments raise a fundamental economic question. If an agricultural commodity exchange improves transparency, standardization, commercialization, price formation, and market coordination, can these improvements ultimately contribute to broader agricultural development?

The analysis presented in this book addresses that question by moving beyond a purely descriptive treatment of commodity exchanges. Its contribution lies in examining the relationship between organized agricultural trading and measurable dimensions of agricultural-sector performance. The study focuses particularly on agricultural production growth, economic value added, and export capacity during the 2011–2024 period. These dimensions provide complementary perspectives on agricultural development because they capture productive performance,

economic value creation, and the ability of agricultural activities to connect with broader markets.

This multidimensional perspective is essential. Agricultural development cannot be adequately measured through physical output alone. Increased production does not necessarily imply greater economic value, nor does a productive agricultural sector automatically possess the institutional, logistical, or commercial conditions required to participate effectively in international markets. By examining production growth, economic value added, and export capacity together, the analysis offers a more comprehensive interpretation of how organized commodity markets may contribute to agricultural transformation.

The study also responds to an important gap in the literature. A substantial body of research has examined financial development, investment, capital markets, agricultural growth, trade, and economic performance. However, the specific role of commodity exchanges in agricultural development has received comparatively less comprehensive attention. Many earlier studies have focused on isolated dimensions of agricultural performance rather than evaluating how organized commodity trading may simultaneously relate to production, value creation, and export potential.

This distinction is important because commodity exchanges occupy a unique position between markets, finance, production, and trade. Their influence may extend well beyond the immediate act of buying and selling commodities. Through greater transparency, standardization, information dissemination, and price discovery, they may affect production decisions, commercialization strategies, investment incentives, product quality, and the organization of agricultural supply chains.

The empirical analysis strengthens this perspective by combining commodity exchange information with official Iranian statistical and agricultural indicators. The study employs descriptive statistics and regression estimation alongside a broader econometric framework that includes normality testing, stationarity analysis, autocorrelation and homogeneity

diagnostics, cointegration analysis, error correction modeling, vector autoregressive models, impulse-response functions, variance decomposition, and structural stability assessment.

This methodological design makes it possible to go beyond the simple identification of statistical association. It provides a basis for examining whether the relationships are stable, whether they persist across time, how variables respond to shocks, how quickly deviations from equilibrium are corrected, and what proportion of fluctuations can be attributed to commodity exchange activity. Such a dynamic approach is particularly appropriate for agriculture because market and institutional changes often require time before their full effects become visible.

The findings reveal a consistent relationship between commodity exchange activity and the principal dimensions of agricultural performance considered. Agricultural production growth, economic value added, and export capacity all show significant relationships with commodity exchange activity, although the magnitude and temporal behavior of these relationships differ.

This differentiated pattern is one of the most important insights of the study. Organized markets do not influence every dimension of agriculture in the same way. Production growth may respond comparatively directly to improved market signals, greater commercialization opportunities, and more predictable conditions. Economic value added may benefit from stronger coordination, standardization, better information, and reductions in transaction inefficiencies. Export capacity, by contrast, depends on a broader range of external conditions, including international demand, exchange-rate movements, transportation infrastructure, logistics, regulations, certification requirements, quality standards, international prices, and access to destination markets.

The agricultural commodity exchange should therefore be understood as one component of a larger institutional and economic system. It cannot replace investment in infrastructure, technology, storage, processing, logistics, water management, human capital, financing, or export promotion. Nor can it

independently resolve the environmental pressures affecting contemporary agriculture. Its potential lies in complementing these dimensions by creating a more organized framework through which agricultural products can move from production toward commercialization.

This broader interpretation connects the subject of commodity exchanges with the concept of sustainable food systems. Sustainability is not exclusively an environmental concern. A food system must also be economically viable, institutionally resilient, socially accessible, and capable of maintaining production and commercialization over time. A system that produces sufficient food but fails to provide viable economic conditions for producers, transparent markets, efficient resource allocation, or stable commercialization channels cannot be considered fully sustainable.

The organization of agricultural markets therefore forms part of the sustainability challenge. Efficient markets can contribute to reducing waste, improving the allocation of products, transmitting clearer price signals, encouraging quality improvements, and creating incentives for producers to respond more effectively to demand. At the same time, market institutions must operate in ways that do not exclude smaller producers or reinforce excessive concentration.

For this reason, the implications of the book extend beyond the commodity exchange itself. The analysis invites consideration of how agricultural institutions can contribute to a model of development that combines productive efficiency, economic viability, social participation, food security, export competitiveness, and responsible resource use.

The findings are also relevant for agricultural policy. If organized commodity markets contribute positively to agricultural performance, policy should not focus exclusively on increasing the number or value of transactions. Attention must also be directed toward the quality of participation. Farmers, cooperatives, processors, traders, and exporters must be able to access the exchange under conditions that promote transparency, competition, and fairness.

The participation of small and medium-sized agricultural producers deserves particular attention. A commodity exchange that remains accessible primarily to large or highly organized actors may reproduce existing inequalities rather than reduce them. Training, technical assistance, digital access, cooperative organization, storage infrastructure, product grading, quality certification, and reliable market information can therefore be as important as the trading platform itself.

The same principle applies to agricultural exports. Transparent price formation and product standardization can strengthen the commercial preparation of agricultural goods, but international competitiveness also depends on traceability, packaging, certification, transportation, storage, logistics, and compliance with destination-market requirements. The empirical results illustrate this complexity. Export capacity exhibits particularly strong internal persistence, and the longer-horizon explanatory contribution of commodity exchange shocks is smaller than that observed for production growth and economic value added.

This does not reduce the importance of the exchange. Rather, it shows that organized commodity trading should be integrated into a broader agricultural and trade strategy. Its role may be especially valuable in creating the market conditions necessary for export development, even when external factors ultimately determine a large proportion of export performance.

The analysis also offers important implications for future research. Agricultural markets should increasingly be studied as dynamic systems in which production, finance, commercialization, trade, institutions, technology, and environmental constraints interact. Further studies can extend the present analysis by examining individual agricultural products, regional differences within Iran, specific agricultural subsectors, market-access inequalities, producer characteristics, and the institutional mechanisms through which exchange participation affects economic outcomes.

Comparative international studies could also provide valuable insights. Iran can be compared with countries possessing

more mature or differently structured commodity exchanges in order to identify the regulatory, technological, infrastructural, and institutional conditions that make agricultural exchanges more effective. Such comparisons could contribute to a wider understanding of how organized markets can be adapted to the realities of emerging and developing economies.

At the same time, the empirical findings should be interpreted with an awareness of the complexity of agricultural development. Production growth, value creation, and export capacity are influenced by climatic conditions, water resources, input costs, technology, labor, energy, financing, exchange rates, international prices, transportation systems, government policies, and many other factors. The commodity exchange is therefore an important institutional component, but not the sole determinant of agricultural performance.

This recognition strengthens rather than weakens the contribution of the study. The value of the analysis lies not in presenting the commodity exchange as a universal solution, but in demonstrating how market institutions matter and how they interact with the broader agricultural economy.

Ultimately, this book invites the reader to reconsider the meaning of an agricultural market. A market is not simply the final destination of production. It influences the information producers receive, the expectations they form, the risks they confront, the standards they adopt, the investments they make, and the opportunities available to transform production into income and economic value.

When agricultural markets become more transparent, organized, accessible, and institutionally reliable, their influence can extend backward into production decisions and forward into processing, trade, exports, and consumption. In this sense, market organization becomes part of the development process itself.

For Iran, this relationship is especially important. The strategic position of agriculture, together with the pressures created by

resource constraints, food requirements, rural development needs, environmental challenges, and international competition, makes institutional efficiency increasingly significant. Strengthening agricultural markets must therefore accompany efforts to improve productivity, sustainability, value creation, and competitiveness.

The pages that follow explore these relationships from theoretical, institutional, historical, and empirical perspectives. They examine the foundations of agricultural development, the evolution and functions of commodity exchanges, the structure of agricultural markets in Iran, and the dynamic relationships between organized commodity trading and agricultural performance.

The broader lesson extends beyond the Iranian context. As countries seek to build more resilient, productive, competitive, and sustainable food systems, attention must be directed not only toward what agriculture produces but also toward the institutions through which production is priced, exchanged, standardized, financed, commercialized, and connected with society.

Commodity exchanges constitute one of those institutions.

Their ultimate contribution should therefore be judged not simply by the volume of commodities traded through them, but by their capacity to help create agricultural markets that are more transparent, efficient, inclusive, competitive, and capable of supporting the long-term sustainability of food systems.

The Authors

INTRODUCTION

Agriculture is one of the fundamental pillars of economic and social development. Beyond its primary function of providing food, the agricultural sector contributes to employment, income generation, rural livelihoods, industrial supply chains, foreign trade, and national economic stability. Its importance becomes even more pronounced in economies where a considerable proportion of productive activity and population remains connected directly or indirectly with farming, livestock production, horticulture, aquaculture, processing, and agricultural commercialization. Consequently, improving agricultural performance requires attention not only to the volume of production but also to the institutional and market structures through which agricultural products are exchanged and transformed into economic value.

Contemporary agricultural development takes place in an increasingly complex environment. Population growth, changing consumption patterns, climatic pressures, water scarcity, fluctuations in input prices, technological transformation, international competition, and instability in global commodity markets have altered the conditions under which agricultural producers operate. Farmers must make production and investment decisions while confronting uncertainty regarding future prices, demand, production costs, market accessibility, and environmental conditions. These challenges make efficient market institutions increasingly important for ensuring that productive efforts are connected with viable commercialization opportunities.

Iran represents a particularly relevant context for examining these relationships. Agriculture occupies an important position within the country's productive structure and contributes to food supply, employment, rural economic activity, value creation, and foreign trade. At the same time, the Iranian agricultural sector faces important structural challenges associated with resource availability, production efficiency, commercialization, market organization, climatic conditions, and the sustainable use of land and water. These characteristics make the improvement of agricultural productivity and market efficiency a strategic economic concern.

The development of agriculture cannot therefore be understood exclusively as a question of increasing physical production. A sector may produce more without necessarily generating proportional increases in economic value or improving its position in domestic and international markets. Agricultural development requires mechanisms capable of connecting production with demand, transmitting reliable price signals, improving product quality, reducing commercialization inefficiencies, facilitating transactions, and creating conditions under which producers can respond more effectively to market opportunities.

Agricultural commodity exchanges emerge within this context as institutions designed to provide a more organized framework for commodity trading. Their economic significance derives from their capacity to bring buyers and sellers together under standardized rules, facilitate price discovery, disseminate market information, establish quality requirements, and create more transparent mechanisms for transactions. In agricultural markets, where information asymmetries, fragmented production, seasonal supply, price volatility, and multiple layers of intermediation may be particularly significant, these functions can acquire considerable importance.

The establishment and development of commodity exchanges can potentially transform the relationship between agricultural production and markets. Transparent price discovery provides producers with information that can contribute to production and commercialization decisions. Standardization reduces uncertainty regarding product characteristics and facilitates transactions between participants who may be geographically separated. Organized trading can also contribute to reducing some transaction costs and unnecessary intermediation while providing a more structured environment for interactions among producers, cooperatives, processors, traders, exporters, and other economic actors.

These mechanisms are particularly relevant to Iran, where the evolution of agricultural commercialization has progressively increased the need for institutional structures capable of

connecting production with changing market conditions. The Iranian Agricultural Commodity Exchange formally began operating in 2004 within a broader process of reorganizing agricultural trading and strengthening market-based mechanisms. Its development reflected the need to improve price transparency, facilitate agricultural commercialization, respond more effectively to consumer demand, promote product standardization, and create stronger connections between producers and markets.

The importance of organized commodity trading is not limited to the transactions conducted within the exchange. Its potential influence extends to the broader economic behavior of agricultural participants. When producers have access to clearer market signals, they may be better positioned to determine what to produce, when to commercialize their products, and how to respond to changes in demand. When quality standards are clearly established, producers have incentives to improve product characteristics. When prices are formed through more transparent interactions between supply and demand, information asymmetries may be reduced and market decisions may become more efficient.

In this sense, the commodity exchange can be interpreted as part of the institutional infrastructure of agricultural development. Its contribution depends not merely on the existence of a trading platform but on the effectiveness of the mechanisms surrounding it, including regulation, transparency, competition, product standardization, storage, transportation, market information, settlement procedures, and accessibility for different categories of producers.

The potential advantages of agricultural commodity exchanges include price discovery, greater product standardization, lower commercialization costs, more organized transportation and warehousing procedures, and access to different transaction mechanisms. Organized exchanges can also contribute to reducing excessive intermediation and creating more transparent relationships between supply and demand. These characteristics

provide the theoretical basis for expecting commodity exchange development to influence agricultural-sector performance.

Nevertheless, the existence of these potential advantages does not automatically demonstrate that commodity exchange activity produces measurable improvements in agricultural development. An organized market may facilitate transactions without necessarily generating substantial changes in production, economic value, or international competitiveness. The magnitude of its contribution may also differ according to the agricultural indicator examined.

This distinction constitutes an important starting point for the present study. Rather than assuming that the agricultural commodity exchange necessarily improves agricultural performance, the analysis evaluates its relationship with measurable dimensions of the Iranian agricultural sector.

The study focuses particularly on three dimensions: agricultural production growth, economic value added, and export capacity. These variables were selected because they represent different but interconnected aspects of agricultural development. Production growth reflects the evolution of productive activity; economic value added represents the capacity of agriculture to generate economic value; and export capacity reflects the ability of the sector to participate in markets beyond the domestic economy.

Agricultural production growth constitutes a fundamental dimension because sustained development ultimately requires an adequate productive base. However, production decisions are influenced by the market conditions confronting producers. Greater price transparency, improved access to commercialization channels, more reliable information, and reduced uncertainty may influence incentives to maintain or expand production. Examining the relationship between commodity exchange activity and production growth therefore provides insight into whether organized trading mechanisms are associated with changes in the productive performance of agriculture.

Economic value added introduces a second and broader dimension. Agricultural development cannot be evaluated solely according to the quantity of goods produced. The economic value generated through production, processing, commercialization, and market participation is equally important. An agricultural system capable of generating greater value from available resources may contribute more effectively to income formation, investment, employment, and national economic performance.

The commodity exchange may contribute to this process by facilitating more efficient commercialization, increasing transparency, promoting standardization, and improving coordination among market participants. For this reason, examining economic value added makes it possible to determine whether the relationship between commodity exchange activity and agriculture extends beyond physical production toward the economic value generated by the sector.

Export capacity represents the third major dimension. Participation in international markets can provide agricultural producers with additional demand, opportunities for market diversification, and potential sources of foreign exchange. However, agricultural exports depend on considerably more than production volume. Quality, standardization, traceability, logistics, transportation, certification, international prices, exchange rates, trade regulations, and access to destination markets all influence export performance.

Commodity exchanges can potentially contribute to some of these conditions by encouraging standardized products, improving market information, and creating more organized commercialization mechanisms. The relationship between exchange activity and export capacity therefore provides an important indication of whether the benefits associated with organized trading extend toward the international dimension of Iranian agriculture.

The study examines these relationships over the 2011–2024 period. During this period, 68 agricultural products included in the analysis were accepted and traded through the commodity

exchange. The descriptive evidence reveals important characteristics of the agricultural economy. Agricultural production growth followed a fluctuating trajectory and recorded an average growth rate of approximately -0.06 over the period analyzed. At the same time, agricultural exports represented an important component of sectoral economic performance, while agricultural gross domestic product and economic value added exhibited considerable variation over time.

These fluctuations reinforce the need to understand whether market institutions can contribute to agricultural performance. A sector characterized by changing production growth, evolving export values, and variations in economic value creation requires mechanisms capable of improving coordination between production and markets. The agricultural commodity exchange represents one such mechanism and therefore constitutes the central institutional focus of this study.

The research is also motivated by a gap in the existing literature. Previous studies have examined different aspects of commodity exchanges, financial-market development, agricultural markets, price risk, and economic growth. Research has also identified potential relationships between financial-market development and agricultural value creation. However, comparatively limited attention has been devoted to simultaneously examining how commodity exchange activity relates to several dimensions of agricultural development.

This study addresses that gap by adopting a multidimensional empirical approach. Rather than reducing agricultural development to a single outcome, it examines how commodity exchange activity relates to production growth, economic value added, and export capacity. The inclusion of these dimensions makes it possible to identify whether the contribution of the commodity exchange is homogeneous or whether its explanatory importance varies across different components of agricultural performance.

The methodological design was developed accordingly. Descriptive statistics provide an initial characterization of the

variables and their evolution, while regression models estimate the relationships between commodity exchange activity and the selected agricultural indicators. The analysis is complemented by diagnostic procedures designed to evaluate the statistical properties of the data and the validity of the estimated relationships.

Because agricultural and economic variables evolve over time, the empirical strategy also incorporates techniques capable of distinguishing short-run fluctuations from longer-term relationships. Stationarity and cointegration procedures are combined with error correction modeling, vector autoregressive estimation, impulse-response functions, variance decomposition, and structural stability analysis. This framework makes it possible to investigate not only whether relationships exist but also how they evolve following shocks and whether variables tend to return toward longer-term equilibrium trajectories.

The empirical findings demonstrate the importance of this multidimensional approach. The agricultural commodity exchange is significantly associated with agricultural production growth, economic value added, and export capacity, although the dynamic contribution differs among the three dimensions. In particular, longer-horizon variance decomposition indicates that commodity exchange shocks account for approximately 10 percent of the variation in agricultural production growth and economic value added, while their contribution to agricultural export capacity is approximately 3 percent.

These differences have important economic implications. They suggest that the influence of the commodity exchange may be more directly transmitted to domestic production and value creation than to export capacity. This is reasonable because agricultural exports depend on additional external factors, including international demand, exchange rates, logistics, regulations, certification requirements, quality standards, international prices, and access to destination markets.

Consequently, the study does not present the agricultural commodity exchange as an isolated or universal solution to

the challenges confronting Iranian agriculture. Agricultural development results from the interaction of numerous factors, including natural resources, technology, investment, infrastructure, financing, public policy, market organization, human capital, environmental conditions, and international economic relationships.

The importance of the commodity exchange lies instead in its institutional contribution. By improving the mechanisms through which agricultural products are priced, standardized, commercialized, and connected with markets, the exchange can complement broader agricultural-development strategies. Its effectiveness therefore depends on the quality of the institutional environment surrounding it.

This perspective is closely connected with the broader challenge of sustainable food systems. Sustainability requires the efficient use of resources, but it also requires economically viable producers, functional markets, stable supply relationships, adequate infrastructure, and institutions capable of adapting to changing conditions. Agricultural sustainability cannot be separated from economic sustainability.

For Iran, this relationship is especially significant because agricultural development must occur under substantial resource constraints. Increasing production without improving efficiency can intensify pressure on land and water. Similarly, expanding agricultural activity without strengthening commercialization may reduce the economic returns generated from scarce resources. Improving market organization can therefore complement technological and environmental strategies by helping agricultural resources move toward activities capable of generating greater economic value.

A sustainable agricultural market must also be inclusive. Small and medium-sized producers frequently face greater difficulties in accessing information, storage, transportation, financing, certification, and formal trading mechanisms. The development of commodity exchanges should therefore be accompanied by measures that broaden participation and prevent organized

markets from becoming accessible only to larger or more powerful actors.

This makes institutional accessibility a central component of market development. Training, cooperative organization, digital platforms, market information systems, quality-control infrastructure, storage facilities, transparent regulation, and effective competition can determine whether the benefits of organized trading reach a broad range of agricultural participants.

The export dimension similarly requires an integrated perspective. Commodity exchange development can contribute to product standardization, transparency, traceability, and commercial organization, but these advantages must be connected with export infrastructure, certification, logistics, transportation, international marketing, and trade facilitation. Strengthening the relationship between organized domestic markets and export strategies can therefore increase the potential contribution of commodity exchanges to the international competitiveness of Iranian agriculture.

The significance of this research consequently extends beyond the estimation of individual econometric coefficients. It contributes to a broader discussion about how market institutions can support agricultural transformation. The results provide evidence relevant to policymakers, agricultural organizations, commodity exchange administrators, producers, cooperatives, processors, traders, exporters, and researchers interested in the interaction between agriculture and organized markets.

For policymakers, the study highlights the importance of evaluating commodity exchanges not merely according to transaction volume or transaction value. Their performance should also be considered in relation to production dynamics, value creation, market transparency, producer participation, export capacity, transaction efficiency, and their integration with broader agricultural policies.

For agricultural producers and organizations, the analysis emphasizes the potential importance of access to organized

markets, reliable price information, quality standards, and transparent commercialization mechanisms. For researchers, it demonstrates the need to examine agricultural markets as dynamic systems in which production, institutions, commercialization, finance, trade, and sustainability interact.

The book is structured to develop this argument progressively. It first establishes the conceptual and economic foundations necessary to understand agricultural development and the role of agriculture within the wider economy. It then examines commodity exchanges, their functions, historical development, institutional characteristics, and relevance to agricultural markets, with particular attention to Iran. The subsequent empirical analysis evaluates the statistical and dynamic relationships between commodity exchange activity and the selected dimensions of agricultural performance. The final discussion integrates these findings and considers their implications for agricultural policy, market development, future research, and the sustainable transformation of the sector.

Ultimately, the central premise of this book is that agricultural development depends not only on the capacity to produce but also on the capacity to organize markets effectively. Production, commercialization, value creation, and market access form part of the same economic process. When the institutions connecting these dimensions operate efficiently, agriculture is better positioned to respond to changing demand, create economic value, strengthen competitiveness, and contribute to sustainable development.

The Iranian agricultural commodity exchange offers an important case through which these relationships can be examined. Its experience demonstrates both the opportunities and the complexity associated with transforming traditional agricultural commercialization into a more organized market system. Understanding its contribution is therefore important not only for assessing the evolution of agricultural markets in Iran but also for considering the broader role that commodity exchanges can play in emerging and developing agricultural economies.

In this sense, the analysis presented throughout this book seeks to contribute to a deeper understanding of the relationship between markets and agricultural transformation. The challenge is not simply to produce more agricultural commodities, nor merely to trade greater quantities of them. The more fundamental objective is to create an agricultural system capable of converting production into sustainable economic value through transparent, efficient, competitive, and accessible markets.

01.

Agricultural Development and Growth in Iran

1.1. Agricultural Markets and the Foundations of Agricultural Development

The financial sector plays a fundamental role in the economy of every country by providing the financial resources required for production and service activities. This sector is generally divided into two major components: the money market and the capital market. As an essential component of the financial system, the capital market channels savings and inactive financial resources toward individuals and organizations seeking capital through specialized financial instruments and institutions. In this way, it contributes to mobilizing available resources and directing them toward productive economic activities (Chizari & Shirzad, 2017).

One of the principal formal institutions operating within the capital market is the stock exchange, which provides an organized environment in which buyers and sellers can conduct transactions. Within this institutional framework, the commodity exchange represents an organized market for trading primary commodities such as wheat, sugar, cotton, coffee, tea, and wool. Its organized structure facilitates transactions under established market conditions and provides participants with mechanisms for exchanging commodities through formal procedures (Food and Agriculture Organization, 2004).

Unlike transactions conducted exclusively through cash markets, commodity exchanges can facilitate operations without requiring the immediate physical delivery of goods at the place where the transaction is concluded. Futures contracts, for example, establish the delivery of commodities at a predetermined price and at a specified future date. Therefore, the commodity exchange can be understood as a formal and regulated market in which producers offer their products within a competitive environment influenced by supply, demand, and agreements between the participating parties.

The importance of this institutional mechanism becomes particularly evident in the agricultural sector. Government intervention through preferential purchasing arrangements, price-setting mechanisms, and subsidies has affected the competitive dynamics of rural commodity markets and contributed to a reduction in their efficiency. In Iran, this situation is accompanied by the existence of small and geographically dispersed farms in rural areas, which has contributed to the persistence of traditional agricultural production and marketing systems.

The structure of the agricultural commodity market in Iran has consequently developed within a context characterized by traditional commercial relationships, institutional limitations, market failures, and several

structural deficiencies. Although considerable efforts and resources have been devoted to reforming these markets, the results have not always been satisfactory. One explanation can be found in the short-term orientation of many programs and policies, as well as in the particular characteristics of agricultural product markets. Traditional market structures frequently lack the organizational mechanisms and capacity for continuous learning and improvement required to respond efficiently to changing economic and social needs.

The principal shortcomings of agricultural markets include high levels of risk, substantial differences between production and consumption prices, and considerable price fluctuations. Risk is an inherent characteristic of agricultural products because firms involved in production and commercialization operate under conditions affected by numerous unpredictable factors.

Another important problem is the difference between the price received by producers and the price ultimately paid by consumers. Intermediaries may capture a considerable proportion of the value generated throughout the commercialization process, which can result in agricultural producers receiving less than half of the price paid by final consumers.

Price instability constitutes another significant weakness of agricultural markets. In addition to seasonal and periodic variations, agricultural product prices may experience substantial fluctuations compared with those of other commodities. Insufficient access to reliable market information and limited transparency can intensify these variations, creating additional uncertainty for both producers and consumers. These conditions can negatively affect production decisions, commercialization strategies, and the overall efficiency of agricultural markets (Shirzad & Damavandi, 2013).

Agriculture is inherently exposed to multiple forms of uncertainty and risk. Natural, social, economic, and human factors interact to create a vulnerable environment in which farmers must make decisions concerning resource allocation and production without complete certainty regarding future prices or production performance. Uncertainty regarding prices and yields directly influences producers' decisions, meaning that the results of those decisions may differ considerably from those obtained under conditions of greater certainty. Agricultural risks can therefore be classified into production risk, market or price risk, financial risk, institutional risk, and human risk.

Several mechanisms can be employed to reduce exposure to these risks, including production diversification, the efficient allocation of credit resources according to the financial requirements of agricultural activities, and the use of forward contracts, futures contracts, call options, and put options. Nevertheless, income instability and losses caused by factors beyond producers' control have placed considerable pressure on governments in many developing countries. As a result, governments have implemented compensatory payments, guaranteed prices, credit purchasing arrangements, agricultural product insurance, and agricultural commodity markets as mechanisms intended to promote greater stability in farmers' incomes.

Governments have also adopted different measures to address agricultural risks and price volatility, including price ceilings, price floors, guaranteed prices, market mechanisms, and subsidy policies. Within this framework, agricultural commodity markets constitute an important government instrument for organizing and managing agricultural trade. Specialized commodity exchanges can provide liquid and relatively stable trading environments while facilitating access to financial resources for productive activities. Consequently,

constraints on agricultural development associated with insufficient productive factors and financial resources can be addressed more effectively through organized market mechanisms.

The presence of specialized agricultural commodity exchanges can also contribute to improving the comparative advantages of the national economy. Commodities traded through organized exchanges are generally required to comply with clearly established characteristics and quality standards. A coordinated and uniform standardization system encourages the production and commercialization of goods capable of satisfying international quality requirements. Participation in specialized exchanges can therefore promote improvements in product quality and standardization while strengthening the capacity of agricultural products to compete in international markets and expand their export potential.

Commodity exchanges also perform an important regulatory function by providing transparent, observable, and institutionally organized trading mechanisms. These characteristics facilitate the implementation of government regulations concerning commodities while improving the conditions under which market transactions and prices can be monitored. Greater transparency can contribute to more efficient price formation and increased agricultural market stability. Evidence concerning products supplied through commodity exchanges indicates that their price growth may be lower than that observed for comparable products traded outside organized exchanges, demonstrating the potential contribution of these institutions to agricultural price regulation (Samadi et al., 2018).

Growth in investment, particularly private investment, together with the expansion of agricultural product exports, represents one of the main objectives and prospects of the agricultural commodity exchange.

Progress in these areas can generate significant benefits for the national economy through increased employment, higher national production, expansion of non-oil exports, and greater foreign exchange inflows. At the same time, instability in agricultural prices creates unfavorable conditions for investment because price fluctuations expose both producers and consumers to risk and uncertainty. Such instability can consequently discourage investment in the agricultural sector. In addition to providing mechanisms for risk coverage, the commodity exchange applies different policies and instruments to manage risks arising from the activities and behavior of market participants (Amjadi & Ahmadi, 2016).

The establishment of agricultural commodity exchanges in different countries has produced several positive effects, particularly greater market transparency and improvements in the quality of traded products. These organized markets can also reduce the time required to obtain relevant market information and thereby decrease implicit transaction costs. In Iran, the long-term objectives of the agricultural commodity exchange include changing cultivation patterns, expanding agricultural product exports, reducing transaction costs, and improving the organization of agricultural product markets. Its short-term objectives include reforming the traditional market structure, preventing severe price fluctuations, facilitating access to financing, and reducing price and transaction risks.

More broadly, the establishment and development of a specialized commodity exchange in Iran can generate three major advantages: strengthening the structure of the national economy, expanding the range of sectors and commodities participating in organized trading, and enhancing the country's export capacity. As an institutional mechanism for improving trading practices, organizing commodity markets, and encouraging investment, the commodity exchange can contribute

substantially to economic development while supporting broader improvements in social welfare.

The growing importance of the Iranian Commodity Exchange is also reflected in official transaction statistics. According to the Central Bank of the Islamic Republic of Iran (2022), both the volume and value of transactions increased substantially between 2014 and 2021, demonstrating the progressive expansion of organized commodity trading during this period.

Previous studies concerning the relationship between commodity exchanges and agricultural development provide additional evidence of these potential effects. Amjadi and Ahmadi (2016) examined agricultural sector development from two main perspectives: increasing agricultural value added and hedging against price risk. Financial market development can contribute to the development of different economic sectors, with particular implications for agricultural services (Diekmann & Westermann, 2010). Similarly, greater diversity in financial markets and the privatization of financial markets associated with agriculture can promote investment, economic growth, and increased value added within the agricultural sector (Andish et al., 2012; Ansari & Hosseini Yekani, 2014).

Nevertheless, a review of previous research reveals that the relationship between commodity exchanges and agricultural development has received relatively limited attention. Several earlier studies have examined only individual dimensions of the agricultural sector rather than evaluating its development from a broader perspective. This limitation creates a research gap concerning the comprehensive effects of commodity exchanges on agricultural performance. In particular, further examination is required regarding production growth, agricultural value added, market price regulation, export capacity, and agricultural gross domestic product. Accordingly, the relationship

between the commodity exchange and agricultural sector development should be analyzed through these interconnected dimensions. This leads to the central research question: What effect does the commodity exchange have on the development of the agricultural sector across its different dimensions?

The practical importance of this research is also associated with the multiple advantages of supplying agricultural products through organized commodity exchanges. These advantages include price discovery, product standardization, cost reduction, direct transportation of goods from warehouses of origin to destination warehouses according to exchange standards, and the availability of different transaction mechanisms, including cash transactions, futures contracts, options, and certificates of deposit. Commodity exchanges also contribute to determining prices according to economic conditions and the interaction between supply and demand, thereby creating more transparent and competitive mechanisms for agricultural trade.

Additional benefits include reducing direct government involvement in agricultural pricing and increasing farmers' incentives to expand production by enabling them to obtain returns that more accurately reflect market conditions. Organized exchanges can also mitigate the negative effects of excessive intermediation and promote fairer price discovery based on the interaction between supply and demand. At the institutional level, these mechanisms can reduce government expenditure, shorten the time required for producers to receive payments, and bring agricultural prices closer to prevailing market values. Furthermore, standardized products, organized transportation procedures, and transparent pricing can facilitate the creation and expansion of export markets while reducing the overall cost structure of agricultural commercialization.

These mechanisms also contribute to more effective agricultural price management by promoting greater stability in the producer price index, reducing inflationary pressures in the food sector, and increasing statistical transparency throughout the agricultural sector. The use of guaranteed pricing instead of guaranteed purchasing can help address deficiencies in agricultural pricing mechanisms and promote broader improvements in the organization and functioning of agricultural markets. In this context, governments seek to design mechanisms that protect agricultural markets from potential shocks associated with shortages of essential products while minimizing their economic consequences.

For many years, the government of the Islamic Republic of Iran relied on the guaranteed purchase mechanism to support farmers producing strategic agricultural commodities. Although this approach initially appeared to provide an effective means of supporting producers, its implementation eventually revealed significant disadvantages for both the government and farmers. Consequently, greater emphasis was placed on guaranteed pricing, using the commodity exchange as the institutional platform through which this strategy for supporting agricultural production could be implemented.

One of the principal disadvantages of the guaranteed purchase system was the additional financial burden imposed on the government, particularly the costs associated with storing purchased agricultural products. Institutions such as the State Trading Company, which was responsible for purchasing products from farmers under the guaranteed purchase mechanism, also encountered considerable operational difficulties. The large volume of commodities involved, together with insufficient supervisory mechanisms, sometimes resulted in the government purchasing shipments

whose characteristics differed from those of the strategic agricultural products originally targeted by the policy.

Farmers also experienced difficulties under the guaranteed purchase system and expressed dissatisfaction with its operation. One of their principal concerns was that market prices could exceed the prices offered by the government, placing producers at an economic disadvantage when they sold their products through the guaranteed purchase mechanism. Farmers also criticized delays in receiving payments for the products delivered to government institutions, which further reduced the effectiveness of the system as a mechanism for agricultural support.

These difficulties contributed to the approval of Article 33 of the Law on Increasing Productivity in the Agricultural Sector and Natural Resources by the Islamic Consultative Assembly in July 2010 in the Iranian calendar. Under this provision, the guaranteed purchase system for agricultural products was maintained while a guaranteed price policy was introduced through annual budgets and approved financial allocations. Agricultural producers were permitted to offer their products through the specialized agricultural commodity exchange. If the exchange price fell below the guaranteed price established by the government, the government was responsible for paying producers the difference between the two prices.

Despite the potential benefits of this mechanism, evidence from agricultural commodity exchange transactions indicates that the supply of agricultural products through the exchange declined between 2018 and 2022, with fewer transactions recorded than in previous periods. Overall, agricultural commodity supply through the exchange followed a downward trend during these years, suggesting persistent limitations in the participation of agricultural products in organized trading (Hassanzadeh & Etemadifar, 2022).

According to statistics from the Food and Agriculture Organization of the United Nations, Iran produced approximately 11.3 million tons of livestock products between 2007 and 2011, while only about 450,000 tons were traded through the commodity exchange. This substantial difference reflects the relatively limited participation of farmers and buyers in the agricultural commodity exchange, as well as the limited institutional involvement of the government during that period (Mohammadi et al., 2017).

The agricultural commodity exchange can be understood as an institutionalized competitive market that complements and strengthens traditional markets operating in rural areas. Agricultural producers in these areas face several difficulties, including insufficient transparency of market information, uncertainty regarding future product prices, inefficient distribution mechanisms, and severe price fluctuations. The commodity exchange provides an institutional mechanism designed to address these problems and improve the organization, transparency, and efficiency of agricultural markets.

Its principal advantages include reducing exposure to price risk, promoting export growth, decreasing direct government intervention in the agricultural sector, and facilitating more targeted support policies. Other benefits include improving producers' access to financing, contributing to the reform of traditional rural markets, encouraging private-sector participation in agricultural development, reducing transaction costs, improving agricultural product markets, changing cultivation patterns, and preventing severe price fluctuations. These functions strengthen the position of both producers and consumers within the agricultural marketing system (Shirzad & Damavandi, 2013).

Previous research nevertheless indicates that the relationship between commodity exchanges and

agricultural sector development has been examined only to a limited extent. Several earlier studies have focused on isolated dimensions of agricultural performance rather than considering the sector from a comprehensive perspective. This limitation reveals a research gap concerning the broader relationship between commodity exchange activities and agricultural development.

A comprehensive examination should therefore consider the effects of the commodity exchange on production growth, agricultural value added, market price regulation, export capacity, and agricultural gross domestic product. Studying these dimensions together can provide a broader understanding of the contribution of organized commodity markets to agricultural development. The results can also offer new evidence concerning the different mechanisms through which the commodity exchange influences the performance and development of the agricultural sector.

The theoretical framework addresses the principal concepts and relationships required to understand this connection between agricultural development and organized commodity markets. It examines the growth and development of the agricultural sector and the indicators affecting its performance, the concept and historical evolution of the commodity exchange, and the effects of commodity exchanges on agricultural growth and development. Previous domestic and international research also provides a basis for identifying similarities and differences in research content, methodological approaches, and findings, thereby contributing to the identification of the study's specific contribution.

Agriculture encompasses a broad range of activities, including farming, horticulture, animal husbandry, poultry farming, silkworm breeding, beekeeping, agricultural and livestock services, hunting, forestry, and related activities. Agriculture and natural resources constitute

one of the most important sectors of the economy because of their fundamental contribution to food provision, food security, and sustainable development. Their importance extends beyond primary production because agricultural activities are closely connected with employment, industry, services, trade, and the broader process of economic development.

In addition to providing food and generating employment, the agricultural sector supplies raw materials to numerous industrial and service activities and contributes to national exports through the commercialization of agricultural products (Vahdati & Sarikhani, 2020). The experience of developed countries demonstrates the importance of agriculture in broader processes of economic transformation. In many of these countries, agricultural production surpluses contributed to the resources and conditions that supported subsequent development.

The role of agriculture in developed economies therefore extends beyond the provision of food and includes important political, social, and economic functions for which there are few direct substitutes. The global average contribution of agriculture to gross domestic product was approximately 3.8 percent in 2015. Agriculture can also provide an important foundation for industrial development, particularly when agricultural and industrial policies evolve in a coordinated manner. The experiences of the United States, Japan, and India illustrate the importance of maintaining complementary attention to agricultural and industrial development rather than treating them as independent processes.

Agriculture represents one of the most important components of the Iranian economy and occupies a significant position after the service sector. Earlier estimates indicated that agriculture accounted for approximately 26 percent of gross domestic product and 26 percent of non-oil exports, while employing

approximately 23 percent of the national workforce and supplying more than 85 percent of the country's food requirements. More recent estimates, however, place the agricultural share of gross domestic product at approximately 9 percent, indicating changes in the relative contribution of the sector over time.

Other recent estimates indicate that agriculture accounts for approximately 21 percent of the value of non-oil exports and 18 percent of national employment, while providing nearly 93 percent of society's food requirements. The sector also supplies raw materials to numerous industries and therefore contributes to broader processes of structural and economic transformation. Consequently, agricultural development remains an important prerequisite for national economic development, since persistent barriers affecting this sector can also constrain prosperity, growth, and development in other areas of the economy.

The relationship between agriculture and economic growth has received considerable attention in development studies. Low productivity and slow agricultural growth are frequently identified as important factors associated with low economic growth and income levels in developing countries (Alston & Pardey, 2014). Conversely, considerable evidence indicates a positive relationship between improvements in agricultural productivity and overall economic growth (Gollin, 2010; Self & Grabowski, 2007). Agriculture has consequently been recognized in international development studies as an essential instrument for promoting economic growth and reducing poverty.

The importance of agriculture becomes even more evident when poverty, employment, population growth, and the use of land and water resources are considered. Approximately 70 percent of global water consumption and 12 percent of the world's land area, equivalent to approximately 1.6 billion hectares, are

devoted to agriculture. The sector is also responsible for approximately 17 percent of greenhouse gas emissions. At the same time, 37.3 percent of the global workforce is employed in agriculture, with women accounting for 41 percent and men for 59 percent of agricultural employment.

Demographic growth will place additional pressure on agricultural systems and natural resources. The global population is projected to exceed 9.6 billion by 2050, potentially increasing food demand by approximately 70 percent. Agricultural water consumption is also expected to increase from approximately 3,100 billion cubic meters to 4,500 billion cubic meters by 2030. These projections indicate that future food requirements will place considerable pressure on the existing capacity of global agriculture, particularly when the effects of climate change and global warming are also considere.

Climate change has already had significant negative effects on agricultural production, and these effects are expected to intensify. Drought stress, shorter periods of winter cold, insufficient fulfillment of chilling requirements, earlier flowering, greater exposure to late spring frosts, and reductions in land suitable for agricultural production are among the consequences associated with changing climatic conditions (Vahdati & Sarikhani, 2020). Such changes affect both the productive capacity of agricultural systems and their ability to respond to increasing food demand.

Projections suggest that the production of nine of the world's ten strategic agricultural crops could decline substantially by 2030 as a consequence of climate change, with corresponding increases in production and market prices. Estimates indicate that corn, rice, and wheat production could decrease by approximately 21 percent, 32 percent, and 13 percent, respectively, while their prices could increase by approximately 90 percent, 89 percent, and 75 percent. These trends

illustrate the simultaneous pressures created by increasing demand, declining resource availability, and adverse climatic conditions.

Population growth is therefore expected to increase food demand considerably at the same time that climate change and diminishing natural resources constrain agricultural production. Although conventional agricultural systems have substantially increased crop production and food availability, these improvements may be insufficient to satisfy future requirements. Moreover, the environmental consequences associated with intensive production practices, particularly the widespread use of chemical inputs, have raised serious concerns regarding the long-term viability of conventional agricultural methods.

The principal objective of conventional agriculture has traditionally been to maximize production and income, often through practices that do not adequately consider their environmental consequences. The need to reconcile increased production with environmental protection has consequently strengthened interest in sustainable agricultural development. As population and food demand continue to increase, preserving the natural resources required for food production becomes both a national and international responsibility.

Sustainable agriculture has emerged as an alternative approach for addressing the environmental and productive problems associated with conventional and traditional agricultural systems. It seeks to reconcile food production with the responsible use of natural resources and environmental protection. The increasing pressure to expand cultivated areas and production in response to population growth has therefore contributed to the emergence of an agricultural development model centered on maintaining productivity without degrading the ecological foundations on which future production depends.

Sustainable development is a broad and multidimensional concept whose interpretation may vary according to historical, geographical, economic, and social circumstances. In general terms, it refers to maintaining the development process over time through an appropriate relationship among economic, social, and ecological systems. From this perspective, the interaction between human societies and the environment constitutes a fundamental component of sustainability and determines the long-term viability of development processes.

From the perspective of the Food and Agriculture Organization of the United Nations, sustainable development involves the management and conservation of natural resources together with the orientation of technological development and administrative structures toward ensuring the continued satisfaction of human needs. This approach emphasizes the importance of simultaneously addressing the requirements of present and future generations through responsible resource management.

The World Commission on Environment and Development, commonly known as the Brundtland Commission, defines sustainable development as development that satisfies present needs without compromising the ability of future generations to satisfy their own needs. This perspective encompasses changes in resource use, investment orientation, technological development, and other dimensions of economic and social transformation that must remain compatible with both present and future requirements.

A systems perspective is therefore one of the most important instruments for understanding and achieving sustainable development. Sustainability, like development itself, cannot be adequately addressed through isolated sectors or individual processes. Although progress in a particular sector may be

necessary for broader development, it is not sufficient by itself. The different components of a social and economic system must advance simultaneously and, particularly, in a coordinated manner toward common development objectives.

Growing concern regarding the environmental consequences of industrial agriculture has increased attention to sustainable agricultural practices. Technological advances and scientific developments have contributed substantially to agricultural productivity, but they have not necessarily ensured the long-term sustainability of industrial agricultural systems. In particular, the excessive use of chemical substances and conventional methods of food production has generated environmental and productive challenges that have strengthened the need for alternative approaches.

Sustainable agriculture can be understood as a production system that gives priority to environmental quality and the conservation of natural resources while promoting their appropriate and efficient management. This perspective recognizes that agricultural productivity cannot be considered independently of the environmental resources that sustain production and therefore seeks to balance economic, productive, and ecological objectives over the long term.

According to the Food and Agriculture Organization of the United Nations, sustainable agriculture involves the management and conservation of natural resource bases together with the orientation of technological and institutional change in ways that ensure the continued satisfaction of human needs for both present and future generations. This approach integrates agricultural production with resource conservation and emphasizes the intergenerational responsibility associated with the use of land, water, and other productive resources.

Achieving sustainability in agriculture consequently requires attention to several interconnected

dimensions. Three considerations are particularly important: ensuring sufficient income, especially for low-income populations; guaranteeing access to food; and protecting and improving the natural resources on which agricultural production depends. Sustainable agriculture therefore involves not only environmental protection but also economic viability and social well-being, which together constitute essential conditions for maintaining agricultural systems over time.

1.2. Sustainable Agricultural Development: Indicators and Development Models

Sustainable agricultural development constitutes a fundamental dimension of national development because the long-term and continuous development of a country depends substantially on the sustainability of its agricultural system. The concept encompasses a broad range of approaches, extending from modernization and structural transformation in advanced industrial agriculture to the adoption of technologies compatible with conventional agricultural systems. For agricultural development to be considered sustainable, it must simultaneously be ecologically appropriate, economically viable, and socially desirable. An important stage in the evolution of this approach can be traced to the 1971 meeting of the Consultative Group on International Agricultural Research, when development and environmental specialists identified sustainable agriculture as an urgent requirement for achieving food security in developing countries.

The indicators used to assess sustainable agricultural development can generally be classified into two major categories: macro-level and micro-level indicators. Macro-level indicators evaluate specific dimensions of sustainability at broader international or global levels, whereas micro-level indicators rely primarily on data collected at lower levels, particularly farms and agricultural fields. At the farm level, these indicators can be organized into three interconnected dimensions:

economic, social, and ecological or environmental. Together, these dimensions provide a comprehensive framework for evaluating whether agricultural development can maintain productive capacity while supporting economic viability, social well-being, and environmental sustainability.

Economic indicators include total farm production, cultivated area, production per unit of land, increases in household savings or income, household consumption patterns, reductions in farmers' dependence on government subsidies, integration between on-farm and off-farm employment, and the costs associated with agricultural inputs. These variables provide information about the productive and economic capacity of agricultural systems and the extent to which farming households can maintain viable livelihoods without excessive dependence on external financial support.

Social indicators encompass farmers' educational levels, management skills, participation in local decision-making processes, migration and emigration rates, mortality rates, farm planning capacity, age, standard of living, and the health and nutritional conditions of farmers and their family members. These indicators emphasize that sustainable agricultural development cannot be assessed exclusively through production and economic performance but must also consider the social conditions, capabilities, participation, and quality of life of rural populations.

Environmental and ecological indicators include soil characteristics and quality, such as mineral balance, erosion, water-holding capacity, and temperature, as well as water quality and the use of water resources. They also encompass land use, pesticide application, the use of fertilizers and chemical pesticides, chemical residues in agricultural products, the application of organic fertilizers, livestock manure and green manure, and the effects of climate change. These indicators provide a basis for evaluating the environmental

consequences of agricultural activities and the capacity of production systems to conserve the natural resources required for their long-term sustainability.

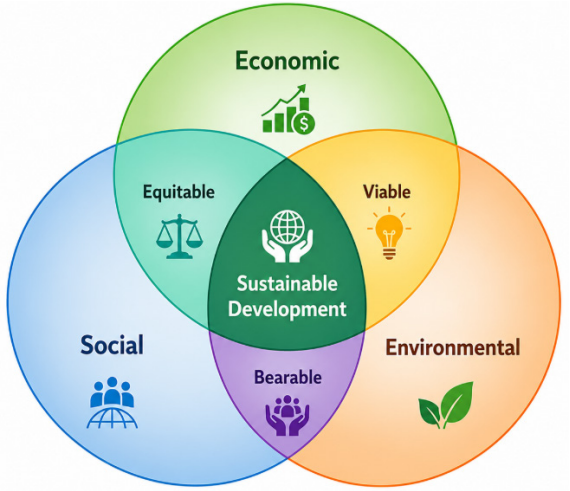


Figure 1.1. Indicators of Sustainable Agricultural Development in Iran.

Source: Kalantari et al. (2008).

Economic experts consider agricultural growth and development (Figure 1.1) to be prerequisites for the sustainable development of the global economy and have made considerable efforts to examine agricultural development through various models and theories. In other words, the study of agricultural development and growth models has been a major concern among development economists. Six models have been proposed to explain agricultural development across different countries: resource exploitation, resource conservation, location and situation recognition, diffusion, high-yield inputs, and induced innovation.

In the resource exploitation model, emphasis is placed on maximizing the use of existing resources and exploiting new resources, including previously uncultivated land. Historically, this model received considerable attention and represented a major source of agricultural and economic development. However, under current conditions, only a limited number of

regions worldwide can consider development based on resource exploitation an effective strategy. Moreover, this model is largely inconsistent with the objectives of sustainable agricultural development.

In the resource conservation model, the fundamental principle is that existing resources, whether renewable or non-renewable, are not permanently available. Therefore, increasing resource productivity and identifying alternative resources are essential. Within this model, efforts are directed toward increasing productivity and ensuring the appropriate use of resources throughout the agricultural production process.

Agricultural development within the framework of the resource conservation model has sustainably supported agricultural production growth of approximately 1% per year over extended periods in many regions of the world.

In the location and situation recognition model, unlike the resource conservation model, geographical and locational differences are explicitly considered. The urban-industrial impact theory also derives from this model. According to this theory, urban-industrial areas influence agricultural development in two principal ways: by increasing demand for agricultural products and by promoting greater utilization of agricultural inputs. This model has limited applicability in developed countries but may be effective in developing countries where decisions concerning the geographical location of industries can influence agricultural development.

In the diffusion model, the dissemination of improved management practices and desirable crop varieties and livestock breeds is regarded as an important source of agricultural development. According to this approach, research and the dissemination of technical knowledge have played a significant role in economic growth, even in developed countries.

The high-yield input model is a comprehensive approach that incorporates principles from the resource conservation, location, and diffusion models. This model has received considerable attention because of the emphasis placed on the adoption and effective use of high-yield inputs.

The induced innovation model is influenced by four key factors: technology, institutions, cultural contexts, and the status of natural resources. This model directly or indirectly incorporates the factors considered in the five preceding models. However, the core of this process lies in factors that influence the economic conditions of producers, particularly technological change and production and management institutions. Overall, the study of agricultural development patterns worldwide, particularly in developed countries, indicates that no single model is sufficient. Instead, agricultural development requires an appropriate combination of the different models described above.

1.3. Agricultural Development and Economic Indicators in Iran

In Iran, as in other developing countries, agriculture constitutes one of the most important sectors of the economy and makes a substantial contribution to both production and employment. An examination of historical trends, climatic conditions, employment patterns, and urbanization indicates the significant position of agriculture within the national economy. The sector has also demonstrated positive growth during periods in which other economic sectors have experienced less favorable performance. Consequently, agriculture occupies a strategic position because of its capacity to generate employment, contribute to foreign exchange earnings, and support broader economic development.

Before examining sustainable agricultural development in Iran, it is necessary to consider the position of agriculture within the national economy and the availability of land suitable for production. Of Iran's total

area of approximately 164.8 million hectares, 0.4 percent, equivalent to 0.7 million hectares, is classified as very suitable for agriculture, while 2.2 percent, equivalent to 3.6 million hectares, is classified as suitable. Another 7.9 percent is classified as moderately suitable, 11.4 percent, equivalent to 18.8 million hectares, as poorly suitable, and 3.6 percent as very poorly suitable. In addition, 59.9 percent, equivalent to 98.7 million hectares, is considered unsuitable for agricultural use, while 11.9 percent, equivalent to 19.6 million hectares, is classified as uncultivable.

The extent to which available agricultural land is currently exploited provides additional insight into the productive capacity of the sector. Approximately 100 percent of land classified as very suitable for agriculture is already under cultivation, compared with approximately 82 percent of suitable land and 70 percent of moderately suitable land. The distribution of cultivated land according to production type indicates that approximately 89 percent of Iran's agricultural land is devoted to field crops, while the remaining 11 percent is allocated to orchards. Of the total area devoted to agricultural crops, approximately 40.4 percent is irrigated and 59.6 percent is rainfed. Wheat, barley, and rice are among the dominant agricultural crops produced in the country.

The importance of agriculture is also reflected in its contribution to employment and national production. Compared with several other productive activities, the agricultural sector has considerable capacity to generate employment relative to the resources required for production. With an output of approximately 1.46 million rials per unit considered in the original estimates, its employment cost is approximately one-half that of the machinery industry and one-third that of the mining and oil industries. The agricultural sector also accounts for approximately 10.7 percent of gross national product, demonstrating its considerable economic importance.

Employment associated with agriculture extends beyond activities performed directly within the sector because agricultural production generates important linkages with related industries. In addition to direct agricultural employment, a significant proportion of the Iranian workforce participates in industries and economic activities connected with agriculture. These productive and employment linkages reinforce the strategic importance of the sector and demonstrate why agricultural development remains closely associated with broader objectives concerning employment generation, national production, and sustainable economic development (Figure 1.2).

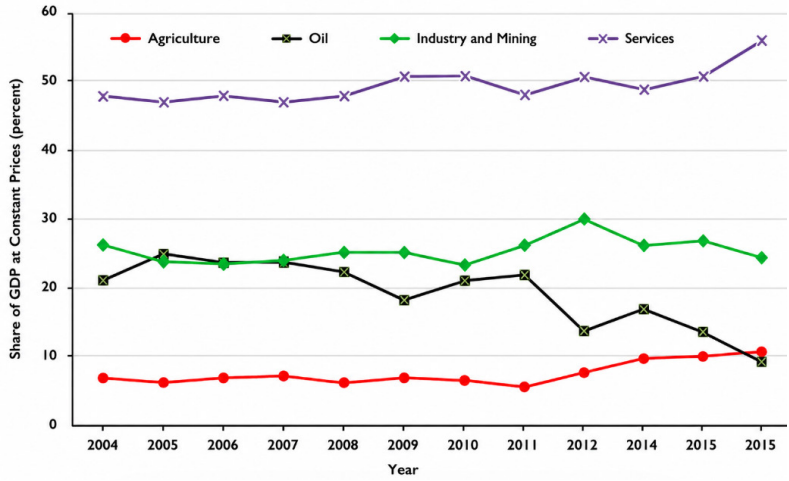


Figure 1.2. Sectoral Shares of Gross Domestic Product at Constant Prices in Iran, 2004–2015.

In addition to its contribution to domestic production and employment, the agricultural sector plays an important role in Iran's foreign exchange earnings. According to statistics from the Food and Agriculture Organization of the United Nations, global agricultural exports reached approximately 1, 264.13 billion dollars in 2016, while Iran ranked seventy-second with agricultural exports valued at approximately 1.74 billion dollars. Fruits and vegetables represented a substantial share of these

exports, reaching approximately 1.3 billion dollars and placing Iran thirty-fifth worldwide in exports of these products. Iran also produced approximately 18.6 million tons of fruits and vegetables, placing the country ninth globally in terms of production.

Dried fruits, particularly pistachios, have traditionally occupied an important position in Iran's agricultural exports and broader non-oil exports. According to statistics from the Customs of the Islamic Republic of Iran, agricultural products accounted for approximately 14.3 percent of the country's non-oil exports in 2018, while pistachios alone represented more than 4.5 percent of the total value of Iranian exports measured in dollars. Iran has also maintained an important position among the world's major pistachio exporters, demonstrating the strategic contribution of selected agricultural commodities to the country's participation in international markets.

Iran is characterized by an extensive territory and considerable climatic diversity, conditions that allow a wide range of agricultural and horticultural crops to be cultivated across different regions. Despite these advantages, domestic agricultural production has not been sufficient to satisfy the country's growing demand for food, and imports of certain agricultural products, particularly field crops and animal feed, have increased substantially. This situation reflects structural constraints that continue to affect the productive capacity and sustainability of Iranian agriculture.

Among the principal challenges are limitations on expanding cultivated areas, the tripling of the national population over approximately four decades, reductions in potentially cultivable land, and increasing ecological pressures in rural production areas. Other difficulties include intensive land use, inappropriate and environmentally damaging exploitation of water resources, declining efficiency of fundamental production factors such as water and land, and the

limited economic viability of some agricultural activities. The aging of the agricultural workforce and declining interest among younger generations in agricultural employment further reinforce the need to prioritize sustainable agricultural development in Iran.

Following the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, Iran's approach to sustainable agricultural development entered a new institutional stage. The High Council for Environmental Protection assumed a central role in addressing sustainability issues, and one of the first practical measures was the establishment of the National Committee for Sustainable Development. Created in September 1993, this committee brought together representatives of relevant executive institutions to formulate policies and coordinate national economic and social development programs with environmental protection objectives and the commitments arising from the international conference.

An examination of Iran's national development plans also demonstrates the strategic importance attributed to agriculture. Across the five-year development plans implemented after the revolution, agriculture has consistently been regarded as a major component of national economic development. Nevertheless, explicit attention to sustainable agricultural development emerged more gradually and was primarily incorporated into the fourth, fifth, and sixth development plans. The fifth and sixth plans placed comparatively greater emphasis on sustainability within agricultural development policies.

Despite this growing policy attention, assessments based on indicators related to agricultural resources, agricultural progress, environmental conditions, rural communities, and education suggest that considerable challenges remain. Agricultural development in Iran has been characterized as unsustainable or only weakly sustainable, with particularly pronounced levels of

unsustainability in western and northwestern provinces and in some provinces located in the eastern part of the country.

Several factors contribute to this situation, including the destruction and conversion of agricultural land for urban and industrial purposes, inappropriate irrigation and soil cultivation practices, genetic erosion affecting indigenous Iranian plant species, and the excessive or inappropriate use of chemical inputs. Declining soil fertility, unsuitable cultivation patterns, insufficient attention to rural development and the welfare of rural populations, and limited farmer awareness of sustainable and organic agriculture further undermine the sustainability of the country's agricultural system.

Achieving sustainable agricultural development therefore requires a coordinated set of measures. These include reforming management structures, improving production and water supply systems, directing research toward indicators of sustainable agricultural development, adopting modern cultivation methods, improving consumption patterns and agricultural marketing systems, and transforming production models. Together, these approaches can strengthen the capacity of Iranian agriculture to respond to economic, social, and environmental pressures while maintaining its productive role over the long term.

The strategic importance of agriculture has made sustained sectoral growth a recurring objective of national policymaking and macroeconomic planning. Achieving this objective requires identifying the principal factors that stimulate or constrain agricultural growth (Ansari & Salami, 2016). Consequently, researchers have examined a broad range of economic, financial, productive, and institutional variables that may influence agricultural performance. Growth theories also provide different criteria for selecting explanatory variables, although empirical studies frequently rely on researcher-defined selections, creating what has been

described as the problem of infinite regress in growth research

The large number of potentially relevant variables also creates methodological difficulties. Conventional econometric approaches may be unable to evaluate all possible determinants simultaneously because increasing the number of variables reduces the available degrees of freedom and increases uncertainty surrounding estimated coefficients. This limitation complicates the identification of the factors that exert the strongest influence on agricultural growth and explains why different empirical studies may emphasize different combinations of determinants.

Empirical research has identified financial development, exports, investment, inflation, oil revenues, trade, and energy consumption as important variables associated with agricultural growth in Iran. Kohansal et al. (2013) similarly found that exports and investment exert positive and significant effects on agricultural growth, with investment producing a greater long-term effect on agricultural value added than exports.

Other studies have examined the effects of broader macroeconomic conditions. Pishbahar et al. (2015) analyzed inflation and found that inflationary shocks contributed relatively little to fluctuations in agricultural production compared with other economic sectors, suggesting that inflation does not exert a substantial influence on agricultural production and growth in either the short or long term.

Exports, investment, and trade have also received considerable attention as determinants of agricultural performance. Energy consumption represents another factor associated with agricultural growth. International evidence further illustrates the influence of macroeconomic conditions on agricultural production. Nnoli et al. (2023) examined agricultural production in Nigeria and found that exchange rates and inflation were associated with agricultural sector growth, while

fluctuations in inflation and interest rates produced adverse effects. Blazejowski et al. (2019), in a study covering 168 countries, identified gross national savings, gross domestic product per capita, gross fixed capital formation, and geographical location in Asia and Oceania among the most important determinants of economic growth. Together, these findings demonstrate that agricultural growth depends on the interaction of financial, productive, commercial, energy, and broader macroeconomic conditions.

Recent empirical research examining the interaction between agricultural growth and overall economic growth has produced mixed and sometimes contradictory findings. Consequently, there is no complete consensus regarding the contribution of agriculture to economic growth. While some researchers consider agricultural development a prerequisite for industrialization and broader economic expansion, others propose alternative development paths. From the first perspective, the development of the agricultural sector constitutes an important foundation for sustained economic growth (Gollin et al., 2002; Schultz, 1964).

The agriculture-led growth perspective maintains that investment in agriculture, accompanied by the development of infrastructure and institutions in other economic sectors, is a prerequisite for national economic growth (Schultz, 1964; Timmer, 1995, 2002). According to this approach, agricultural growth can stimulate national production by increasing rural incomes and generating resources that facilitate the transition toward an industrial economy (Datt & Ravallion, 1998; Eicher & Staatz, 1990). Historical experiences also indicate that attempts to accelerate industrialization without previously strengthening agriculture have sometimes resulted in limited economic growth and highly unequal income distribution (Bhagwati & Srinivasan, 1975).

Empirical evidence provides support for some of these arguments. Tiffin and Irz (2006) examined the causal

relationship between agricultural value added and economic growth across a group of countries using bivariate Granger causality tests. Their findings provided strong evidence of causality running from agriculture to economic growth in developing countries, although the evidence was less robust for developed economies. These differences suggest that the contribution of agriculture to economic growth may depend substantially on a country's level of development and economic structure.

Johnston and Mellor (1961) identified five principal intersectoral mechanisms through which agriculture contributes to economic growth and development. The agricultural sector can provide surplus labor for industrial enterprises, supply goods for domestic consumption, create markets for industrial products, generate domestic savings for industrial investment, and provide foreign exchange through agricultural exports. Foreign exchange earnings from agriculture can subsequently finance imports of capital and intermediate goods required for the expansion of other productive sectors.

Timmer (1995) further emphasized the importance of indirect and non-market linkages through which agriculture can improve the quality and productivity of major production factors, particularly labor and capital. According to this perspective, the contribution of agriculture may be underestimated because limitations in available data make it difficult to quantify its indirect effects on labor efficiency, capital efficiency, and total factor productivity. To address these limitations, Timmer proposed a modeling approach suitable for analyzing broader national time-series data.

An alternative perspective questions the agriculture-led interpretation of economic growth. Scholars associated with this position argue that agriculture may have relatively (Hirschman, 1958; Jorgenson, 1961) weak linkages with other economic sectors and may lack

the innovative structure required to generate higher productivity and sustained export growth (Lewis, 1954; Ranis & Fei, 1961). From this perspective, industrial development rather than agricultural expansion can constitute the principal mechanism for accelerating structural transformation and economic growth.

Matsuyama (1992) further challenged the proposition that improvements in agricultural productivity necessarily function as an engine of economic growth by applying the concept of comparative advantage. Arguments of this nature influenced policymakers in several developing countries to adopt development strategies that placed greater emphasis on industrial production and comparatively less emphasis on agriculture. Such policies reflected a more restrictive interpretation of the contribution of agriculture to the broader development process (Okonkwo, 1989; Schiff & Valdes, 1998).

Other theoretical and empirical studies have examined how the contribution of agriculture changes throughout the development process. Kuznets (1964) developed a model for determining the agricultural sector's contribution to gross domestic product, while Ghatak and Ingersent (1984), drawing on the Solow (1957) model, argued that agriculture's relative share tends to decline as development advances. According to this interpretation, the growth of the non-agricultural sector eventually exceeds agricultural growth, and the difference becomes particularly pronounced in developed economies.

Block (1999) examined the effects of agricultural growth on other sectors of the Ethiopian economy and found that agriculture had the largest growth coefficient after the service sector. These findings further illustrate that the contribution of agriculture can extend beyond direct production and influence the performance of interconnected sectors of the economy.

Research conducted in Iran has similarly produced substantial evidence concerning the relationship

between agriculture and economic growth. Samadi (1999) likewise provided evidence supporting the contribution of agriculture to Iran's economic growth. Haji Rahimi and Torkmani (2003) examined the effect of agricultural growth on Iran's overall economic growth and concluded that agricultural value added exerted an important influence on total economic value added and consequently on economic growth.

Mardani Najafabadi et al. (2022) examined the relationship between economic growth, agricultural expansion, and chemical pollution in Iran. Their findings indicate that agricultural development and economic growth are closely associated with environmental pressures, particularly those resulting from the use of chemical inputs. The study highlights the need to reconcile agricultural productivity and economic development with environmental sustainability through more efficient resource use and less polluting agricultural practices.

Mozezi et al. (2008) examined the effects of agricultural exports on industrial exports and economic growth in Iran and identified a negative relationship between agricultural export growth and gross domestic product growth in both the short and long term. Falsafian et al. (2010), however, investigated causality between agricultural sector growth and economic growth and identified a bidirectional long-term relationship between the two variables. These contrasting findings demonstrate the complexity of the relationship between agricultural performance and broader economic development.

Khorami and Pierof (2013) compared agriculture with other economic sectors, including industry, services, mining, and trade, and concluded that agriculture had made a significant contribution to Iran's economic development and growth. In contrast, Kohansal et al. (2013) concluded that agriculture had played a comparatively limited role in Iranian economic growth

and development when compared with services, mining, industry, and trade.

Mohammadi et al. (2017) analyzed agricultural price volatility in the Iran Mercantile Exchange, focusing on barley prices and comparing their behavior with domestic traditional markets and the Chicago Mercantile Exchange. Their findings showed greater barley price fluctuations in the Iranian exchange and demonstrated that macroeconomic factors, particularly crude oil prices and exchange rate movements, significantly influence agricultural commodity prices. The study highlights the importance of macroeconomic stability for improving price stability and the effectiveness of agricultural commodity markets in Iran.

These results support the interpretation of agriculture as a potential engine of economic growth in Iran. Strengthening and developing the agricultural sector can therefore create favorable conditions for broader economic growth and development. Trade liberalization, increased investment, and higher employment have also been identified as important factors contributing positively to economic performance.

Agricultural research and development play an important role in strengthening the productive performance and long-term growth of the agriculture and horticulture subsector. Investment in research can contribute to technological improvement, greater production efficiency, innovation, and increased agricultural value added. At the same time, the agricultural labor force remains a fundamental component of sectoral development, as human resources are essential for applying knowledge, adopting technologies, and improving productive processes.

However, the effectiveness of agricultural research expenditure depends not only on the volume of financial resources invested but also on how these resources are allocated and managed. An appropriate allocation strategy can direct investment toward priority areas,

productive needs, technological development, and the practical application of research results. Therefore, agricultural development requires an integrated approach in which research investment, human resources, productive capacity, and efficient resource allocation interact to support sustained improvements in sectoral performance.

Rezvani et al. (2025) examined the relationship between inflation and inflation uncertainty in Iran while accounting for structural breaks. Their findings revealed a unidirectional causal relationship from inflation to inflation uncertainty, indicating that persistent inflationary pressures increase uncertainty about future price developments. The study therefore highlights price stability as an important condition for reducing macroeconomic uncertainty and improving the predictability of economic decisions.

Abbasi et al. (2022) investigated the effects of trade liberalization on agricultural growth and trade using a Markov-switching approach and annual time-series data covering the period from 1979 to 2018. The results indicated that reductions in import tariffs associated with trade liberalization increased exports by 56.1 percent in the short term, while imports declined by approximately 65.7 percent in the long term. The estimated growth model further showed that the liberalization index had a positive and significant effect on agricultural growth under both regimes, with trade liberalization contributing approximately 1.981 percent to agricultural sector growth during the period analyzed.

These findings indicate that trade liberalization can stimulate agricultural exports in the short term and, through increased domestic production, contribute to higher export volumes and lower imports over the longer term. Such changes can ultimately support broader economic growth. Accordingly, strengthening the trade capacity of the agricultural sector requires tariff policies consistent with trade liberalization objectives

and national development priorities, while maintaining adequate bargaining capacity in international trade negotiations (Abbasi et al., 2022).

Mehdizadeh Rayeni et al. (2022) examined the effects of financial development and economic freedom on agricultural economic growth in selected Middle Eastern countries, with particular emphasis on Iran. Using consolidated data covering the period from 2006 to 2017, the study found that financial development, economic freedom, physical capital, and employment in the agricultural sector had positive and significant effects on agricultural production growth, with estimated coefficients of 0.39, 0.42, 0.31, and 0.12, respectively. These findings support the adoption of policies aimed at reducing tariff barriers and trade restrictions while creating more favorable conditions for agricultural production and economic growth.

Overall, agricultural sector growth is influenced by a broad range of interconnected economic and financial factors. Evidence from previous studies highlights capital investment and financial development as particularly important determinants, as they influence the availability and allocation of productive resources and shape the conditions under which agricultural activities can expand and improve their performance.

Capital investment constitutes one of the principal factors of production and plays an essential role in stimulating productive activity. The relative scarcity of capital within an economy makes investment particularly important for achieving sustained economic progress. By expanding productive capacity, improving infrastructure, and providing complementary public goods, investment can also create more favorable conditions for private-sector participation.

Investment is therefore not limited to increasing the stock of productive assets but can also create conditions that facilitate broader economic transformation. Public investment in infrastructure and essential services can

strengthen the environment in which private-sector activities operate, while productive investment expands the capacity of the economy to generate goods, employment, and income. Consequently, there is broad agreement on the importance of increasing investment as an essential mechanism for supporting economic growth and development.

The theoretical literature presents different perspectives regarding the relationship between financial development and economic growth. One perspective, associated with scholars such as Meier, Seers, and Stern, questions whether financial development exerts a significant independent effect on economic growth. An alternative perspective maintains that a causal relationship exists between the development of the financial sector and growth in the real economy.

Financial development and economic growth can interact through changes in the demand for financial services and the expansion of productive activity. As the real sector of the economy grows and national income increases, households, firms, and investors tend to require greater access to liquidity, credit, savings instruments, and other financial services. These increasing needs can stimulate the expansion of financial intermediaries and encourage the development of more sophisticated financial structures. From this perspective, financial sector development may emerge as a response to broader economic expansion, reflecting the growing financial requirements associated with higher levels of investment, production, and economic activity.

The second perspective reverses the direction of causality and proposes that financial development stimulates growth in the real sector. Under the supply-leading hypothesis, the expansion of financial institutions and services precedes and promotes economic growth. The findings associated with Goldsmith and McKinnon support the proposition that expansion of the financial sector can contribute to higher economic

growth (Salmani & Amiri, 2010). Financial institutions can achieve this effect by mobilizing resources and directing them toward sectors with greater productive and growth potential.

From this perspective, financial development facilitates the transfer of resources from traditional and low-growth activities toward modern and expanding sectors while simultaneously encouraging entrepreneurial activity. The creation of financial institutions and improvements in the quantity and quality of their services may therefore occur before explicit demand for these services has fully developed. Greater access to financial services can subsequently generate additional demand within modern and expanding sectors of the economy.

A third perspective proposes a bidirectional causal relationship between financial development and economic growth. According to this interpretation, expansion of financial markets initially provides resources and services required for growth in the real sector, while subsequent growth in productive activities generates additional demand for financial services and promotes further development of the financial sector. Financial development and real economic growth can therefore reinforce one another over different stages of the development process (Calderón & Liu, 2003).

The relationship between financial development and agriculture is particularly important in developing countries because financial markets can accelerate investment while agriculture itself constitutes an important component of economic growth and development. Nevertheless, agricultural financial markets operate under specific productive and informational conditions that distinguish them from financial markets serving other sectors. These characteristics can restrict both the supply of and demand for financial services and contribute to persistent shortcomings in agricultural financial markets.

Financial market development can promote growth across economic sectors by facilitating access to required capital and increasing the productivity of production factors. However, financial expansion may also accelerate the circulation of money and, under certain conditions, contribute to inflationary pressures that can adversely affect economic growth. The overall effect of financial development therefore depends on the interaction between improved access to capital, productive efficiency, monetary conditions, and the characteristics of the sector receiving financial resources.

These relationships are particularly relevant to agriculture because financial development can facilitate investment in productive activities, while agricultural development can, in turn, contribute to broader economic growth. The nonlinear relationship between financial development and agricultural value added suggests that the effects of financial expansion vary according to the level of financial development. In the first regime, financial development has a positive effect on agricultural value added; however, this effect becomes negative once the transition to the second regime occurs.

Inflation has a positive but statistically insignificant effect in the first regime, whereas it becomes negative and statistically significant in the second. Capital and labor have positive and significant effects on agricultural value added in both regimes, although their contributions diminish in the second regime. These findings suggest that once financial development exceeds the identified threshold, its contribution to agricultural value added may weaken, particularly in an environment characterized by greater inflationary pressures.

These findings suggest that weaknesses in the allocation and direction of credit can limit the contribution of financial markets to agricultural development. Improving

their performance therefore requires measures such as strengthening competition within the banking system, improving the selection of loan applicants, and allocating financial resources more efficiently among agricultural activities and other productive sectors. Such measures can create more favorable conditions for agricultural growth and strengthen the contribution of agriculture to broader economic development.

Limited access to financial resources is frequently identified by agricultural producers as one of the main constraints affecting their activities (Pish Bahar et al., 2015). Budget constraints can prevent agricultural enterprises in developing countries from taking advantage of economies of scale and reaching optimal production levels. When liquidity is restricted, the quantity and combination of inputs used by agricultural enterprises may differ considerably from their theoretically optimal levels.

Access to credit can reduce these constraints by enabling producers to bring input utilization closer to optimal levels, thereby increasing production and improving the productivity of productive resources. Financial limitations also restrict farmers' ability to acquire modern inputs and technologies, including machinery and irrigation systems. Consequently, the development of financial markets and greater access to credit constitute fundamental mechanisms for providing the capital required for technological transformation in agriculture, particularly in developing countries (Khorami & Pierof, 2013).

Financial development in the agricultural sector can therefore improve farmers' access to essential inputs and facilitate the adoption of modern and highly productive technologies by reducing capital constraints. This process can contribute directly to productivity growth. In developing economies, the productivity of production factors is strongly influenced by physical capital and human resources, while sustained productivity growth

depends on improving both the quantity and quality of available capital and skilled labor.

Theoretical approaches to economic growth and development indicate that improvements in factor productivity in many developing countries have occurred alongside the development of financial markets and the expansion of financial incentives. From this perspective, financial development can facilitate the mobilization and allocation of resources required to strengthen productive capacity and improve the efficiency of production factors. Development economists have therefore regarded capital accumulation as a necessary, although not sufficient, condition for achieving sustained development. Consequently, insufficient accumulation of physical capital remains an important constraint that can limit productivity improvements and contribute to persistent underdevelopment (Shakeri-Bostanabadi et al., 2022).

An effective financial system composed of appropriate financial instruments, institutions, and markets can increase factor productivity by facilitating asset diversification, reducing risk, and improving the capacity to estimate expected returns from innovative activities. A developed financial system also provides profitable saving opportunities for individuals with limited entrepreneurial capacity and high risk aversion while simultaneously allowing entrepreneurs and individuals willing to assume greater risks to obtain investment resources at appropriate costs.

The high-productivity input model provides an important theoretical framework for understanding the interaction between agricultural productivity and financial development. This model considers both microeconomic and macroeconomic conditions required to improve agricultural productivity. At the microeconomic level, attention is directed toward factors that improve labor productivity, while the macroeconomic dimension emphasizes the conditions necessary for providing

technology and other productive resources. Agricultural productivity therefore depends not only on conventional factors such as labor and capital but also on external conditions and the effectiveness of supporting institutions.

Empirical evidence from different countries further demonstrates the complex relationship between financial development and economic growth. Calderón and Liu (2003) examined this relationship in 109 countries during the period from 1960 to 1994 and identified bidirectional Granger causality between financial development and economic growth. Their findings indicate that financial development can stimulate economic growth while economic expansion can simultaneously create conditions that encourage further development of financial markets.

Liu and Hsu (2006) examined the contribution of financial development to economic growth in Taiwan, Korea, and Japan. Their findings showed that high investment accelerated economic growth in Japan, although investment did not necessarily generate better growth performance when resources were allocated inefficiently, as illustrated by the experiences of Korea and Taiwan. Financial deepening positively affected the Taiwanese economy but negatively affected the Korean and Japanese economies. Stock market development also produced a positive effect in Taiwan, while the adverse effects of the Asian financial crises were less pronounced there than in Korea and Japan. Capital outflows negatively affected these economies, whereas the effects of capital inflows were statistically insignificant.

Abu-Bader and Abu-Qarn (2008) examined the relationship between financial development and economic growth in Egypt during the period from 1960 to 2001. Their findings indicated a reciprocal relationship between the two variables and showed that financial development contributed to economic growth

by increasing the resources available for investment and improving investment efficiency. Based on these results, they emphasized the importance of accelerating financial structural reforms to stimulate investment and savings as mechanisms for promoting economic growth.

Shahbaz et al. (2011) examined Pakistan during the period from 1971 to 2011 and identified a positive relationship between financial market development and agricultural sector growth.

Bojanic (2012) analyzed the effects of financial development and trade openness on economic growth in Bolivia. The findings demonstrated a long-term equilibrium relationship between indicators of financial development, trade openness, and economic growth. The causality analysis also identified a unidirectional relationship running from financial development and trade openness toward economic growth, providing further evidence that improvements in financial conditions and greater integration with international trade can contribute to long-term economic performance.

Chen et al. (2013) examined the relationship between financial development and economic growth across 28 provinces in China using a threshold regression approach. Their findings revealed substantial differences according to regional development levels. Financial development exerted a strong positive effect on economic growth in highly developed provinces, whereas the relationship was strongly negative in less developed provinces. These results demonstrate that the contribution of financial development can depend substantially on structural and institutional conditions.

Finally, Shahbaz et al. (2017) examined the asymmetric relationship between energy consumption and economic growth in India during the period from 1960 to 2015, emphasizing the role of financial development. Their findings showed that negative shocks to financial development adversely affected economic growth

through reductions in energy consumption. This evidence further illustrates the interconnected nature of financial conditions, productive resource utilization, and economic performance.

Parivash and Torkamani (2008) examined the role of financial market development in the growth of the agricultural sector during the period from 1959 to 2005. Their findings showed that financial markets generally exerted a positive effect on agricultural growth. More specifically, expansion of the country's financial structure contributed to increasing agricultural value added. The study also identified a unidirectional causal relationship running from financial market development to agricultural value added, providing support for the supply-leading perspective within the agricultural sector.

Evidence from other countries and groups of economies demonstrates that the effects of financial development can vary according to economic structure. Asari et al. (2008) compared oil-producing countries with non-oil developing countries during the period from 1990 to 2004. Their findings indicated that financial development negatively affected economic growth in oil-producing countries, whereas the relationship was positive in non-oil developing economies. These differences suggest that the contribution of financial development depends substantially on the productive and institutional characteristics of each economy.

Rasekhi and Ranjbar (2009) examined the effect of financial development on economic growth in member countries of the Organization of the Islamic Conference during the period from 1980 to 2004. Their results indicated a positive relationship between financial development and economic growth. Countries characterized by greater financial development, greater trade openness, higher rates of physical and human capital investment, lower labor force growth, and smaller government size generally experienced faster economic growth during the period analyzed.

Within the Iranian context, Shahabadi et al. (2017) examined how the development of Iran's money and capital markets influences value-added growth in the industrial sector. Using principal component analysis to construct financial development indicators, the study highlights the positive role of deeper and more efficient financial markets in supporting industrial growth. The findings emphasize that improving access to financing, strengthening financial institutions, and expanding capital-market mechanisms can facilitate investment and enhance the productive capacity of Iran's industrial sector.

Salari et al. (2014) examined the long-run relationship between financial development and economic growth in Iran over the period 1981–2011 using the autoregressive distributed lag approach. Their findings revealed a positive relationship between financial development and economic performance, particularly through the expansion of credit to the private sector. The results indicated that greater access to financial resources can stimulate economic activity by facilitating investment and directing capital toward productive sectors.

Investment was also found to exert a positive influence on gross domestic product, reinforcing the importance of capital formation as a driver of economic growth. In contrast, government size and the economic instability associated with periods of war negatively affected economic performance. These findings highlight the importance of strengthening financial institutions, improving the allocation of financial resources, and expanding productive credit as mechanisms for promoting sustainable long-term economic growth in Iran.

Shahbazi and Saeedpour (2013) investigated the threshold effect of financial development on economic growth in the Developing Eight countries during the period from 1980 to 2011. Their results identified two distinct regimes. Financial development negatively

affected economic growth in the first regime, whereas after the threshold was crossed, its effect became positive, although relatively small. These findings reinforce the argument that the relationship between financial development and growth may be nonlinear and dependent on the level of financial development achieved.

Kohansal and Hatef (2015) examined the interaction among financial development, foreign investment, and agricultural economic growth in Iran. Their findings showed that financial development exerted a positive and significant effect on agricultural growth through domestic investment, although its direct effect on agricultural growth was not statistically significant. The results therefore suggest that investment represents an important transmission mechanism through which financial development can influence agricultural performance.

Ansari and Hosseini Yekani (2014) examined the effect of financial market development on agricultural growth in Iran. Their findings revealed different effects according to the component of the financial system considered. Capital market development negatively affected agricultural sector growth, whereas money market development exerted a positive effect. These findings demonstrate that financial development should not necessarily be treated as a homogeneous process because different financial markets can influence agricultural production through distinct mechanisms.

Ahangari and Kamranpour (2016) examined the effects of financial development and value added on energy consumption in Iran's industrial and agricultural sectors. Their findings indicated that increases in financial development and value added were associated with greater energy consumption in both sectors in the short and long term. More broadly, the results demonstrated a positive relationship between financial development and growth in the industrial and agricultural sectors.

Shakeri-Bostanabad et al. (2022) examined the effect of financial development on agricultural productivity growth in selected Islamic countries. Their findings revealed a positive and statistically significant relationship between financial development and agricultural productivity. Specifically, a one percent increase in the financial development index was associated with a 0.709 percent increase in agricultural productivity. The authors attributed this positive relationship primarily to greater credit availability for the private sector, which can improve farmers' and agricultural enterprises' access to financing while contributing to reductions in transaction and production costs.

Exports constitute another important determinant of agricultural growth. From a theoretical perspective, changes in export activity can influence production by expanding market opportunities and stimulating demand for domestically produced goods. Consequently, export growth can encourage increases in production and employment and, through these mechanisms, contribute to the expansion of gross domestic product.

The relationship between exports and economic growth operates through several interconnected mechanisms. Foreign trade can promote greater specialization, expand the potential market available to domestic producers, and enable enterprises to benefit from economies of scale. Export expansion can also encourage technological innovation, improve management practices, reduce anticompetitive behavior among domestic firms, and increase productivity by limiting rent-seeking activities. These mechanisms explain why export performance can influence not only agricultural production but also the broader efficiency and competitiveness of the economy.

Exchange rate movements can influence production growth through both aggregate demand and aggregate supply. On the demand side, changes in the exchange rate affect net exports, while on the supply side they

influence the cost of imported intermediate goods and production inputs. The final effect therefore depends on the initial conditions and structural characteristics of the economy, meaning that exchange rate movements can generate different outcomes across countries and economic sectors.

Exchange rate fluctuations also affect agricultural production and related subsectors in both the short and long term (Amiri et al., 2021). Evidence from Iran indicates that greater exchange rate volatility is associated with reductions in value added in both the industrial and agricultural sectors. An increase in exchange rate fluctuations was associated with a 0.0349 percent decline in industrial and mining value added and a 0.008 percent decline in agricultural value added. The service sector was comparatively less affected because of its lower dependence on imported inputs.

The negative effect of exchange rate volatility on economic and agricultural growth is particularly relevant in economies where production depends substantially on imported raw materials and intermediate inputs. In Iran, this dependence increases the vulnerability of industrial and agricultural activities to exchange rate instability. Reducing dependence on imported production inputs through appropriate import-substitution strategies may therefore contribute to limiting the adverse consequences of exchange rate fluctuations.

Economic freedom generally refers to conditions in which market mechanisms operate with reduced government intervention in production, distribution, and consumption. Contemporary economic approaches frequently emphasize voluntary interaction among individuals and enterprises as an important mechanism for improving economic efficiency. Within this framework, free trade, access to foreign currency, international movements of goods, capital and labor, market-based

price formation, and protection of property rights constitute important dimensions of economic freedom (Amiri et al., 2021).

Economic freedom can influence numerous economic and social outcomes, including economic and human development, sectoral growth, poverty, income distribution, and political and civil conditions. Its relationship with economic growth is particularly important because sustained growth remains one of the principal objectives of economic policy. Economic freedom can consequently be understood as the absence of unnecessary constraints on individuals' ability to produce, distribute, and consume goods and services within the economy.

Empirical evidence indicates a positive and significant relationship between agricultural product diversification and economic freedom. Kohansal and Hatef (2015) examined the interaction among financial development, foreign investment, and agricultural economic growth in Iran. Their findings indicated that financial development positively and significantly affected agricultural growth through domestic investment, although its direct effect on agricultural growth was not statistically significant. This result again highlights domestic investment as an important channel connecting financial development with agricultural performance.

Ahangari and Kamranpour (2016) found that financial development and value added increased energy consumption in Iran's industrial and agricultural sectors in both the short and long term. Their results also demonstrated a positive relationship between financial development and growth in these two sectors, emphasizing the connections among financial expansion, productive activity, and energy demand.

Ansari and Salami (2016) examined the effect of technological change on agricultural production growth in Iran. Their findings showed that agricultural production growth was strongly influenced by

technological change in the food industry, particularly through greater utilization of livestock and poultry products and comparatively lower utilization of other agricultural products. These results highlight the importance of expanding processing industries for agricultural, horticultural, and aquatic products alongside the continued development of livestock and poultry processing activities.

Finally, Pish Bahar et al. (2015) examined the effects of instability and fluctuations in agricultural trade on agricultural sector growth in Iran. Their findings indicated that export instability negatively affected agricultural production, whereas exports, imports, capital, and the real exchange rate exerted positive and significant effects. Labor had a negative and significant effect. The analysis further showed that horticulture, field agriculture, livestock, and fisheries were important sources of agricultural export fluctuations, with several products within these subsectors demonstrating considerable competitiveness in international markets.

02.

Agricultural Commodity Exchange and Agricultural Sector Development

2.1. Empirical Evidence on Commodity Exchanges and Agricultural Sector Development

A commodity exchange is an organized marketplace in which buyers and sellers conduct transactions involving commodities under established institutional rules and procedures. These markets allow multiple participants to trade commodity-related contracts and can operate with or without the physical delivery of the underlying goods. Consequently, commodity exchanges may function as both physical and non-physical markets, providing institutional mechanisms through which commodity transactions can be standardized and organized.

Commodity exchanges commonly provide platforms for standardized contracts involving future delivery, although their activities are not limited to this type of transaction. Depending on the institutional characteristics of each market, trading instruments may include spot transactions for immediate delivery, futures contracts, warehouse receipts, and repurchase agreements. These instruments expand the possibilities available to producers, buyers, investors, and other market participants for managing commodity transactions under different delivery, financing, and risk conditions.

Commodities characterized by substantial short-term price fluctuations are particularly suitable for organized exchange trading. Agricultural products such as wheat and cotton generally exhibit characteristics that make them appropriate for these markets. Commodity exchanges can improve market efficiency by bringing together buyers and sellers and facilitating the coordination of supply and demand across different periods and geographical locations. This function can reduce market fragmentation and improve the conditions under which physical commodities are exchanged.

Commodity exchanges can also contribute to broader market development by reducing transaction costs, facilitating price discovery, and providing mechanisms for managing risks associated with commodity price fluctuations. Market transparency can be strengthened through grading systems, quality certification, and the dissemination of information concerning the characteristics and demand conditions of traded products. These mechanisms provide market participants with more reliable information and can improve the efficiency of commercial decisions.

Spot and futures contracts represent two common forms of commodity exchange transactions. In addition to facilitating commercial exchange, these instruments can help market participants manage price uncertainty associated with weather conditions, seasonal

production patterns, inventories, and other factors affecting commodity supply and demand. Commodity exchanges therefore perform not only a transactional function but also important informational, regulatory, and risk-management functions within agricultural markets.

Historically, organized commodity trading was concentrated primarily in industrialized economies until structural adjustment programs expanded during the 1980s and 1990s. Important exceptions included Brazil and Argentina, where organized commodity exchanges had been established considerably earlier, and Malaysia, where an exchange was created specifically for trading crude palm oil. The subsequent international expansion of commodity exchanges demonstrates that these institutions can operate under substantially different economic, political, and agricultural conditions.

Commodity exchanges have developed under diverse ownership and governance structures. Brazilian exchanges were state-owned until the mid-1960s and subsequently evolved toward a for-profit model. China's Dalian Commodity Exchange operates under state supervision and primarily serves the domestic market. Other countries, including Ethiopia, Malaysia, Thailand, and Brazil, have developed arrangements involving cooperation between public and private actors. These experiences demonstrate that there is no single institutional model for establishing and operating a commodity exchange.

The agricultural environments in which commodity exchanges operate are equally diverse. Organized exchanges exist in economies characterized by smallholder agriculture, as in Ethiopia and China, as well as in systems combining large-scale and smallholder production, such as South Africa and Thailand. They are also present in economies characterized by extensive commercial agriculture, including those of North America and Europe. Their institutional design

must therefore respond to the particular characteristics of agricultural production, market organization, and the broader economic environment.

The performance of commodity exchanges has nevertheless differed considerably among countries. Exchanges established following structural adjustment reforms have achieved notable success in several emerging economies, including China, India, Brazil, and Thailand. By contrast, many exchanges established in developing African countries have either failed or maintained only limited operations. These differences illustrate the importance of institutional capacity, market structure, trading volume, and the broader economic environment for the sustainability of commodity exchanges.

The development of specialized commodity exchanges in Iran became an important institutional objective of the Tehran Stock Exchange Organization beginning in 1997. Preparatory efforts included studies of organizational structures, operational mechanisms, regulatory frameworks, trading procedures, and international experiences with commodity exchanges. Three principal advantages were identified for developing specialized exchanges in Iran: improving the economic structure, expanding sectors capable of participating in organized exchange trading, and strengthening the country's export potential.

The establishment of commodity exchanges was therefore conceived not merely as a mechanism for facilitating transactions but also as an instrument for organizing commodity markets, improving methods of exchange, stimulating investment, and supporting broader economic development. Through these functions, organized commodity markets were expected to contribute to economic efficiency and ultimately to social welfare.

The institutional origins of the Iranian Commodity Exchange can be traced to two separate organizations.

The Tehran Metals Exchange Brokers Organization began operating in September 2003, followed by the Iranian Agricultural Commodity Exchange Brokers Organization in September 2004. Subsequently, the Iranian Commodity Exchange Company was established under the Securities Market Law approved by the Islamic Consultative Assembly in December 2005. In October 2007, the activities of the two earlier organizations were transferred to the newly established company, creating an integrated institutional structure for commodity exchange operations in Iran.

The institutional position of the Iranian Commodity Exchange subsequently evolved within the country's capital market. The company entered the basic over-the-counter market in October 2011, moved to Basic Market A in December 2016, transferred to the sub-board of the First Market of the Tehran Stock Exchange in February 2018, and finally entered the First Market of the Main Board in October 2019. Its trading infrastructure currently supports transactions involving industrial and mineral products, petrochemical products, petroleum products, and agricultural commodities.

The Iranian Commodity Exchange has progressively expanded the range of instruments available to market participants. In addition to cash, credit, and forward transactions in the physical market, the exchange has introduced commodity-based securities and other financial instruments designed to meet the requirements of different groups of economic participants. These include futures contracts, options contracts, commodity deposit certificates, standard parallel forward contracts, and commodity funds. The diversification of these instruments has expanded the exchange beyond its traditional role as a marketplace for physical commodities and strengthened its financial and risk-management functions.

The physical market of the Iranian Commodity Exchange encompasses four principal commodity

groups: industrial and mineral products, petrochemical products, petroleum products, and agricultural products. Transactions are conducted through cash, credit, forward, and premium discovery contracts, while settlement can occur through cash, credit, or a combination of both methods. This structure allows market participants to select trading and settlement mechanisms according to their financial requirements and commercial objectives.

Cash transactions represent the most straightforward form of trading in the physical market but perform an important function in promoting economic transparency. Information concerning the commodity offered for sale is first communicated to market participants, after which qualified buyers compete to purchase the product. Successful competition results in a contract between the buyer and supplier. Because prices emerge through interaction between supply and demand, this mechanism contributes to transparent and comparatively fair price discovery.

The clearing mechanism also reduces transaction risk by monitoring compliance with contractual obligations. Following the conclusion of a cash transaction, the buyer is generally required to complete settlement within three business days. Once settlement has been completed, the seller is required to deliver the commodity within the corresponding period. Credit and combined settlement methods provide additional flexibility by allowing all or part of the transaction value to be settled according to previously established credit conditions.

Credit contracts provide another trading mechanism within the Iranian Commodity Exchange. Under these contracts, the commodity is delivered when the agreement is concluded, while payment occurs at a predetermined future maturity date. This mechanism can be particularly useful for downstream producers because it facilitates access to raw materials while

reducing some of the immediate financial constraints associated with their acquisition.

Forward transactions constitute another important financial instrument available to market participants. Under a forward contract, the seller undertakes to deliver a specified commodity to the buyer at an agreed future date. These transactions may be settled through cash, credit, or a combination of the two methods. For producers, forward contracts can provide access to financing by allowing goods to be sold several months before delivery, thereby generating resources for production while reducing exposure to future market uncertainty.

Commodity transactions in the physical market can also be organized through domestic and export trading sessions. Domestic transactions involve commodities intended for the national market, whereas export transactions involve goods destined exclusively for international markets. Although acceptance, trading, and settlement procedures are generally similar, export transactions are subject to additional requirements, including the obligation to ensure that traded goods leave the country after completion of the transaction. This mechanism provides an institutional connection between the Iranian Commodity Exchange and international commodity markets.

Another type of transaction conducted in the physical market is the premium discovery transaction, which is primarily designed for the exchange of commodities between large industries that maintain regular commercial relationships. Under this type of contract, the parties agree to purchase and sell a commodity on one or more specified future dates at a price determined according to a predefined formula. The parties establish a specific premium or discount in relation to a base price, which may correspond to a domestic or international reference price applicable on the maturity date. At the beginning of the agreement, both parties

are required to deposit a portion of the transaction value with the clearing house as collateral. In premium discovery transactions, a base price, such as the price of the corresponding commodity on an international exchange, is specified in the offer notice, while buyers compete by proposing the amount to be added to or deducted from that reference price.

Since the establishment of the Iranian Commodity Exchange, transactions in the physical commodity market have traditionally been conducted through an auction-based and supply-oriented mechanism. Under this system, suppliers offer their commodities and buyers compete to acquire them. Buyers can submit purchase requests only after the corresponding commodity has been accepted and offered by the supplier. However, the supply-oriented mechanism alone proved insufficient to cover the characteristics and requirements of certain commodity markets. Consequently, the Iranian Commodity Exchange introduced trading systems based on tender mechanisms to complement the existing structure.

Under the tender mechanism, an applicant submits the characteristics and conditions of its demand to the exchange through a tender notice. Once the exchange approves the request, the notice is published and potential suppliers compete to satisfy the demand. The supplier presenting the lowest acceptable bid becomes the successful participant. Tender transactions also incorporate a degree of flexibility to account for differences in commodity quality, packaging, or delivery location. For this purpose, a price adjustment mechanism is applied to reflect differences between the conditions specified in the tender notice and those existing at the time of delivery. The corresponding adjustment is paid by the buyer or seller or incorporated into the final settlement between the parties.

The Iranian Commodity Exchange has also introduced an open auction mechanism to provide buyers with

better conditions for rational purchasing decisions, reduce the likelihood of decisions driven by short-term market pressures, and facilitate the continuous supply of raw materials required by purchasing companies. Transactions conducted through this mechanism are organized into four trading periods identified as green, yellow, blue, and red. Unlike conventional auction procedures, the final auction period can be extended whenever a new order is submitted at a price higher than the existing order. Competition continues until no buyer submits a higher price within the period previously established by the market supervisor. Once that period expires following the most recent purchase order, the auction closes and the successful buyer is determined.

The open auction mechanism permits transactions involving both single and multiple consignments. When several consignments are available, multiple buyers can acquire portions of the commodities supplied by a single seller. If the distribution of the offered commodities among buyers changes during the process, the competition period may be repeated. This mechanism increases flexibility in the allocation of commodities and allows a larger number of market participants to participate in transactions involving substantial quantities of goods.

The Iranian Commodity Exchange also operates a secondary market whose transactions generally follow procedures similar to those used in the physical market. The principal difference is that commodities traded in the secondary market are those that, because of insufficient continuity of supply or limitations in standardization, do not satisfy the requirements for admission and trading in the principal physical commodity market. Among the main advantages of the secondary market are transparent and fair price discovery, centralized supervision of transactions, and greater efficiency in completing the different stages of the trading process. Immovable property and commodities that have lost the conditions required for continued acceptance in

the physical market may also be traded through this mechanism.

Immovable property eligible for trading includes real estate and buildings intended for administrative, commercial, residential, and agricultural purposes. These assets can be offered in the secondary market through a single-offering mechanism in which the entire asset is presented by the supplier as a single transaction and each purchase order must correspond to the complete asset being offered. Individuals and legal entities can submit eligible properties to the Iranian Commodity Exchange through an admission consultant. Once the conditions for sale have been established, the property is announced and subsequently sold through an auction process.

The use of the commodity exchange for real estate transactions can provide several institutional and economic advantages. These include reducing administrative procedures associated with traditional tenders and auctions, lowering transaction costs, strengthening guarantees concerning fulfillment of the parties' obligations, and facilitating marketing through a nationwide network of brokers. The exchange therefore provides an alternative institutional mechanism for organizing transactions involving certain categories of immovable property.

Another important component of the Iranian Commodity Exchange involves instruments designed primarily to manage the risk associated with commodity price fluctuations. Futures and options contracts constitute two of the most widely used derivative instruments for this purpose internationally and have been incorporated into the Iranian Commodity Exchange, where they can be traded continuously on a daily basis. These instruments enable market participants to manage their exposure to future changes in commodity prices and complement transactions conducted in the physical market.

A futures contract establishes an obligation under which a seller agrees to sell a specified quantity of a particular commodity at an agreed price on a predetermined future date, while the buyer assumes the corresponding obligation to purchase the commodity under the same specifications and conditions. To ensure fulfillment of these obligations, both parties must deposit an initial guarantee with the clearing house. This guarantee is adjusted daily according to changes in the market price of the corresponding futures contract.

Futures transactions offer several characteristics that contribute to their usefulness as risk-management instruments. The clearing house guarantees transactions, thereby reducing credit risk, while exchange-based trading contributes to price transparency. Futures contracts can also provide relatively low transaction costs, financial leverage, high liquidity, standardization, and certain tax advantages. Because of these characteristics, futures contracts frequently develop active and liquid secondary markets and represent some of the most extensively traded instruments on commodity exchanges in developed economies.

Options contracts provide another mechanism for managing commodity price risk. Under an option contract, one party acquires the right to purchase or sell a commodity from another party. The buyer obtains this right by paying a specified amount to the seller of the option and may decide whether to exercise it. Unlike the option buyer, who possesses a right rather than an obligation, the seller must fulfill the contractual obligations when the buyer chooses to exercise the option.

When a call option is exercised, the seller is required to deliver the underlying asset according to the quantity, characteristics, and price specified in the contract. When a put option is exercised, the seller of the option is required to purchase the underlying asset from the option buyer according to the contractual conditions.

Options therefore provide flexible mechanisms for hedging against commodity price fluctuations. They can also provide financial leverage, involve relatively low transaction costs, and permit the implementation of a broad range of trading and risk-management strategies.

The Iranian Commodity Exchange also incorporates financial instruments specifically designed to facilitate financing. Through these instruments, different economic sectors can obtain broader and potentially lower-cost access to financial resources. At the same time, the availability of these mechanisms can attract additional investors to commodity markets and strengthen the connection between commodity trading and the financial system.

Standard parallel forward transactions represent an evolution of conventional forward transactions conducted in the physical commodity market. Although traditional forward transactions provide important financing advantages, they also present limitations, particularly during periods of economic recession. Buyers participating in conventional forward transactions are exposed to both price and liquidity risks because the absence of a secondary market prevents them from transferring the purchased commodity or contractual position to another participant before maturity. Consequently, buyers may be reluctant to enter into long-term advance purchase agreements, particularly those extending beyond six months.

Standard parallel forward instruments were developed to address these limitations. Although their structure resembles conventional forward transactions, they allow purchasers to transfer the corresponding securities to another participant before the maturity date. The securities are initially offered by the issuer, generally the commodity producer, in the primary market. After the secondary market is established, purchasers can transfer the securities to other investors. The possibility

of repeated buying and selling in the secondary market increases liquidity and expands the potential use of these instruments for financing purposes.

Commodity deposit certificates constitute another important financial instrument within the Iranian Commodity Exchange. A commodity deposit certificate is a security confirming its holder's ownership of a specified quantity of a commodity. The certificate is issued when commodities are delivered to warehouses supervised by the Iranian Commodity Exchange and contains information concerning their quantity and quality. Specialized warehouses must satisfy the standards established by the exchange and provide the required guarantees and insurance coverage before being authorized to participate in the system.

The entry and withdrawal of commodities from these warehouses are continuously supervised by the exchange. Owners can deposit commodities that satisfy the established quality specifications and receive corresponding commodity deposit certificates through the exchange's systems. Holders can subsequently buy or sell these securities in the market established for this purpose. Transactions may be conducted through continuous or discontinuous auction mechanisms. The continuous auction includes the submission of supply and demand orders, price discovery, continuous matching of orders, and the closing of the trading session. In the discontinuous mechanism, trading concludes after the opening price has been determined and the corresponding transactions have been completed.

Commodity deposit certificates can also facilitate access to financing through the banking system. Holders may use verified certificates to obtain financial facilities, while banks can rely on the underlying commodities as collateral. If the certificate holder fails to meet the corresponding financial obligations, the bank can recover its resources by selling the certificate

through the commodity exchange. If such a sale cannot be completed, the bank may take possession of the underlying commodity and sell it directly. By reducing default risk and increasing the liquidity of collateral, commodity deposit certificates can accelerate access to financial resources, reduce financing costs, and facilitate the allocation of banking resources toward productive activities.

Commodity funds provide an additional mechanism for connecting investors with commodity markets. These funds have achieved considerable development in international financial markets because they allow members of the public to participate in commodity investment without directly purchasing, transporting, storing, or managing physical commodities. Their units can be traded on the exchange, while their principal activity consists of investing in commodity-based securities associated with one or more underlying commodities.

Fund managers invest pooled resources on behalf of investors with the objective of generating appropriate returns. Investors participate in the profits and losses of the fund according to their respective ownership interests or investment amounts. Commodity funds therefore allow investors to benefit from commodity price movements while reducing the operational burdens and costs associated with purchasing, warehousing, transporting, and preserving physical commodities (Table 2.1).

Table 2.1. Products Traded on the Iran Commodity Exchange.

Market	Products	Main Types	Notable Varieties
Industrial and Manufacturing Market	Wheat flour, pasta, biscuits, confectionery, instant noodles	Various types of flour; biscuits and cookies; pasta; instant noodles	Durum wheat; soft wheat

Market	Products	Main Types	Notable Varieties
Agricultural Inputs Market	Nitrogen, phosphorus, and potassium fertilizers; seeds; agricultural machinery and equipment	Nitrogen fertilizers; phosphorus and potassium fertilizers; seeds; agricultural machinery and equipment	Fertilizers and agricultural inputs
Petrochemical Products Market	Urea, methanol, ethylene, polypropylene, other petrochemical products	Urea; methanol; ethylene; polypropylene; other petrochemical products	Petrochemical products
Pharmaceutical Products Market	Various types of pharmaceuticals: antibiotics, pain relievers, antihistamines, vitamins, etc.	Antibiotics; pain relievers; antihistamines; vitamins; other pharmaceuticals	Generic and branded pharmaceuticals
Food Products Market	Sugar, vegetable oils, dairy products, dates, processed meats	Sugar; vegetable oils; dairy products; dates; processed meats	Basic and processed foods
Consumer Goods Market	Various types of home appliances, detergents, cosmetics, hygiene products, etc.	Home appliances; detergents; cosmetics; hygiene products; other consumer goods	Home appliances and consumer goods
Construction Materials Market	Cement, steel, bricks, tiles, sanitary ware, pipes and fittings	Cement; steel; bricks; tiles; sanitary ware; pipes and fittings	Building and construction materials
Metals Market	Billets, rebar, sheets, pipes, ingots	Billets; rebar; sheets; pipes; ingots	Steel and non-ferrous metals

Source: Organisation of Islamic Cooperation Exchanges Forum (2025).

According to statistics from the Central Bank of the Islamic Republic of Iran (2022, both the trading volume and trading value of the Iranian Commodity Exchange increased during the period from 2014 to 2021, as illustrated in Figure 2.1.

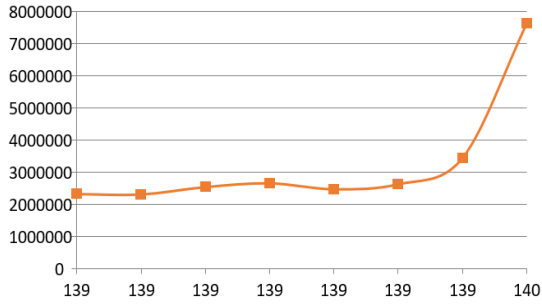


Figure 2.1. Volume of Physical Transactions on the Iranian Commodity Exchange.

According to Kazemi Najaf Abadi et al. (2022), the volume of physical transactions on the Iranian Commodity Exchange increased considerably during the period from 2014 to 2021. The volume of transactions rose from approximately 23 million in 2014 to more than 76 million in 2021. During the same period, the value of transactions increased substantially, from approximately 395 trillion rials in 2014 to more than 6,339 trillion rials in 2021.

Despite this substantial expansion in the physical market, the performance of futures transactions on the Iranian Commodity Exchange followed a different pattern. An examination of these transactions reveals trends that differ from those observed in the physical commodity market, indicating that growth in physical trading activity was not necessarily accompanied by a similar trajectory in the futures market.

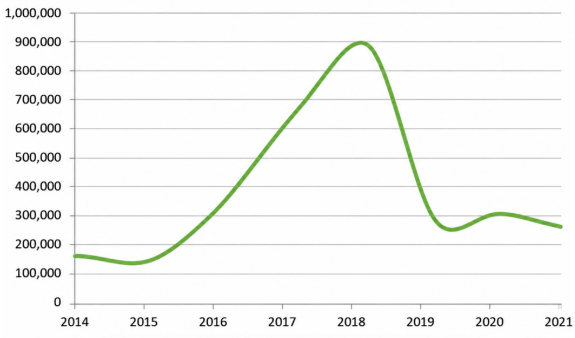


Figure 2.2. Value of Futures Transactions on the Iranian Commodity Exchange.

Source: Ministry of Economic Affairs and Finance of Iran (2022).

As illustrated in Figure 2.2, the value of futures transactions on the Iranian Commodity Exchange increased substantially between 2014 and 2018, rising from approximately 167 trillion rials in 2014 to more than 900 trillion rials in 2018. After 2018, however, the futures market experienced a considerable decline in transaction value. By 2021, the value of futures transactions had fallen to approximately 273 trillion rials, representing a decline of about 70 percent compared with 2018 (Ministry of Economic Affairs and Finance of Iran, 2022).

An agricultural commodity is a raw product derived from agricultural activities and intended for consumption, trade, or further processing. Agricultural commodities are generally produced and traded in large quantities and constitute an important component of domestic and international markets. Major agricultural commodities include soybeans, corn, wheat, rice, cocoa, coffee, cotton, spices, and other agricultural products. Soybeans, for example, are cultivated primarily for their protein-rich seeds and are widely used in food production, animal feed, edible oils, soy milk, and various industrial applications.

Agricultural commodities can be commercialized through both online and offline channels and exchanged among different categories of market participants. Transactions may occur between businesses or between businesses and final consumers. From a market perspective, agricultural commodities can therefore be classified according to the type of product traded, the commercial channel through which transactions are conducted, and the characteristics of the final users participating in the market.

The agricultural commodities market has expanded considerably in recent years. Its global market size was estimated at approximately 208.83 billion dollars in 2023 and was projected to increase to approximately

220.48 billion dollars in 2024, representing a compound annual growth rate of 5.6 percent. This expansion has been associated with several factors, including improvements in crop yields, increasing agricultural production, greater attention to nutritional value, improvements in agricultural water-use efficiency, and rising income levels.

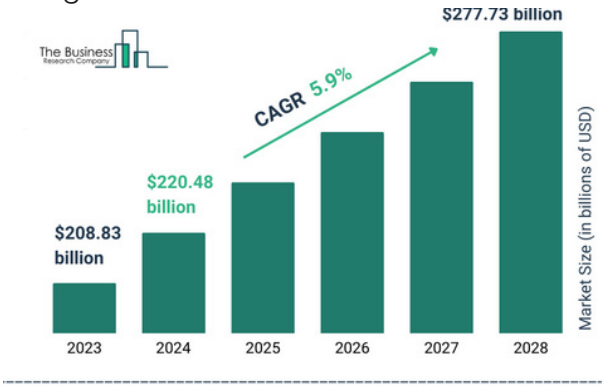


Figure 2.3. Global Agricultural Commodities Market Size and Growth, 2023–2028.

The agricultural commodities market is expected to experience substantial growth over the coming years, reaching approximately 277.73 billion dollars by 2028 (Figure 2.3), with a compound annual growth rate of 5.9 percent. This expansion is associated with increasing demand for healthier diets, greater adoption of hydroponic production systems, growing interest in renewable energy sources, population growth, changing consumer preferences, and increasing demand for biofuels. Major trends expected to influence the market include technological advances, sustainable farming practices, biotechnological innovations, changing food preferences, and the increasing adoption of digital technologies in agriculture (The Business Research Company, 2024).

The growing demand for healthier diets is expected to be an important factor supporting the expansion of the agricultural commodities market. Healthier dietary patterns seek to promote physical well-being and reduce the risk of chronic diseases. Increasing

health awareness, concerns regarding food safety, interest in weight management, the prevalence of chronic diseases, and greater access to nutritious food options have contributed to changes in consumer behavior. Agricultural commodities are fundamental to these dietary patterns because they provide essential nutrients, increase food diversity, and contribute to overall health and well-being (The Business Research Company, 2024).

Evidence of changing dietary behavior can be observed in the United States. According to the 2022 Food and Health Survey conducted by the International Food Information Council, approximately 52 percent of Americans reported following a specific diet or eating pattern, compared with 39 percent in 2021. Among the most frequently reported approaches were clean eating, followed by 16 percent of respondents, mindful eating, followed by 14 percent, and calorie counting, reported by 13 percent. These trends support the expectation that increasing consumer interest in healthier dietary practices will contribute to continued growth in demand for agricultural commodities (Global Agricultural Commodities Market Report, 2024).

The history of agricultural commodity exchanges extends back approximately 150 years. Their emergence was closely associated with the need to address limitations and inefficiencies affecting traditional agricultural trade. Severe price fluctuations caused partly by climatic conditions, inefficient mechanisms for distributing agricultural products, and problems concerning product quality and compliance with established standards were among the principal factors that encouraged the creation of organized agricultural commodity exchanges (Chizari & Shirzad, 2017).

During the final decade of the twentieth century, the collapse of the economies of the Eastern bloc was accompanied by the establishment of numerous

exchanges intended to stimulate economic activity and attract capital. However, the rapid and insufficiently planned development of some of these institutions resulted in operational difficulties and, in certain cases, their eventual closure. Toward the end of the twentieth century, interest in establishing and strengthening commodity exchanges also expanded across developing countries, contributing to the geographical diversification of organized agricultural commodity markets.

Agricultural commodity exchanges in North America have historically been concentrated primarily in the United States and Canada. Major exchanges in the United States included the Chicago Board of Trade, the Chicago Mercantile Exchange, the Central American Commodity Exchange, the Minneapolis Grain Exchange, and the New York Board of Trade. The New York Cotton Exchange and the New York Sugar, Coffee, and Cocoa Exchange were subsequently integrated into the institutional structure that resulted in the New York Board of Trade (Chizari & Shirzad, 2017).

Commodity exchanges in the United States generally began operating during the late nineteenth or early twentieth centuries and initially concentrated on physical commodities. From the early 1980s onward, however, financial futures became increasingly important within their trading activities. The Chicago Board of Trade remained one of the world's principal futures markets and, until 1988, was considered the largest futures trading center internationally. In 2003, approximately 343 million contracts were traded through this exchange, representing about 11 percent of global trading volume. Important products included cotton, fibers, meat, grains, and dairy products. The Chicago Mercantile Exchange also became a major international trading center and accounted for approximately 8.5 percent of global trading volume in 1999. Latin America has also developed an extensive network of agricultural

commodity exchanges. More than thirteen officially registered agricultural exchanges have operated across the region, with those of Argentina and Brazil among the most prominent. Agricultural commodity trading institutions have also operated in Colombia, Costa Rica, Ecuador, El Salvador, Mexico, Nicaragua, Panama, Venezuela, and Peru, demonstrating the widespread adoption of organized agricultural markets throughout the region.

In Oceania, organized commodity trading has historically included the Australian Futures Exchange and the New Zealand Futures Exchange, with the latter operating as a subsidiary of the Australian institution. Although the number of exchanges in the region has been comparatively limited, these institutions have contributed to the development of organized commodity and futures trading within Pacific markets.

Western Europe has also maintained several agricultural commodity exchanges with different areas of specialization. The Spanish Commodity and Futures Exchange, based in Valencia, has traded products including electricity and lemons. The French Commodity Exchange in Paris has handled commodities such as wheat flour, corn, turnip seeds, and turnip seed oil. The Netherlands Agricultural Commodities and Futures Exchange has included potatoes, eggs, and pig manure among its traded products. The London Mercantile Exchange, which merged with the London International Financial and Futures Exchange in September 1996, traded commodities including cocoa, coffee, sugar, barley, wheat, and potatoes (Chizari & Shirzad, 2017).

Agricultural commodity exchanges have also developed on the African continent. Among the principal institutions identified are the Kenya Agricultural Commodity Exchange, the Zambia Agricultural Commodity Exchange, the South African Futures Exchange, and the Zimbabwe Agricultural Commodities Exchange. The South African Futures Exchange emerged as the

largest and most active of these institutions. Established in 1987, it progressively developed an agricultural commodities market alongside its financial market activities.

The agricultural commodities market of the South African Futures Exchange began operating in 1995. Beef and vegetables were among the first agricultural commodities traded, and contracts involving these products were initially settled through physical delivery. This experience illustrates the progressive integration of agricultural commodities into organized futures markets and the adaptation of exchange mechanisms to the specific characteristics of agricultural production and commercialization.

In Iran, the development of an agricultural commodity exchange emerged from transformations in the organization of agricultural production and marketing. Traditionally, agricultural policy and productive activity concentrated primarily on increasing production, while producers frequently determined what to produce according to their own capabilities and preferences. As market conditions evolved, consumer preferences acquired greater importance and increasingly influenced farmers' production decisions and agricultural planning.

This transition toward a more market-oriented and consumer-centered agricultural economy increased the need for reliable mechanisms through which producers could commercialize their products. The development of organized exchanges became particularly relevant in the context of globalization, export expansion, increasing market specialization, and the need to reduce the distance between producers and consumers. Commodity exchanges were also expected to reduce unnecessary intermediation, increase producers' share of the final price paid by buyers, and improve the overall organization of agricultural markets.

The establishment of an organized agricultural exchange was additionally associated with broader economic objectives, including supporting economic development, facilitating recovery from periods of stagnation, improving consumers' access to required goods, and reducing inefficiencies resulting from geographically dispersed producers and small-scale production. Greater emphasis on product quality, compliance with national and international standards, prevention of severe price fluctuations, and improved responsiveness to consumer preferences further strengthened the rationale for establishing an organized agricultural commodity exchange in Iran.

The Iranian Agricultural Commodity Exchange formally began its activities in October 2004. Despite the institutional efforts associated with its establishment, its initial performance revealed important limitations. During the nine-month period ending on July 26, 2005, only approximately 23 percent of the total volume of products supplied through the exchange was ultimately settled by traders. Furthermore, only 56.6 percent of the volume of commodities demanded resulted in completed settlements despite the availability of corresponding supply.

The initial trading experience also demonstrated substantial differences among agricultural products. During the nine-month period ending on July 26, 2005, the relationship between the value of transactions involving traded products and the overall value of transactions varied considerably, with corn, flour, and barley presenting distinctive patterns Exchange. Overall, the value associated with completed transactions represented approximately 74.7 percent during the period analyzed, illustrating both the initial achievements and the operational limitations encountered during the early development of the Iranian Agricultural Commodity (Table 2.2).

Table 2.2. Agricultural Products Traded on the Iranian Commodity Exchange.

Main Subgroup	Secondary Subgroup
Meals, Pulps, and Concentrates	Cottonseed meal; soybean meal; rapeseed meal; sunflower meal; sesame meal; cotton-seed cake; soybean cake; rapeseed cake; sunflower cake; sesame cake
Corn	Forage corn; grain corn; feed corn; seed corn
Sugar	Refined sugar; white sugar; raw sugar
Pistachios	Closed-shell pistachios; open-shell pis-tachios; closed-shell pistachio kernels; open-shell pistachio kernels
Cottonseed	Mixed cottonseed
Cumin	Green cumin
Saffron	Saffron threads (Pushal); cut saffron threads (Pushal)
Lentils	Small lentils; large lentils; medium lentils
Chickpeas	Small chickpeas; medium chickpeas; large chickpeas
Barley	Industrial barley; feed barley; hulled barley
Rice	Tarom; Hashemi; Khazar; Fajr; Neda; Vareda-ti; Ali Kazemi; rice bran
Dates	Mozafati; Kabkab; Estamaran; Shahani
Oil	Crude sunflower oil; crude soybean oil; cru-de sesame oil; crude rapeseed oil
Raisins	Green raisins; golden raisins; seedless rai-sins; seeded raisins
Wheat	Feed wheat; durum wheat; semolina wheat; food wheat
Tea	Barooti tea; old tea; broken tea; premium tea
Frozen Chicken	Frozen chicken
Oilseeds	Peanuts; sesame; rapeseed; sunflower; soy-bean; cottonseed
Day-old Chicks	Laying chicks; broiler chicks
Eggs	Chicken eggs
Flour	Wheat flour

Source: Iran Commodity Exchange (2024).

2.2. Role and Functions of Commodity Exchanges in Agricultural Market Development

The establishment of agricultural commodity exchanges in developed countries has been associated with the need to improve market efficiency, reduce transaction costs, facilitate information flows, manage market risks, and strengthen agricultural trade. One of their principal objectives is to reduce the costs involved in commodity transactions. In countries such as the United States and Canada, organized commodity exchanges have contributed to lowering the costs associated with identifying counterparties, obtaining and disseminating market information, transportation, unnecessary warehousing, and other activities that become more expensive when transactions take place in fragmented and poorly organized markets.

Another important objective is to accelerate the transmission of market information to producers and consumers. Both groups constitute fundamental participants in agricultural markets, and their decisions influence supply, demand, and price formation. When information circulates rapidly and transparently, producers and consumers can respond more efficiently to changes in market conditions. In the absence of an organized commodity exchange, information may be incomplete, unclear, or disseminated slowly, delaying adjustments to excess supply or demand and consequently reducing the speed at which agricultural markets return to equilibrium.

Agricultural commodity exchanges also provide mechanisms for managing crises associated with fluctuations in product supply and demand. Agricultural commodities are particularly vulnerable to seasonal conditions, climatic variations, and other factors that can generate substantial changes in production and availability. These fluctuations can produce significant price instability and increase uncertainty among market

participants. Organized exchanges can contribute to reducing these problems by providing mechanisms through which market participants obtain information, coordinate transactions, and manage exposure to changing market conditions.

Reducing price and transaction risks constitutes another fundamental objective. Agricultural producers and consumers face price risk arising from changes in commodity prices, while the characteristics of agricultural production can make such fluctuations particularly significant. Agricultural commodity exchanges provide instruments, including options contracts, that allow market participants to manage exposure to price volatility. Transaction risk also arises when one of the parties fails to fulfill contractual obligations. Organized exchanges reduce this risk by establishing standardized procedures and institutional mechanisms that strengthen compliance with transactions.

Commodity exchanges can additionally create favorable conditions for expanding scientific research on agricultural markets. In developed economies, the concentration of market participants and the availability of systematic information have encouraged the establishment and development of organizations devoted to studying market conditions, exchange performance, prices, supply, demand, and future trends. Although commodity exchanges may not directly establish these research institutions, their operation creates demand for specialized market analysis and provides information that facilitates scientific research.

Another important objective is the expansion of commodity exports. Commodity exchanges establish standards governing the quality, characteristics, and other attributes of products admitted for trading. Agricultural commodities must comply with these requirements before entering organized markets. Standardization can improve product quality and facilitate access to international markets, thereby

strengthening the capacity of agricultural producers to participate in export activities. The experience of developed economies indicates that commodity exchanges can consequently contribute to agricultural export development.

In developing countries, the objectives of commodity exchanges also reflect the particular structural and institutional characteristics of their agricultural sectors. One important objective is reducing excessive government participation in agricultural markets. Governments in many developing economies maintain a substantial presence in production, commercialization, and pricing. Extensive bureaucracy, restrictive regulations, and multiple pricing mechanisms can generate inefficiencies. Through organized and transparent trading mechanisms, commodity exchanges can reduce direct government intervention, particularly in the determination of agricultural prices.

Commodity exchanges can also improve the targeting of government support policies. Agricultural protection policies in developing countries may generate unintended consequences when their implementation mechanisms distort market incentives or reinforce existing inefficiencies. An organized agricultural commodity exchange can provide governments with a more transparent institutional framework for directing support toward intended beneficiaries while reducing some of the adverse effects associated with generalized intervention.

Financing agricultural producers represents another important objective. Agricultural commodity exchanges do not necessarily provide financing directly, but they can facilitate farmers' access to financial resources. Documents, contracts, and other instruments generated through exchange transactions can support producers when applying for financing from specialized or commercial banks. In this way, participation in an organized exchange can strengthen the connection

between agricultural production and formal financial institutions.

Reforming the traditional agricultural market structure is particularly important in developing economies. Traditional commercialization systems frequently involve multiple layers of intermediaries between producers and final consumers, contributing to higher transaction costs and unequal distribution of market benefits. Commodity exchanges can help reorganize these distribution structures, reduce unnecessary intermediation, improve competition, and limit the market power exercised by particular institutions or groups.

In Iran, the establishment of an agricultural commodity exchange has been associated with both long-term and short-term objectives intended to address structural problems affecting the agricultural sector. Long-term objectives include reducing transaction costs, improving the organization of agricultural product markets, accelerating the transmission of market information to producers and consumers, expanding agricultural exports, and contributing to changes in cultivation patterns.

The short-term objectives include preventing severe agricultural price fluctuations, reducing price and transaction risks, improving product quality through standardization, facilitating financial support for farmers, and reducing the costs associated with identifying production sources and market demand. Together, these objectives indicate that the agricultural commodity exchange is intended not merely to provide a venue for transactions but also to contribute to the modernization and improved efficiency of agricultural commercialization in Iran.

The broader benefits of agricultural commodity exchanges can be understood in relation to the limitations of traditional commodity markets. Historically, organized exchanges emerged in response to problems affecting

supply, demand, distribution, and commercialization while simultaneously providing advantages that traditional markets were unable to offer efficiently. Commodity exchanges generally facilitate transactions involving raw materials and primary commodities and may operate as general markets or specialize in particular products such as cotton or gold.

More advanced commodity exchanges have developed beyond their basic trading functions and increasingly operate as important centers for market information. They disseminate domestic and international prices, information concerning supply and demand, and relevant government policies, thereby strengthening the informational infrastructure available to market participants. Technological and institutional development has expanded the range of functions performed by commodity exchanges, although their fundamental roles continue to include reducing transaction costs, facilitating price discovery, increasing price transparency, and providing mechanisms for managing risk.

These functions have become increasingly relevant as agricultural trade has undergone liberalization and governments in many countries have reduced traditional forms of direct support for agricultural commodities. Under these conditions, organized commodity exchanges can provide mechanisms for risk management, transparent price discovery, and the physical commercialization of agricultural products. Their importance is therefore closely connected to the need for agricultural markets capable of operating efficiently under increasingly competitive and market-oriented conditions.

Traditional agricultural markets are affected by several persistent shortcomings, including high production and marketing risks, insufficient price transparency, inadequate market information, limited competition at different stages of commercialization, seasonal and

sometimes severe price fluctuations, insufficient access to financial resources, and difficulties associated with transporting agricultural commodities. The interaction of these problems can progressively reduce the efficiency of agricultural product markets. Agricultural commodity exchanges provide an institutional mechanism through which many of these limitations can be addressed in a more organized, transparent, and competitive environment.

Among the principal benefits of transferring commodity transactions to an organized and structured commodity exchange are the concentration of trading activities and the promotion of greater market competition. Organized commodity exchanges also contribute to reducing transaction costs, facilitating the discovery of fair and market-based prices, preventing artificial price fluctuations, and providing mechanisms for transferring and hedging market risks. These functions improve the efficiency of transactions and provide market participants with mechanisms for managing the uncertainty associated with commodity trading.

Another important benefit is the reduction of opportunities for individual market participants to obtain exclusive advantages from information asymmetries or information rents. Commodity exchanges also strengthen the reliability of transactions by providing institutional mechanisms that help ensure the fulfillment of contractual obligations. At the same time, the complete and regular dissemination of market information improves transparency and facilitates the decision-making processes of producers, consumers, traders, and other market participants.

The establishment of executive and supervisory mechanisms within commodity exchanges further contributes to ensuring that the obligations assumed by the parties to a transaction are properly fulfilled. Effective monitoring of transactions can reduce uncertainty,

strengthen confidence among market participants, and consequently increase economic security within the market.

Commodity exchanges can also contribute to improving the quality and standardization of agricultural products. Compliance with established standards encourages producers to improve product characteristics and quality, while greater standardization facilitates participation in international markets. Consequently, commodity exchanges can provide an institutional foundation for strengthening the competitiveness and international commercialization of agricultural products (Figure 2.4).

Figure 2.4. Benefits of the Agricultural Commodity Exchange.

Source: Ghazali et al. (2016).

Trading agricultural commodities in traditional markets is generally associated with high transaction costs. Evidence from developing countries indicates that these elevated costs can be attributed to several factors related to the structure, organization, and functioning of traditional agricultural markets (Table 2.3).

Table 2.3. Factors Contributing to Increased Costs in Traditional Agricultural Markets.

No.	Factors Affecting Transaction Costs	Source
1	Lack of systematic classification and appropriate product standards	Garbe-Madhin et al. (2003)
2	High risk and insufficient information regarding the products in question	Newbery and Stiglitz (1981); Stiglitz (2001)
3	Insufficient access to financial resources	McMillan and Woodruff (1998)
4	Lack of adequate marketing infrastructure	Rapsomanikis and Panayiotis (2007)
5	Lack of appropriate and binding contractual obligations	World Bank 2002)
6	High cost of searching for the desired product	McMillan and Woodruff (1998); Minten and Kyle (1999)

Source: Ghazali et al. (2016).

In Iran, the need for a structured and organized market capable of facilitating the free interaction of supply and demand led to important institutional developments in commodity trading. In 2000, the Stock Exchange Council was authorized to establish a commodity exchange as part of broader efforts to improve market organization and strengthen the positive contribution of organized trading mechanisms to the national economy.

The Agricultural Commodity Exchange was subsequently established in September 2004 as the country's second commodity exchange, following the Metals Exchange. Its creation was intended to address persistent problems affecting agricultural product markets, particularly insufficient price transparency, uncertainty in the execution of transactions, and artificial price fluctuations. The exchange therefore provided an organized institutional framework designed to

improve price discovery, guarantee transactions, and strengthen the overall functioning of agricultural markets (Organisation of Islamic Cooperation Exchanges Forum, 2025).

2.3. Role of Commodity Exchanges in Agricultural Sector Growth and Development

Controls and regulatory mandates represent one of the first formal mechanisms used by governments to address inefficiencies in the management of public resources. When regulatory measures fail to resolve these problems, governments may move toward more direct forms of intervention and, in some cases, public ownership. However, when these forms of intervention subsequently prove inefficient, conditions emerge for adopting market-based alternatives and deregulation. Conversely, when insufficient regulation or imbalances in private relationships generate serious market problems, a new process of regulation may become necessary.

Economic literature provides different theoretical explanations for regulation. The helping-hand theory considers regulation an instrument for preventing or correcting market failures, whereas the public-interest theory emphasizes the use of regulation to protect broader societal interests. Economic theories of regulation can also be distinguished between positive and normative approaches. Positive theories seek to explain why regulation emerges and examine its consequences in relation to public and private interests. Normative theories, by contrast, focus on identifying the most efficient form of regulation and comparing alternative regulatory instruments through cost-benefit analysis.

From the perspective of welfare economics, competitive markets can contribute to the efficient allocation of resources, but the conditions necessary

for perfect competition are rarely fully present in actual economies. Consequently, market mechanisms may generate inefficiencies or inequitable outcomes that justify regulatory intervention. Government regulation can therefore serve as an instrument for correcting these deficiencies and improving the allocation and distributional consequences generated by market mechanisms.

The principal problems associated with market self-regulation include imperfect competition, natural monopolies, market disequilibrium, information asymmetries, externalities, public goods, moral hazard, and requirements related to social justice. At the same time, deregulation may become appropriate when technological or demand-related changes reduce the relevance of particular market failures or when alternative institutional mechanisms can address them more efficiently. These alternatives may include regulatory arrangements implemented by public or civil institutions rather than through direct government intervention.

Markets can be understood as institutions created to facilitate exchange and reduce transaction costs. This function is particularly important because transaction costs influence the efficiency with which buyers and sellers interact. Nevertheless, conventional economic models frequently assume that transaction costs are negligible, making it difficult to represent fully the institutional role performed by markets and the conditions under which market mechanisms may fail.

Government intervention intended to correct market failures does not necessarily produce efficient outcomes. The literature on market failure is therefore complemented by an extensive discussion of government failure, recognizing that public intervention itself may generate inefficiencies. Such failures are not limited to regulation but may also arise from government

decisions concerning taxation and other forms of economic intervention.

From this perspective, an efficiently functioning market requires an appropriate legal and institutional framework rather than the complete absence of regulation. The market can operate freely when a central set of rules establishes the conditions within which transactions occur. Regulation therefore does not necessarily represent an obstacle to market freedom; appropriately designed rules can instead provide the institutional foundation required for markets to function effectively.

Regulatory institutions also reflect a broader transformation in the role of the state. Government does not necessarily have to act as the exclusive institution responsible for regulating collective economic activity, nor must regulation depend exclusively on traditional and rigid public institutions. Certain supervisory and monitoring responsibilities can be transferred to private or professional institutions operating within securities markets, provided that appropriate legal, professional, and ethical standards are maintained.

Within financial markets, regulatory and supervisory responsibilities are distributed among different institutions, including securities exchanges, commodity exchanges, securities depositories, brokers, and professional associations. Stock exchanges themselves perform important regulatory functions by providing efficient trading and settlement systems, monitoring transactions and market operations, supervising members' activities, and facilitating the dissemination of information required for informed investment and trading decisions.

An appropriate legal framework for supply and demand establishes the conditions governing relationships between sellers as suppliers and buyers as demand participants. Direct supervision, appropriate legal and executive mechanisms, and systematic collection,

processing, and dissemination of market information can contribute to reducing excessive fluctuations and improving participants' knowledge of past and expected market conditions. In this context, commodity exchanges constitute an important institutional mechanism for organizing transactions and improving market transparency.

One of the most important advantages associated with commodity exchanges is their capacity to contribute to reducing undesirable price fluctuations. Commodity prices respond to changes in supply and demand and therefore naturally increase or decrease according to market conditions. However, an organized commodity exchange can provide information that allows market participants and policymakers to identify emerging economic developments before their consequences become fully visible. This informational function can partially compensate for limitations in governments' capacity to anticipate market disturbances (Samadi et al., 2018).

The transition toward a more market-oriented economy in Iran has also contributed to the emergence of regulation as a distinct area of economic policy. Under this approach, government intervention increasingly relies on regulatory methods and instruments that differ from traditional mechanisms such as direct public management and conventional monetary, fiscal, and commercial policies.

Empirical research provides additional evidence concerning the effects of regulation on financial markets. Berkman et al. (2008), examining the Chinese stock market, showed that regulatory changes can affect firms differently according to the quality of their management and governance structures. These findings indicate that the consequences of regulation depend partly on the institutional characteristics of the firms and markets to which regulatory measures are applied.

Del Brio et al. (2001) compared regulatory conditions in the United Kingdom and Spanish stock markets and examined their effects on market efficiency. Despite stricter regulation in the United Kingdom, insiders were able to obtain comparatively higher abnormal returns. Nevertheless, regulation contributed to greater market efficiency by increasing transparency and accelerating price corrections. This finding illustrates that regulation can simultaneously affect market behavior through different mechanisms and that its effectiveness cannot be assessed exclusively by the degree of regulatory intensity.

Cumming et al. (2011) examined volatility and liquidity across 42 stock markets worldwide and found that financial market behavior is strongly influenced by the specific legal and regulatory frameworks governing individual markets. Differences in market characteristics may therefore reflect differences in regulatory structures rather than exclusively market manipulation or the use of private information. Evidence from the Chinese stock market similarly indicates that government regulation and intervention have significantly influenced market volatility over time.

The establishment and operation of specialized commodity exchanges can generate multiple benefits for agricultural sector growth. These institutions can improve market organization, strengthen transparency, facilitate transactions, provide mechanisms for managing price fluctuations, and create more favorable conditions for financing agricultural activities. One particularly important contribution concerns the persistent liquidity constraints faced by agricultural producers.

Insufficient liquidity constitutes one of the principal financial difficulties faced by producers. Limited financial resources and delays in receiving payment for delivered commodities can create uncertainty

regarding the resources required to finance subsequent production cycles. In Iran, producers have traditionally attempted to address these constraints through short-term bank loans, financing from financial and non-bank credit institutions, and resources obtained through informal markets. However, the limited effectiveness of these mechanisms has encouraged producers to seek alternative forms of financing.

One alternative is the advance sale of agricultural commodities. Under this mechanism, producers sell all or part of their output before production has been completed or while the production process is still underway. Advance sales can therefore provide producers with financial resources during the production cycle and reduce some of the liquidity constraints that would otherwise limit their ability to acquire inputs, maintain operations, and complete production.

However, advance sales have not always operated efficiently in agricultural product markets. In the absence of alternative organized markets, traders may take advantage of producers' urgent liquidity needs by purchasing agricultural products in advance at prices considerably below their potential market value. The establishment of commodity exchanges can mitigate this problem by attracting consumers, traders, and investors who previously had limited access to agricultural markets and by directing financial resources that might otherwise be invested in more liquid assets toward agricultural commodity transactions.

The participation of a broader range of market actors can make the financing of agricultural production easier and less costly. At the same time, greater competition can reduce excessive intermediary profit margins and allow producers to retain a larger proportion of the economic returns generated by their products. In this way, organized commodity exchanges can indirectly contribute to alleviating farmers' liquidity constraints and improving their access to financial resources.

Another important benefit is the possibility of using futures contracts as collateral for obtaining financial resources. The development of specialized commodity exchanges in Iran can facilitate greater recognition of these contracts within the banking system. Producers requiring financing may use futures contracts as collateral when applying for credit, thereby creating an additional connection between agricultural commodity markets and formal financial institutions. Similar mechanisms have been used by local banks in the United States, where farmers can use futures contracts as collateral for agricultural loans.

Commodity exchanges can also contribute to reducing agricultural price fluctuations. Futures markets provide producers, traders, and other participants with mechanisms for anticipating market conditions and managing exposure to future price changes. By improving the coordination of supply decisions and providing information about expected market conditions, these markets can moderate the magnitude of price adjustments resulting from unexpected changes in demand. Consequently, the development of organized commodity markets can contribute to greater agricultural price stability and may also support broader efforts to control inflationary pressures.

The establishment of an agricultural commodity exchange can additionally contribute to improving cultivation patterns. Market prices provide farmers with signals regarding the relative profitability and demand for different agricultural products, allowing them to make better-informed production decisions. As a result, farmers may progressively redirect production toward commodities offering more favorable economic opportunities while considering broader market demand.

This function does not imply merely increasing the production of particular agricultural commodities. Rather, the trading process can provide information

that helps reconcile farmers' economic interests with broader market and societal requirements. Because price information is frequently incomplete or distorted in traditional agricultural markets, transparent exchange prices can provide producers and other participants with more reliable information regarding current market conditions. Greater transparency can also reduce the ability of monopolistic intermediaries to purchase agricultural products from farmers at artificially low prices.

Another fundamental contribution of agricultural commodity exchanges is the provision of transparent and accessible market information. Forward markets are widespread in many agricultural regions of Iran, particularly because farmers frequently face financial constraints during the months preceding harvest. When information regarding current and expected prices is incomplete or circulates inefficiently, producers may be compelled to accept conditions imposed by advance purchasers, even when the prices offered are substantially below prevailing or anticipated market prices.

Limited access to reliable information consequently restricts farmers' ability to make appropriate decisions when negotiating advance-sale contracts. High transaction costs can further discourage other participants from entering these markets and investing in agricultural commodities, particularly when no organized institutional framework exists. Commodity exchanges can address these limitations by systematically collecting and disseminating market information on a daily basis. Greater access to current and expected price information allows producers to evaluate market conditions more accurately and make better-informed production, financing, and commercialization decisions (Figure 2.5).

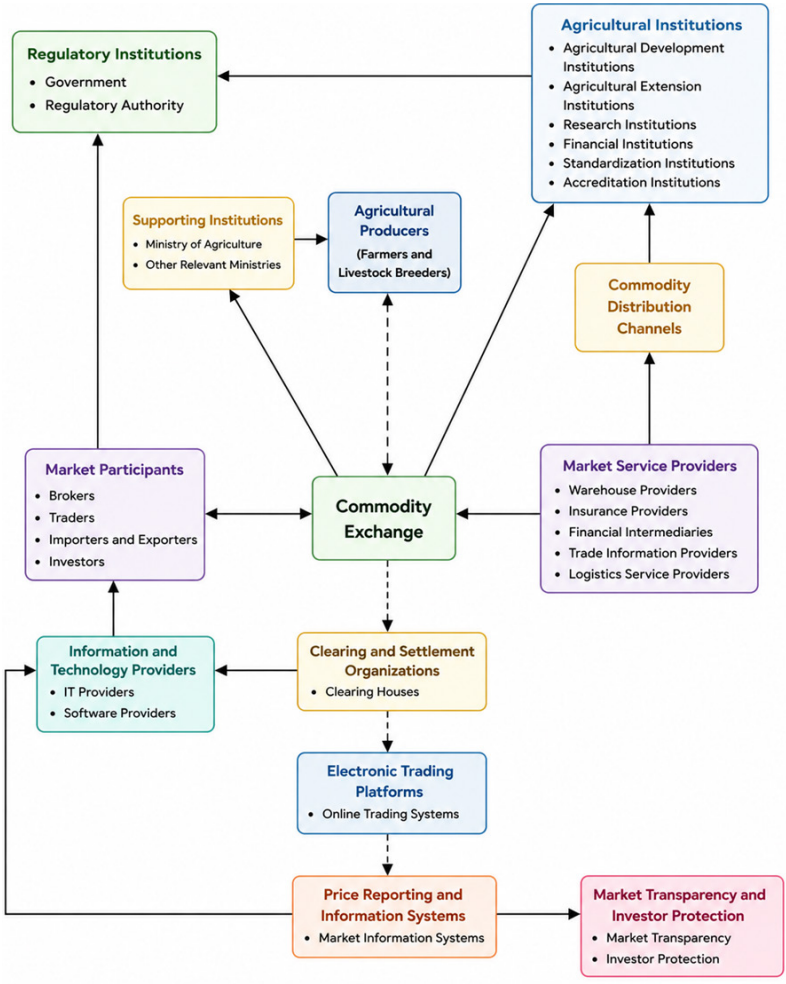


Figure 2.5. Relationship Between the Commodity Exchange and Agricultural Sector Growth.

The analysis shows that the contribution of commodity exchanges to agricultural development depends substantially on the institutional environment in which transactions take place. Effective markets require a balanced regulatory framework capable of protecting participants while preserving competition, transparency, and efficient price formation.

For agricultural producers, organized exchanges can reduce structural disadvantages traditionally associated with limited liquidity, dependence on intermediaries, and restricted access to financing. The possibility of attracting a broader range of market participants and connecting commodity transactions with formal financial instruments creates opportunities for producers to improve their bargaining position and obtain resources under more favorable conditions.

The broader developmental importance of these institutions lies in their capacity to improve the quality of economic decisions throughout the agricultural production cycle. More reliable price signals can guide cultivation choices, facilitate anticipation of market conditions, and reduce information disadvantages that frequently affect farmers in traditional markets. Consequently, a well-regulated commodity exchange can become part of the institutional infrastructure supporting a more competitive, financially accessible, and better-informed agricultural sector.

2.4. Empirical Evidence on Commodity Exchanges and Agricultural Development

A study on the role of the Iranian Commodity Exchange in removing production barriers and achieving the objectives of the resistance economy examined the factors influencing non-oil gross domestic product as an indicator of productive capacity. The analysis applied an autoregressive distributed lag model using seasonal data from 2014 to 2015. The strengths, weaknesses, opportunities, and threats associated with the Iranian Commodity Exchange were also evaluated to identify appropriate strategies for strengthening its contribution to production.

The findings indicated that the volume of commodity exchange transactions had a positive and significant effect on non-oil gross domestic product. Specifically, a one percent increase in the volume of transactions on the Iranian Commodity Exchange was associated

with a 1.21 percent increase in gross domestic product excluding oil. The study also emphasized that government institutions can contribute to the expansion of the exchange by strengthening relationships with producers and traders and encouraging their participation in organized commodity markets. Supportive legislation, credit facilities, and tax incentives for small businesses were also identified as mechanisms capable of increasing their participation in the Iranian Commodity Exchange over the long term.

Hassanzadeh and Etemadifar (2022) analyzed agricultural commodity transactions on the Iranian Commodity Exchange during the period from 2018 to 2022. Their findings showed a declining trend in the supply of agricultural commodities and a reduction in the number of transactions compared with previous years. Overall, the results indicate that agricultural commodity supply through the exchange decreased during the period analyzed, highlighting persistent challenges affecting the participation of the agricultural sector in organized commodity trading.

Research on the agricultural industries represented on the Tehran Stock Exchange has also examined the influence of macroeconomic variables and economic policies on the performance of agricultural industry stocks. The analysis considered variables such as value added, interest rates, liquidity, exchange rates, economic openness, and speculative price movements. The findings emphasized the importance of supportive financial policies, access to affordable financing, improvements in export capacity, government support for productive enterprises, and control of excessive liquidity and inflation as mechanisms for strengthening capital market participation by agricultural industries.

Another study examining development strategies for the agricultural commodity exchange in Fars Province combined an analysis of strengths, weaknesses, opportunities, and threats with the analytical hierarchy

process. Expert assessments collected in 2016 were used to prioritize strategies for developing agricultural commodity trading. The results identified the provision of low-interest bank financing to agricultural producers, guaranteed through sales conducted on the exchange, as the highest-priority strategy. By contrast, establishing an agricultural product marketing group within the exchange received the lowest priority.

Mahdavizadeh and Chavoshi (2018) examined the effects of selected macroeconomic variables and international prices on soybean price fluctuations on the Iranian Commodity Exchange. Using weekly soybean price data from April 2011 to March 2017, the study analyzed the influence of exchange rates and oil prices and compared price behavior on the Iranian Commodity Exchange with international commodity markets. The results showed that soybean prices were affected by fluctuations in exchange rates and oil prices. Price volatility was also greater on the Iranian Commodity Exchange than on the Chicago Mercantile Exchange, suggesting comparatively lower market efficiency in Iran.

Research examining the influence of the Iranian Commodity Exchange on failures of the traditional agricultural market has similarly emphasized the potential contribution of organized commodity trading to agricultural development. Traditional agricultural markets in Iran exhibit structural limitations that can restrict efficiency, transparency, and effective commercialization. The establishment of an agricultural commodity exchange provides an institutional mechanism for addressing some of these limitations and can consequently contribute to greater activity and development within the agricultural economy.

Other research has focused specifically on the factors responsible for the limited development of agricultural trading on the Iranian Commodity Exchange. The findings classify the principal barriers into three

broad categories: macro-level government factors, factors associated with the organization and operation of the commodity exchange itself, and structural characteristics of the agricultural sector. Improving agricultural trading therefore requires coordinated policies capable of addressing obstacles within each of these areas rather than relying on isolated market interventions.

Amjadi and Ahmadi-Kaliji (2016) examined the role of agricultural commodity exchanges in agricultural sector development. Their panel analysis showed that increases in the value of agricultural commodity exchange transactions significantly increased agricultural value added in China, India, South Korea, and Japan. The study also evaluated the effectiveness of futures contracts for corn, soybeans, wheat, and cotton as risk-hedging instruments and found significant risk coverage for each commodity. These findings indicate that financial institutions and instruments such as commodity exchanges can mobilize financial resources and direct them toward investment in priority sectors, particularly agriculture, thereby contributing to economic growth and development.

Research examining barley price fluctuations on the Iranian Commodity Exchange found that macroeconomic conditions also influence the performance of agricultural commodity markets. Changes in exchange rates and crude oil prices significantly affected barley prices, while price fluctuations on the Iranian Commodity Exchange were greater than those observed in both the Iranian free market and the Chicago Mercantile Exchange. These findings suggest that important efficiency limitations remain within the Iranian agricultural commodity market.

The relationship between financial market development and agricultural growth in Iran has also been examined through bank credit to agriculture as an indicator of money market development and commodity exchange transaction volume as an indicator of capital market

development. The findings showed that the money market had a positive effect on agricultural growth, whereas the capital market had a negative effect during the period analyzed. Capital stock and labor had positive and significant effects, with capital exerting the strongest influence. The study consequently emphasized the importance of improving financial resource allocation, strengthening competition in the banking system, expanding agricultural commodity exchanges in provinces with appropriate potential, and increasing liquidity within agricultural commodity markets.

Research on wheat prices further demonstrates the interaction between agricultural commodity exchanges and broader domestic and international markets. An analysis of weekly wheat prices from March 2009 to December 2011 found that wheat prices on the Iranian Commodity Exchange were influenced by price movements in the Iranian free market, the Chicago Mercantile Exchange, exchange rates, and Iranian crude oil prices. Price shocks originating in the free market, international commodity markets, and oil markets were transmitted rapidly to wheat prices on the Iranian Commodity Exchange.

International evidence also demonstrates the relationship between futures markets and agricultural market performance. Zhang et al. (2024) analyzed the effect of the grain futures market on stock price volatility among listed agricultural companies using data from June 2019 to September 2023. The findings revealed short-term interactions between grain futures prices and the stock prices of agricultural companies, together with a long-term equilibrium relationship. These results confirm that developments in grain futures markets can significantly influence the financial performance and price behavior of listed agricultural companies.

Lee and Park (2026) examined the influence of the monthly World Agricultural Supply and Demand

Estimates reports issued by the United States Department of Agriculture on volatility in grain futures markets. Using high-frequency data, the authors compared intraday volatility on report-release days with that observed on non-release days. The results revealed distinctive volatility patterns associated with the publication of these reports, indicating that the dissemination of public agricultural information can significantly influence market expectations and trading behavior. These findings highlight the importance of timely, reliable, and transparent information for improving the functioning and efficiency of agricultural futures markets.

Kashif et al. (2023) investigated the asymmetric effects of agricultural commodity prices on agricultural value added in Pakistan. Using secondary data covering the period from 1970 to 2018, the study examined how positive and negative agricultural price shocks, credit disbursement, and labor force participation affected agricultural growth. A nonlinear autoregressive distributed lag model was applied to identify both short-term and long-term relationships among these variables.

The findings showed that both positive and negative agricultural price shocks contributed positively to agricultural growth, although positive shocks generated a stronger stimulatory effect. Credit disbursement and labor force participation also exerted significant effects on agricultural value added in both the short and long term. These results demonstrate the importance of considering the asymmetric behavior of commodity prices when designing policies aimed at strengthening agricultural growth, while also emphasizing the role of credit availability and labor resources in supporting the performance of the agricultural sector (Kashif et al., 2023).

Chowdhury (2023) analyzed the influence of commodity markets on the economies of developing countries,

with particular emphasis on their contribution to export earnings, gross domestic product, and overall economic growth. Commodity markets represent an important source of income and foreign exchange for many developing economies; however, strong dependence on commodities can also increase exposure to price fluctuations and market volatility. Such dependence may create additional vulnerabilities by limiting economic diversification, technological advancement, and investment in human capital. Consequently, the contribution of commodity markets to economic development depends not only on their capacity to generate income and exports but also on the ability of countries to manage volatility and reduce excessive dependence on commodity-based economic activities.

The transformation of commodity markets in developing economies is influenced by factors such as population and income growth, technological innovation, globalization, and trade liberalization. Although corruption, political instability, and institutional weaknesses can limit the benefits derived from these markets, technological development, economic diversification, regional integration, and sustainable production practices provide opportunities for improving their contribution to development. The effects of commodity markets on economic growth are therefore not uniform, making diversification, innovation, and human capital development particularly important for commodity-dependent developing economies.

Belay and Venugopal (2017) examined the impact of the Ethiopian Commodity Exchange on the performance of commodity exporters through a mixed-method approach combining quantitative export data with qualitative information obtained from key stakeholders. The quantitative component evaluated trends in commodity exports, price volatility, and market integration before and after the establishment of the Ethiopian Commodity Exchange. The analysis also considered changes in export volumes, prices

received by exporters, overall market stability, export diversification, and the international competitiveness of Ethiopian commodities.

The qualitative component incorporated the perspectives of exporters, policymakers, and officials associated with the Ethiopian Commodity Exchange. Particular attention was given to perceptions regarding market transparency, the effectiveness of the exchange in fulfilling its objectives, and its contribution to fair and efficient trading practices. By integrating quantitative and qualitative evidence, the study provided a broader assessment of how an organized commodity exchange can influence exporter performance and the functioning of commodity markets in a developing economy (Belay & Venugopal, 2017).

Shirzad and Damavandi (2013) examined the contribution of the Agricultural Commodity Exchange to the economic development of rural areas in Iran, emphasizing its capacity to improve the functioning of agricultural markets and the economic conditions of rural producers. Their findings indicate that participation in the exchange can contribute to higher farmers' incomes by providing more organized and transparent mechanisms for agricultural transactions. The study also highlights the exchange's role in reducing agricultural price fluctuations, which can decrease market uncertainty and provide producers with more favorable conditions for production and commercialization decisions. In addition, the authors identified positive effects on the standardization of agricultural products, an important mechanism for improving product quality and facilitating transactions in organized markets.

The Agricultural Commodity Exchange was also associated with greater satisfaction with agricultural commercial activities and with improvements in some of the traditional problems affecting rural commodity markets. Furthermore, the study suggests that the development of organized agricultural trading can

influence cultivation patterns by providing farmers with clearer market signals regarding prices and demand. Overall, Shirzad and Damavandi (2013) provide evidence that the Agricultural Commodity Exchange can contribute to rural economic development through interconnected mechanisms involving income generation, price stability, product standardization, market organization, commercialization, and more efficient agricultural production decisions.

The evidence reviewed in this section demonstrates that commodity exchanges can contribute to agricultural development, but their effectiveness depends on the institutional, financial, and macroeconomic environment in which they operate. In the Iranian context, organized commodity trading has considerable potential to connect agricultural production with broader financial and commercial mechanisms; however, persistent barriers continue to limit the full realization of these benefits.

The empirical findings also suggest that market development cannot be achieved solely by increasing trading activity. Agricultural exchanges require adequate financing, effective regulation, reliable information, appropriate incentives for producers, and mechanisms capable of managing exposure to domestic and international price shocks. The evidence on wheat, barley, and soybeans particularly demonstrates that agricultural prices are closely interconnected with exchange rates, energy markets, and international commodity prices.

International experience further confirms that commodity and futures markets can support agricultural value creation, risk management, export performance, and market integration when appropriate institutional conditions are present. Nevertheless, excessive dependence on commodity markets and insufficient economic diversification may also generate vulnerabilities.

Consequently, the contribution of agricultural commodity exchanges should be understood as part of a broader development strategy rather than as an isolated market instrument. Their long-term effectiveness depends on integrating financial accessibility, producer participation, institutional coordination, market transparency, technological development, and sound agricultural policies. In Iran, strengthening these complementary conditions could enable the commodity exchange to play a more substantial role in transforming agricultural commercialization and supporting sustainable rural and sectoral development.

03.

Empirical Results and Econometric Analysis of the Agricultural Commodity Exchange

3.1. Statistical Profile and Dynamics of the Agricultural Sector

The empirical analysis of the agricultural sector begins with a comprehensive examination of the statistical behavior of the variables incorporated into the research models. This initial characterization provides the basis for understanding their distribution, variability, and evolution over the period under study, while establishing the statistical conditions required for the subsequent econometric analysis.

Descriptive statistics were calculated using the mean, median, minimum, maximum, and standard deviation as the principal measures of central tendency and dispersion. These indicators provide an initial overview of the

magnitude and variability of the variables associated with the agricultural commodity exchange, agricultural production growth, economic value added, and export capacity.

The descriptive analysis was complemented by diagnostic procedures aimed at evaluating the statistical properties of the data before estimating the econometric models. Normality was assessed using the Jarque–Bera test, while stationarity was examined through the Dickey–Fuller unit root test. Autocorrelation and homogeneity of variance were also evaluated to identify potential violations of the assumptions underlying the estimated models and to minimize the risk of obtaining spurious regression results.

Once the statistical properties of the variables had been established, the analysis was extended through causality and cointegration tests, vector autoregressive models, vector error correction models, impulse-response functions, and variance decomposition analysis. These techniques provide a comprehensive framework for identifying the direction, magnitude, persistence, and temporal dynamics of the relationships between the agricultural commodity exchange and the main indicators of agricultural-sector performance.

Taken together, these procedures make it possible to assess not only whether the agricultural commodity exchange significantly influences the agricultural sector, but also how its effects evolve over time. The empirical strategy therefore combines descriptive, diagnostic, and dynamic econometric analyses to evaluate the role of the commodity exchange in agricultural production growth, economic value creation, and export capacity. Table 3.1 presents the variables incorporated into the empirical analysis, their corresponding symbols, and their roles within the econometric models.

Table 3.1. Descriptive Indicators of the Research Variables.

Type	Symbol	Variable
Independent	Exchange	Commodity exchange
Dependent	EVA	Added value of the agricultural sector
Dependent	Expert_Total	Product export potential
Dependent	Expert_P	Export potential of the agricultural sector
Dependent	Sg	Agricultural production growth

Measures of central tendency and dispersion provide a fundamental statistical characterization of the distribution of the research variables. A measure of central tendency represents the value around which observations tend to cluster within a dataset. Among these measures, the mean and median are the most commonly used, as they provide complementary information about the central position of the observed values.

Dispersion measures, in turn, indicate the extent to which observations vary around their central value. The standard deviation is one of the most widely used measures of dispersion because it quantifies the average degree of variation of observations around the mean. A standard deviation close to zero indicates that the observations are highly concentrated around the mean, whereas a larger standard deviation reflects greater variability within the dataset. As the standard deviation is calculated as the square root of the variance, it is expressed in the same units as the original variable, which facilitates the interpretation and comparison of the results.

The distributional characteristics of the variables were further examined through skewness and kurtosis. Skewness, derived from the standardized third central moment, measures the degree and direction of asymmetry in a distribution. A value close to zero

indicates an approximately symmetric distribution, positive values indicate a longer or heavier right tail, and negative values indicate a longer or heavier left tail. This indicator therefore provides useful information about whether observations are disproportionately concentrated toward higher or lower values.

Kurtosis, which is based on the standardized fourth central moment, provides information about the shape of the distribution, particularly its tail behavior and concentration relative to the center. Higher kurtosis values are generally associated with heavier tails and a greater likelihood of extreme observations, whereas lower values indicate comparatively lighter tails. Considered jointly, skewness and kurtosis provide a more complete assessment of the distributional properties of the research variables and support the subsequent evaluation of their suitability for econometric analysis.

Table 3.2. Descriptive Statistics of the Research Variables.

Index	exchange	GDP	EVA	EXPERT_T
Mean	0.683761	3628005	7.258769	6266.515
Median	1.000.000	3606787 .	7.390383	6131.000
Maximum	1.000.000	8880785 .	8.459299	8835.000
Minimum	0.000000	64748.10	5.052496	2876.000
Std. Dev .	0.467008	3020862 .	0.953963	2142.112
Skewness	-0.790356	0.447144	-0.803255	-0.240278
Kurtosis	1.624662	2.044742	3.044913	1.670631
Observa-tions	117	117	117	117

The results presented in Table 3.2 provide an overview of the principal characteristics of the agricultural sector and its participation in the commodity exchange during the period under study. A total of 68 agricultural products included in the research were accepted and traded on the commodity exchange between 2011 and 2024, reflecting the breadth of agricultural commodities incorporated into this market mechanism.

During the 2011–2024 period, the agricultural sector recorded an average gross domestic product of 3,628,005 million rials. The sector accounted for an average of 25.7 percent of economic value added, indicating a comparatively limited contribution to overall value creation despite its importance within the productive structure. At the same time, the average value of agricultural exports reached 6,266.51 thousand billion rials, highlighting the significant role of external markets in the economic performance of the sector.

Taken together, these descriptive indicators provide an initial quantitative profile of the agricultural sector and establish the empirical context for examining the relationships between commodity exchange participation, production growth, economic value added, and export capacity in the subsequent econometric analyses.

Table 3.2. Descriptive Statistics of the Research Variables (Continued).

Index	Expert_P	Sg
Mean	49.76871	-0.062752
Median	19.90000	0.042500
Maximum	439.4700	0.788814
Minimum	0.000000	-3.468182
Std . Dev .	88.17788	0.485865
Skewness	2.770934	-3.710022
Kurtosis	10.20007	23.83890
Observations	117	117

The descriptive results further show that the average growth rate of agricultural production during the 2011–2024 period was -0.06. The negative value indicates that, on average, agricultural production experienced a slight contraction over the period analyzed. This result reveals an unfavorable overall growth pattern and

provides an important empirical basis for subsequently assessing whether participation in the agricultural commodity exchange contributed to changes in production dynamics.

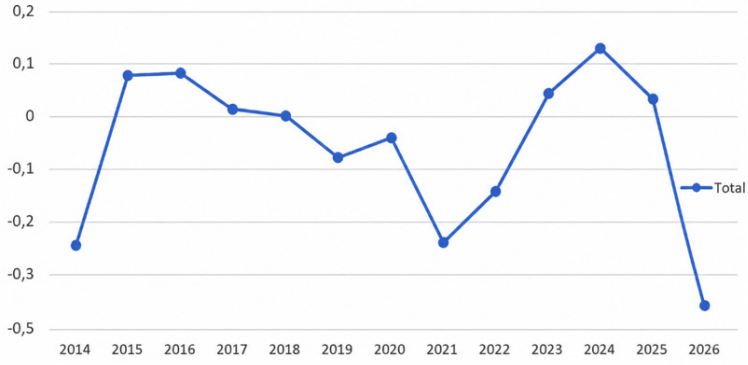


Figure 3.1. Changes in Agricultural Production Growth, 2011–2024.

Figure 3.1 illustrates the evolution of agricultural production growth over the 2011–2024 period. Agricultural production growth followed a fluctuating trajectory rather than a stable trend. Growth increased during the initial years of the period, approximately from 2011 to 2013, before entering a downward phase that continued until approximately 2016. A temporary recovery was subsequently observed between 2016 and 2017, although the growth rate remained negative.

This improvement was followed by another decline between 2017 and 2018. From approximately 2018 onward, agricultural production generally exhibited a recovery trend through 2022, despite the persistence of negative growth during part of the period, particularly around 2018–2019. Overall, the observed fluctuations indicate considerable instability in agricultural production growth and provide an important empirical basis for examining the extent to which the agricultural commodity exchange may have influenced production dynamics.

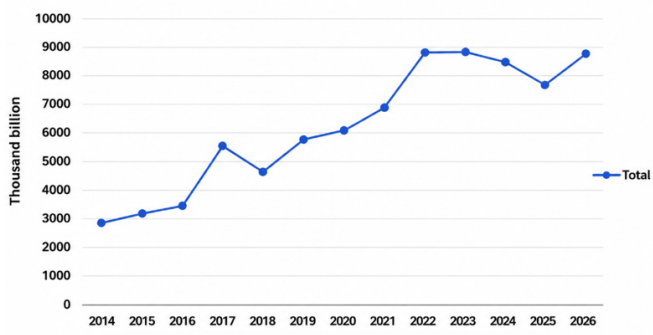


Figure 3.2. Average Value of Agricultural Product Exports, 2011–2024.

Figure 3.2 shows the evolution of the average value of agricultural product exports during the 2011–2024 period. Overall, the export value of the agricultural sector followed an upward trajectory, although this general expansion was accompanied by several temporary declines. According to the available data, a noticeable decrease occurred approximately between 2014 and 2016, interrupting the prevailing upward trend. A more moderate downward movement was also observed between approximately 2019 and 2023. Despite these fluctuations, the overall pattern indicates sustained growth in the value of agricultural exports over the period analyzed, highlighting the increasing importance of external markets for the agricultural sector.

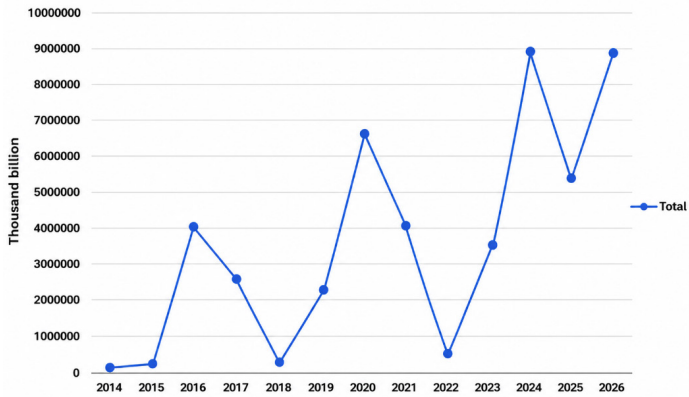


Figure 3.3. Average Gross Domestic Product of the Agricultural Sector, 2011–2024.

Figure 3.3 illustrates the evolution of the agricultural sector's gross domestic product during the 2011–2024 period. The series exhibits a cyclical pattern characterized by alternating phases of expansion and contraction, indicating that agricultural economic activity did not follow a continuous growth trajectory. The highest values were recorded approximately in 2013, 2017, 2021, and 2023–2024, whereas the lowest levels occurred approximately in 2011, 2012, 2015, and 2019. Overall, these recurrent fluctuations reveal considerable variability in the agricultural sector's contribution to gross domestic product throughout the period analyzed.

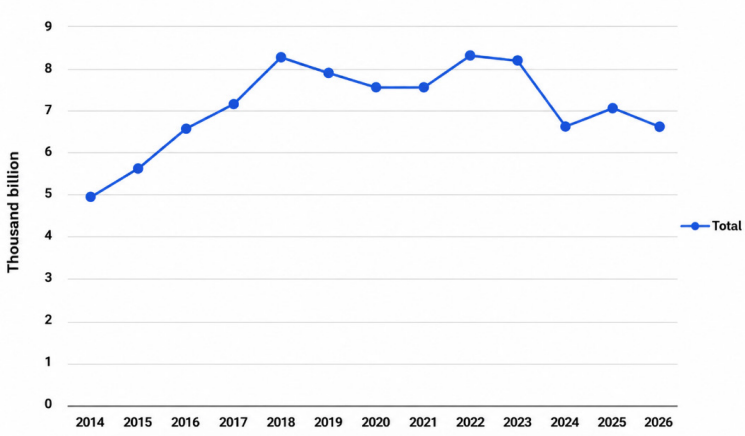


Figure 3.4. Average Economic Value Added of the Agricultural Sector, 2011–2024.

Figure 3.4 illustrates the evolution of the agricultural sector's average economic value added during the 2011–2024 period. The values fluctuate within a range of approximately 5 to 9, indicating noticeable variations in the sector's capacity to generate economic value over time. The lowest level was recorded at the beginning of the period, in approximately 2011, whereas the highest value was reached around 2019–2020. Overall, the observed trajectory reflects changes in the agricultural sector's contribution to economic value creation and provides an important descriptive basis for the subsequent econometric analysis of the relationship

between the commodity exchange and agricultural economic value added.

Overall, the descriptive evidence portrays an agricultural sector marked by substantial variability across production, exports, gross domestic product, and value creation. Although export performance shows a broadly favorable evolution, production dynamics remain comparatively unstable, suggesting that improvements in external market performance have not translated uniformly into productive expansion. These patterns justify a deeper econometric examination of the role played by the agricultural commodity exchange in shaping the sector's performance over time.

3.2. Econometric Validation and Statistical Robustness of the Research Models

Before estimating the research, models and addressing the research questions, a series of diagnostic tests was conducted to assess whether the data and model specifications satisfied the statistical conditions required for reliable regression analysis. These procedures included tests of normality, stationarity, homogeneity of variance, and autocorrelation, together with assessments of the appropriate model estimation method, structural stability, and robustness. The purpose of these diagnostic procedures was to reduce the risk of model misspecification and ensure that the subsequent econometric estimates provided statistically reliable evidence.

The normality of the variables was initially examined using the Jarque–Bera test. Normality assessment is relevant to regression analysis because the distributional properties of the residuals affect the validity of statistical inference, particularly hypothesis testing and confidence intervals. The residuals represent the differences between the observed and estimated values generated by the regression model; therefore, their behavior must be carefully evaluated when assessing model adequacy.

The Jarque–Bera test was applied to examine the distributional characteristics of the variables included in the empirical models. Where departures from normality were identified, appropriate transformations could be considered before model estimation. In addition to normality, particular attention was given to stationarity because the use of nonstationary time-series variables may produce spurious regression results and consequently lead to misleading statistical relationships. The combined application of these diagnostic procedures therefore provides an essential foundation for the reliability of the econometric analysis developed in the following stages. Table 3.3 presents the results of the normality tests applied to the research variables.

Table 3.3. Normality Test of the Research Variables.

Variable	Statistics	P-Value
Exchange	21.40224	0
GDP	8.347311	0.015
EVA	12.59161	0.001
Expert_Total	9.741012	0.007
Expert_P	399.0076	0
Sg	2385.420	0

The results of the Jarque–Bera test indicate that the significance levels associated with all the variables are below the 5 percent threshold (P-value < 0.05). Accordingly, the null hypothesis of normality is rejected, indicating that the variables do not follow a normal distribution. Nevertheless, given the relatively large number of observations, the sampling distributions may be considered asymptotically normal under the central limit theorem. This consideration supports the subsequent application of the econometric procedures, while the observed departures from normality should be taken into account when interpreting the results.

Stationarity was subsequently examined using the Dickey–Fuller unit root test. This procedure is essential in time-series analysis because nonstationary variables may generate spurious relationships and compromise the reliability of regression estimates. The test was conducted under three alternative specifications: with an intercept, with an intercept and deterministic trend, and without an intercept or deterministic trend. Considering these alternative specifications provides a more comprehensive assessment of the stochastic properties of the variables and helps determine whether their statistical behavior remains stable over time. The tests were performed using the Schwarz Information Criterion for lag selection, with a maximum lag length of 12.

Table 3.4. Dickey–Fuller Stationarity Test Results for the Research Variables with an Intercept.

Variable	At Level, I(0)		First Difference, I(1)		Second Difference, I(2)		Result
	Statistics	P-Value	Statistics	P-Value	Statistics	P-Value	
Exchange	-4.934735	0	-	-	-	-	I(0)
GDP	-9.006386	0	-	-	-	-	I(0)
EVA	-122/0	0/45	1.45	-0.07	3.76	0	I(2)
Expert_Total	0.531	0.701	-4.10	0	-	-	I(1)
Expert_P	-12.21075	0	-	-	-	-	I(0)
Sg	-10.66152	0	-	-	-	-	I(0)

Note. **Significant at the 1% level. *Significant at the 5% level.

The results presented in Table 3.4 indicate that, under the specification including an intercept, the Dickey–Fuller

test statistics for the commodity exchange, agricultural production growth, export capacity, and agricultural-sector gross domestic product are statistically significant at the 5 percent level (P-value < 0.05). Accordingly, the null hypothesis of a unit root is rejected for these variables, indicating that they are stationary at level, I(0).

In contrast, the agricultural export value variable (Expert_Total) becomes stationary after first differencing, as its associated test statistic is significant at the 5 percent level. This result indicates that the variable is integrated of order one, I(1). The economic value added variable (EAV) becomes stationary after second differencing and is therefore integrated of order two, I(2). These findings reveal different orders of integration among the variables and provide essential information for selecting the appropriate econometric procedures in the subsequent stages of the analysis.

Table 3.5. Dickey–Fuller Stationarity Test Results for the Research Variables with an Intercept and Trend.

Variable	At Level, I(0)		First Difference, I(1)		Second Difference, I(2)		Result
	Statistics	P-Value	Statistics	P-Value	Statistics	P-Value	
Exchange	-4.911959	0	-	-	-	-	I(0)
GDP	-1.29	0.09	-5.95	-0	-	-	I(1)
AVA	1.5	0.93	0.89	0.81	4.32	0	I(2)
Expert_Total	-0.515	0.30	-2.58	0.004		-	I(1)
Expert_P	3.947896 -	0.0134	-	-	-	-	I(0)
Sg	-1.94	0.026	-	-	-	-	I(0)

The results presented in Table 3.5 show the Dickey–Fuller stationarity test under the specification that includes both an intercept and a deterministic trend. The significance levels associated with the test statistics for the commodity exchange, agricultural production growth, and export capacity variables are below the 5 percent threshold (P-value < 0.05). Accordingly, the null hypothesis of a unit root is rejected, indicating that these variables are stationary at level, I(0).

In contrast, the agricultural export value variable (Expert_Total) and agricultural-sector gross domestic product become stationary after first differencing, with their corresponding test statistics reaching significance at the 5 percent level. These variables are therefore integrated of order one, I(1). Finally, the economic value added variable (EAV) becomes stationary after second differencing and is consequently integrated of order two, I(2).

Overall, the results confirm that the variables exhibit different orders of integration under the intercept-and-trend specification. This evidence is particularly important for determining the appropriate econometric procedures and for avoiding spurious relationships in the subsequent estimation of the research models.

The autocorrelation of the residuals was assessed using the Breusch–Godfrey test. This diagnostic procedure is designed to detect serial correlation in the error terms of regression models and can be applied even when lagged values of the dependent variable are included among the explanatory variables. Compared with the Durbin–Watson test, the Breusch–Godfrey test provides greater flexibility because it can detect autocorrelation beyond the first order and can be applied to a broader range of econometric specifications.

The results show that the significance levels associated with the F-statistics for the research models are below the 5 percent threshold (P-value < 0.05). Consequently, the null hypothesis of no serial correlation is rejected,

providing statistical evidence of autocorrelation in the residuals of the estimated research models. This finding must therefore be considered in the subsequent model estimation and diagnostic procedures to ensure the reliability of the econometric results. Table 3.6 presents the results of the Breusch–Godfrey autocorrelation test for the research models.

Table 3.6. Breusch–Godfrey Autocorrelation Test Results for the Research Models.

Model	F statistics	P-Value	Result
Model.1	22.76578	0	Autocorrelation
Model.2	35.73323	0	Autocorrelation
Model3	44.63057	0	Autocorrelation

The homogeneity of variance assumption constitutes one of the fundamental conditions of the classical linear regression model. It requires the variance of the error terms to remain constant across observations. When this condition is satisfied, the residuals exhibit homoscedasticity; conversely, variations in the dispersion of the residuals indicate the presence of heteroscedasticity, which may affect the efficiency of the estimated coefficients and the reliability of statistical inference.

To evaluate this assumption, the Breusch–Pagan–Godfrey test was applied to the residuals of the research models. The hypotheses were formulated as follows:

H_0: The residuals exhibit homoscedasticity (constant variance).

H_1: The residuals exhibit heteroscedasticity (nonconstant variance).

The decision criterion was based on a significance level of 5 percent. When the probability value associated with the test statistic is greater than 0.05 (P-value > 0.05), the null hypothesis cannot be rejected, indicating no statistically significant evidence of heteroscedasticity.

Conversely, a probability value below 0.05 (P-value < 0.05) provides evidence for rejecting the null hypothesis and indicates the presence of heteroscedasticity.

Table 3.7. Breusch–Pagan–Godfrey Test Results for Homogeneity of Variance.

Research Models	F statistic (Sig)	Obs *R-squared(sig)	Result
Model.1	0.233649(0.792)	0.477637(0.787)	Heterogeneity of variance
Model.2	1.802205(0.0846)	12.50632(0.0851)	Heterogeneity of variance
Model.3	1.9276522(0.0654)	13.2326(0.0520)	Heterogeneity of variance

The results presented in Table 3.7 show that the probability values associated with the F-statistic and Chi-square statistic for all four research models are greater than the 5 percent significance level (P-value > 0.05). Accordingly, the null hypothesis of homoscedasticity cannot be rejected. The results therefore indicate that the residuals of the estimated models exhibit constant variance, providing no statistically significant evidence of heteroscedasticity.

Given that some of the research variables were found to be nonstationary at level and exhibited different orders of integration, the analysis was subsequently extended to examine the existence of long-run relationships among the variables. For this purpose, the Kao residual cointegration test was applied. Cointegration analysis is particularly important when working with nonstationary variables because it makes it possible to determine whether they maintain a stable long-run equilibrium relationship and helps prevent the erroneous interpretation of spurious regression results.

The Kao test was therefore used to assess whether the residuals derived from the statistical models were stationary and, consequently, whether evidence of cointegration existed among the variables. The results obtained for the four research models indicate cointegration of the residuals, supporting the existence of long-run equilibrium relationships among the variables included in the models. This finding provides an important econometric foundation for the subsequent analysis of both short- and long-run dynamics. Table 3.8 presents the results of the Kao residual cointegration test for the research models.

Table 3.8. Kao Residual Cointegration Test Results for the Research Models.

ADF	t-Statistic	Prob.	Result
	7.358381	0.0000	cointegration
Residual variance	14.40298		
HAC variance	0.387077		

The diagnostic evidence confirms that the proposed econometric framework provides an adequate basis for the subsequent empirical analysis. Despite differences in the integration properties of the variables and the presence of serial correlation, the models maintain constant residual variance, while the cointegration results demonstrate stable long-run relationships among the variables. These statistical conditions strengthen the validity of the following analysis of the influence of the agricultural commodity exchange on agricultural-sector performance.

3.3. Commodity Exchange as a Driver of Agricultural Production Growth

To assess the extent to which the agricultural commodity exchange influences agricultural production growth, a simple regression model was specified in which production growth constitutes the dependent variable and participation in the commodity exchange represents

the explanatory variable. The model is expressed as follows:

$$Sg_{i,t} = \beta_0 + \beta_1 * Exchange_{i,t} + * e_{i,t}$$

where $Sg_{i,t}$ represents the growth of agricultural production for product i at time t; Exchangei,t represents the agricultural commodity exchange variable for product i at time t; $\beta 0$ is the intercept; $\beta 1$ measures the effect of the agricultural commodity exchange on production growth; and ei,t represents the error term.

The model was estimated to determine whether participation in the agricultural commodity exchange is significantly associated with changes in agricultural production across the principal subsectors considered in the study, including livestock, horticulture, crop farming, and aquaculture.

Table 3.9. Results of the First Regression Model for Agricultural Production Growth.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.707451	0.067028	10.55454	0.0000
exchange	0.017730	0.039594	5.447812	0.000
AR(1)	0.655993	0.049396	13.28030	0.0000
Effects Specification				
R-squared	0.436580	Mean dependent var	0.347260	
Adjusted R -squared	0.429166	SD dependent var	0.689655	
SE of regression	0.350293	Akaike info criterion	0.463635	
Sum squared remainder	27.97673	Schwarz criterion	0.756995	
Log likelihood	-83.81146	Hannan-Quinn criter .	0.816422	
F-statistic	58.89045	Durbin-Watson stat	0.780961	
Prob(F-statistic)	0			

Table 3.9 presents the estimation results for the first regression model. Before interpreting the individual regression coefficients, the overall statistical significance of the model must be assessed and the principal assumptions underlying the regression specification must be considered. The F-statistic is used to evaluate the joint significance of the model. As shown in Table 3.9, the probability associated with the F-statistic is below the 5 percent significance level (P-value < 0.05), indicating that the model is statistically significant as a whole.

The Durbin–Watson statistic is 1.83, a value that falls within the commonly accepted range for indicating the absence of serious first-order serial correlation in the residuals. In addition, the coefficient of determination (R^2) is 0.436, indicating that approximately 43.6 percent of the variation in agricultural production growth is explained by the commodity exchange variable and the dynamic structure incorporated into the model.

The coefficient associated with the commodity exchange variable is also statistically significant, with a probability value of 0.000 (P-value < 0.05). Accordingly, the null hypothesis of no effect is rejected. The results therefore provide evidence that the agricultural commodity exchange has a statistically significant effect on agricultural production growth (Figure 3.5 and 3.6).

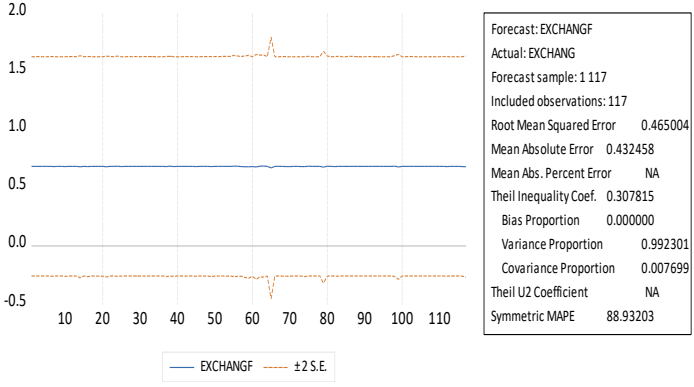


Figure 3.5. Predicted Values of Agricultural Production Growth in the First Regression Model.

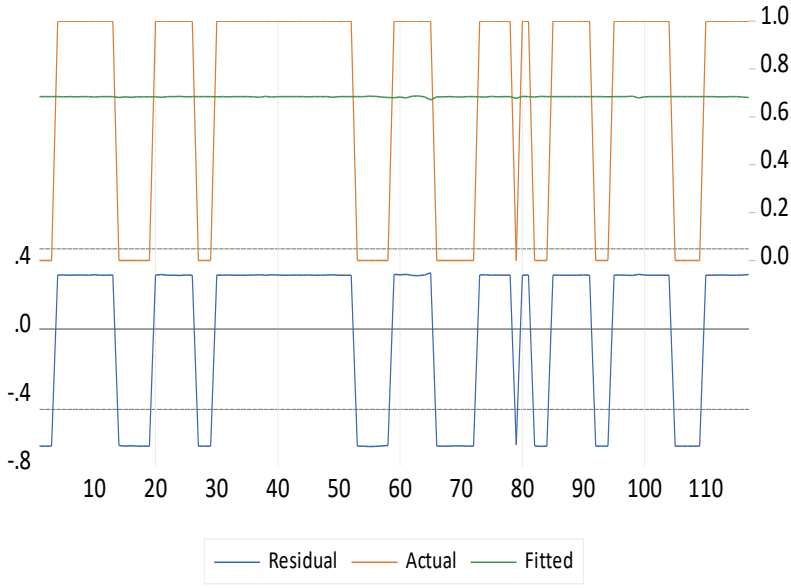


Figure 3.6. Actual, Fitted, and Residual Values of Agricultural Production Growth in the First Regression Model.

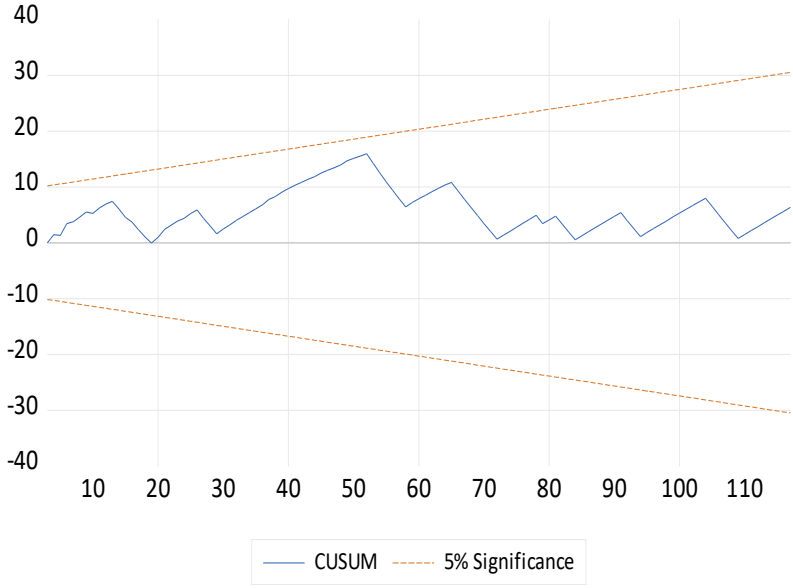


Figure 3.7. CUSUM Test for Structural Stability of the First Regression Model.

Figure 3.7 indicates that the cumulative sum remains within the established critical bounds throughout the period analyzed. This behavior provides evidence of structural stability, suggesting that the estimated parameters of the first regression model remain stable over time. Accordingly, no significant structural break is detected in the relationship between the agricultural commodity exchange and agricultural production growth during the study period. This result supports the temporal stability of the estimated relationship, although evidence of a long-run equilibrium relationship must be established through the corresponding cointegration analysis.

To strengthen the econometric assessment and reduce the possibility of spurious relationships, the analysis was subsequently extended to examine the dynamic interactions between the agricultural commodity exchange and agricultural production growth. For this purpose, Granger causality analysis, vector autoregressive (VAR) modeling, the vector error correction model (VECM), and impulse-response functions were employed. These procedures make it possible to distinguish short-run dynamics from long-run adjustment mechanisms and to determine how changes in the commodity exchange are transmitted to agricultural production growth over time.

The first step in estimating the VAR model is to determine the optimal lag length. Appropriate lag selection is essential because an insufficient number of lags may fail to capture the dynamic structure of the variables, whereas an excessive number may reduce estimation efficiency. The optimal lag length was therefore evaluated using the Schwarz Bayesian Information Criterion and the Akaike Information Criterion. The specification that provides the most appropriate balance between model fit and parsimony is subsequently used in the dynamic analysis. Table 3.10 presents the criteria used to determine the optimal lag length for the first model.

Table 3.10. Optimal Lag Length Selection for the First Model.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	113.4142	NA	6.13e-09	-1.884467	-1.746405	-1.832021
1	280.2034	333.0947	6.18e-10	-4.179007	-3.717093*	-3.729887*
2	307.2335	48.08583	7.21e-10	-4.284621	-3.153333	-3.268771
3	337.5061	49.80327	4.53e-10	-4.557406	-2.812250	-3.447335
4	422.4826	72.48161	3.02e-10	-4.784467	-1.808206	-3.319433
5	481.2644	86.11297	2.45e-10*	-5.183794	-0.722070	-3.374575
6	519.3378	50.99328	2.53e-10	-5.380066	0.111334	-3.054573
7	549.8284	35.49322	3.15e-10	-5.184850	1.107064	-3.071717
8	596.9995	56.05728*	2.84e-10	-5.310727*	1.740785	-2.451885

Note: * indicates the lag order selected by the criterion.

Based on the results presented in Table 3.10, the optimal lag length for the first model is two periods according to the Schwarz Information Criterion. Once the appropriate lag structure had been established, the analysis proceeded to determine whether a stable long-run equilibrium relationship existed between the variables. For this purpose, the Johansen cointegration test was applied to assess the presence and number of cointegrating relationships based on the corresponding test statistics. The results provide the basis for evaluating the long-run relationship between the agricultural commodity exchange and agricultural production growth.

Given the existence of a cointegrating relationship between the variables in the validated model, the analysis was subsequently extended through an Error Correction Model (ECM). The cointegrating equation was first estimated to identify the long-run relationship, after which the ECM was employed to capture the short-run dynamics and determine the speed at which deviations from the long-run equilibrium are corrected.

The error correction coefficient plays a central role in this framework because it measures the speed of adjustment toward long-run equilibrium following a short-run disturbance. Consequently, the ECM integrates the long-run equilibrium relationship with the short-run dynamics of the variables, providing a more comprehensive assessment of how agricultural production growth responds over time to changes in the agricultural commodity exchange. The estimation results for the first model are presented below.

Sg = 1.064750 + 0.33 * EXCHANG (-1)

The estimated error correction coefficient indicates the speed at which short-run deviations from equilibrium are corrected and the system returns to its long-run trajectory. Based on the reported results, approximately 0.36, or 36 percent, of the disequilibrium generated by a short-run shock is corrected in each period. This adjustment mechanism indicates that deviations from the long-run equilibrium are progressively absorbed over time, allowing agricultural production growth and the commodity exchange variables to converge toward their long-run relationship.

The statistical significance of the error correction term (T = 3.88 > 1.96) provides further evidence of a long-run adjustment mechanism toward agricultural production growth. This result is consistent with the Granger causality findings and supports the existence of a causal relationship running from the agricultural commodity exchange to agricultural production growth. Taken together, the results indicate that the commodity

exchange is associated not only with short-run changes in agricultural production but also with the process through which production returns to its long-run equilibrium following temporary disturbances (Table 3.11).

Table 3.11. Estimated Error Correction Model for Agricultural Production Growth.

Cointegration equation	Coefficient
EXCHANGE(- 1)	1.000000
SG _(-1)	0.332634
	(0.085891)
	[3.88288]
C	1.064750

The unrestricted vector autoregressive (VAR) method was subsequently employed to examine the dynamic relationships among the variables included in the first model. The VAR framework is one of the most widely applied approaches in time-series analysis because it treats all variables within the system as endogenous. Accordingly, each variable is explained by its own lagged values as well as by the lagged values of the other variables incorporated into the model.

Determining the optimal lag length is a critical stage in VAR estimation. Increasing the number of lags may enhance the model's ability to capture the dynamic interactions among the variables and improve its explanatory capacity. However, an excessive number of lags also increases the number of parameters to be estimated and reduces the available degrees of freedom. The appropriate lag structure must therefore balance the need to represent the temporal dynamics of the system with the requirement for model parsimony and estimation efficiency.

Because the VAR framework captures a system of interdependent dynamic relationships, interpretation is not limited to the estimated coefficients. Impulse-response

functions and variance decomposition analysis are subsequently employed to evaluate how shocks originating in one variable affect the other variables over time and to determine the relative contribution of these shocks to fluctuations within the system. These procedures provide a more comprehensive understanding of the dynamic interaction between the agricultural commodity exchange and agricultural production growth. Table 3.12 presents the results obtained from the unrestricted VAR estimation for the first model.

Table 3.12. Unrestricted Vector Autoregressive Model Estimation Results for the First Model.

	EXCHANGE	SG_
EXCHANGE(-1)	0.736376	0.105051
	(0.09451)	(0.03249)
	[7.79130]	[3.33287]
EXCHANGE(-2)	-0.132559	0.179748
	(0.09387)	(0.03159)
	[-1.41218]	[5.60603]

The results presented in Table 3.12 describe the short-run dynamic relationships between the variables in the first model, estimated through the VAR framework with an optimal lag length of two periods. The analysis covers the 2012–2024 period and includes 117 observations. Within each cell, the first value represents the estimated coefficient, the value in parentheses corresponds to the standard error, and the value in brackets represents the t-statistic.

The results indicate that the commodity exchange has a statistically significant positive effect on agricultural production growth. At the first lag, the t-statistic associated with the commodity exchange variable is 3.32 (T = 3.32 > 1.96), providing evidence of a positive short-run effect on agricultural production growth. At the second lag, the corresponding t-statistic increases

to 5.60 (T = 5.60 > 1.96), confirming that the effect remains statistically significant over the two-period horizon. These findings demonstrate that changes in the agricultural commodity exchange generate significant short-run effects on agricultural production growth and that this influence persists across both lags considered in the model.

The dynamic analysis was subsequently extended through impulse-response functions (IRFs), which measure how an endogenous variable responds over time to an unexpected shock affecting another variable within the system. More specifically, an impulse-response function traces the current and future effects of a one-standard-deviation innovation while accounting for the dynamic interactions among all endogenous variables incorporated into the model.

In the context of the first model, impulse-response analysis makes it possible to determine the magnitude, direction, and persistence of the response of agricultural production growth to shocks originating in the agricultural commodity exchange. This approach therefore complements the VAR results by showing how the effects of an unexpected change are transmitted and evolve across successive periods. Table 3.13 presents the response of agricultural production growth to shocks in the variables included in the first model.

Table 3.13. Response of Agricultural Production Growth to Shocks in the First Model.

Period	EXCHANG	SG_
1	0.021170	0.049739
	(0.00315)	(0.01170)
2	-0.012574	-0.004111
	(0.00230)	(0.00174)
3	0.006968	-0.041728

	(0.00210)	(0.00180)
4	0.005946	-0.015008
	(0.00044)	(0.00193)
5	0.028736	0.027734
	(0.00326)	(0.00444)
6	0.058202	0.029996
	(0.00030)	(0.00042)
7	0.050071	0.028205
	(0.00022)	(0.00031)
8	0.051131	0.016038
	(0.00019)	(0.00020)
9	0.052107	0.014019
	(0.00018)	(0.00015)
10	0.053515	0.015020
	(0.00018)	(0.00013)

Table 3.13 shows the response of agricultural production growth over ten periods to shocks originating from the variables included in the first model. The corresponding impulse-response analysis illustrates the effect of a one-standard-deviation innovation in each variable on the subsequent trajectory of agricultural production growth.

The results indicate that shocks generate varying responses across the ten-period horizon. In particular, a one-standard-deviation shock to the agricultural commodity exchange produces an initial increase of 0.49 in agricultural production growth during the first period. In the second period, the response becomes slightly negative, reaching -0.004, and declines further to -0.041 in the third period. In the fourth period, the negative response reaches -0.25, followed by a positive response of 0.051 in the fifth period. Subsequent periods continue to exhibit adjustments of varying magnitude and direction.

Overall, the impulse-response pattern shows that the effect of a commodity exchange shock is transmitted dynamically through agricultural production growth, producing alternating positive and negative responses before progressively stabilizing. By the end of the ten-period horizon, the fluctuations associated with the initial shock tend toward a stable trajectory, indicating that the effect of the disturbance is gradually absorbed by the system rather than generating persistent instability.

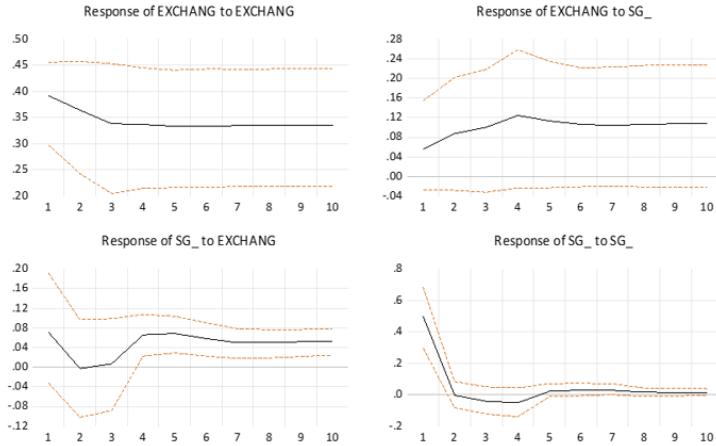


Figure 3.8. Response of Agricultural Production Growth to Shocks in the First Model.

Figure 3.8 shows that the response of agricultural production growth to shocks originating from the variables included in the first model gradually converges toward its equilibrium path. During the initial periods, agricultural production growth exhibits fluctuations of varying magnitude and direction in response to shocks from the agricultural commodity exchange. However, these effects progressively diminish over time. By approximately the tenth period, the response converges toward the equilibrium path, indicating that the effects of the initial disturbances are gradually absorbed, and that agricultural production growth returns to a stable trajectory.

Variance decomposition analysis was subsequently employed to determine the relative contribution of shocks in each variable to fluctuations in agricultural production growth over the forecast horizon. Unlike impulse-response analysis, which traces the direction and evolution of a specific shock over time, variance decomposition quantifies the proportion of forecast error variance attributable to innovations in the dependent variable itself and to shocks originating from the other variables in the model.

The results indicate that, in the short run, approximately 89 percent of the fluctuations in agricultural production growth are explained by innovations in agricultural production growth itself. This finding demonstrates a strong degree of persistence in the variable's own dynamics. The remaining proportion of the fluctuations is attributable to shocks originating from other variables in the model, including the agricultural commodity exchange. The evolution of these contributions across successive periods provides additional evidence regarding the short- and long-run dynamic interactions between the variables.

Table 3.14. Variance Decomposition of Agricultural Production Growth in the First Model.

Period	S.E.	EXCHANG	SG_
1	0.497739	2.044520	97.95548
		(3.18813)	(3.18813)
2	0.497760	2.047021	97.95298
		(4.55531)	(4.55531)
3	0.499676	2.050797	97.94920
		(5.36931)	(5.36931)
4	0.507756	3.672864	96.32714
		(5.61451)	(5.61451)
5	0.512528	5.402844	94.59716
		(5.68418)	(5.68418)
6	0.516284	6.595392	93.40461

		(5.71887)	(5.71887)
7	0.519142	7.453236	92.54676
		(5.75196)	(5.75196)
8	0.521634	8.305806	91.69419
		(5.75729)	(5.75729)
9	0.524272	9.210268	90.78973
		(5.76162)	(5.76162)
10	0.527049	10.14447	89.85553
		(5.76546)	(5.76546)

Table 3.14 presents the variance decomposition of agricultural production growth across a ten-period horizon. In the first period, 100 percent of the forecast error variance in agricultural production growth is explained by innovations in the variable itself, indicating that its immediate short-run behavior is driven entirely by its own dynamics.

As the forecast horizon expands, the relative contribution of other variables gradually increases. By the tenth period, slightly more than 89 percent of the fluctuations in agricultural production growth continue to be explained by its own innovations, while approximately 10 percent are attributable to the other variables included in the model. In particular, the agricultural commodity exchange accounts for approximately 10 percent of the variation in agricultural production growth over the ten-period horizon.

These results indicate that agricultural production growth is predominantly driven by its own dynamics, especially in the short run. Nevertheless, the contribution of the agricultural commodity exchange becomes more relevant over time, providing additional evidence that its influence on agricultural production growth extends beyond the immediate period and contributes to explaining longer-term fluctuations in the sector (Figure 3.9).

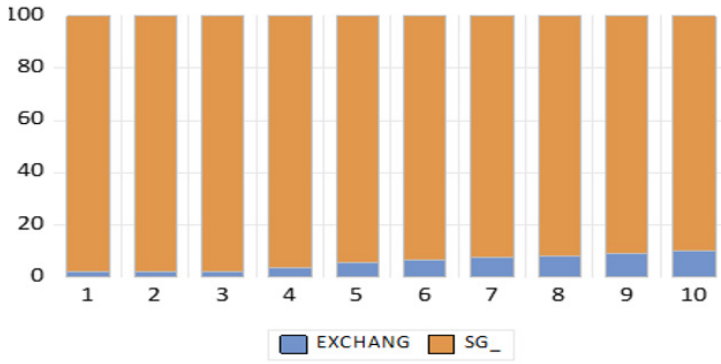


Figure 3.9. Contribution of the Agricultural Commodity Exchange to Changes in Agricultural Production Growth Based on Variance Decomposition.

The results demonstrate that the agricultural commodity exchange plays a significant role in agricultural production growth, with effects that extend across both the short and long run. The regression estimates confirm a statistically significant relationship, while the stability tests indicate that this relationship remains structurally consistent throughout the period analyzed.

The dynamic analysis further shows that changes in the commodity exchange generate significant effects on production growth across successive periods. The error correction mechanism indicates that approximately 36 percent of short-run disequilibrium is corrected in each period, supporting the existence of a gradual adjustment toward long-run equilibrium.

The impulse-response results reveal that shocks associated with the commodity exchange produce temporary fluctuations in agricultural production growth that are progressively absorbed, allowing production to return to a stable trajectory. Finally, variance decomposition confirms that production growth is predominantly explained by its own dynamics, although the contribution of the commodity exchange increases

over time and accounts for approximately 10 percent of its variation by the tenth period. Taken together, these findings support the commodity exchange as a relevant mechanism for strengthening the dynamics and sustained growth of agricultural production.

3.4. Commodity Exchange and the Creation of Agricultural Economic Value

To assess the impact of the agricultural commodity exchange on the economic value added generated by the agricultural sector, a regression model was specified in which agricultural economic value added constitutes the dependent variable and the commodity exchange represents the principal explanatory variable. This model provides the empirical basis for determining whether participation in the commodity exchange contributes significantly to the sector's capacity to generate economic value. The model is expressed as follows:

$$Sg_{i,t} = \beta_0 + \beta_1 * EVA_{i,t} + * e_{i,t}$$

The second regression model examines the relationship between the agricultural commodity exchange and the economic value added generated by the agricultural sector. Agricultural economic value added is specified as the dependent variable, while the commodity exchange constitutes the principal explanatory variable. The estimation results provide evidence regarding the magnitude and statistical significance of the effect of the commodity exchange on agricultural value creation. The results of the second regression model are presented in Table 3.15.

Table 3.15. Results of the Second Regression Model for Agricultural Economic Value Added.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.751843	0.181556	4.141115	0.0001
exchange	6.715240	0.171311	39.19907	0.0000
AR(1)	0.592963	0.112338	5.278374	0.0000

Effects Specification				
R-squared	0.441384	Mean dependent var	7.258769	
Adjusted R-squared	0.426553	SD dependent var	0.953963	
SE of regression	0.722400	Akaike info criterion	2.224819	
Sum squared remainder	58.97045	Schwarz criterion	2.319252	
Log likelihood	-126.1519	Hannan-Quinn criter .	2.263158	
F-statistic	29.76183	Durbin-Watson stat	1.655281	
Prob(F-statistic)	0.000000			

Table 3.15 presents the estimation results for the second regression model. The overall statistical significance of the model was assessed using the F-statistic. The associated probability value is below the 5 percent significance level (P-value < 0.05), indicating that the model is statistically significant as a whole and provides an appropriate basis for evaluating the relationship between the agricultural commodity exchange and agricultural economic value added.

The Durbin–Watson statistic is 1.65, which falls within the commonly accepted range of 1.50 to 2.50 and therefore indicates no evidence of serious first-order serial correlation in the residuals. Furthermore, the coefficient of determination (R^2) is 0.44, indicating that approximately 44 percent of the variation in the economic value added of the agricultural sector is explained by the commodity exchange variable and the specification incorporated into the model.

The coefficient associated with the agricultural commodity exchange is statistically significant, with a probability value of 0.000 (P-value < 0.05). This result provides evidence that the agricultural commodity exchange has a statistically significant effect on the

economic value added generated by the agricultural sector. Taken together, the results support the explanatory relevance of the commodity exchange in agricultural value creation and provide the basis for the subsequent analysis of the dynamic behavior of this relationship (Figure 3.10 and 3.11).

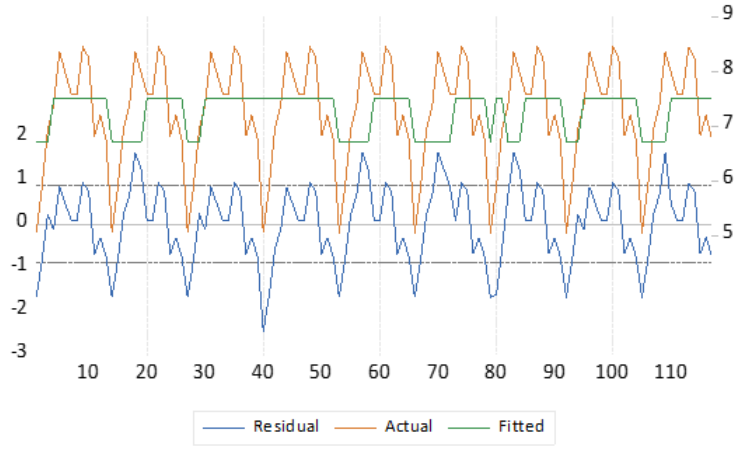


Figure 3.10. Predicted Values of Agricultural Economic Value Added in the Second Regression Model.

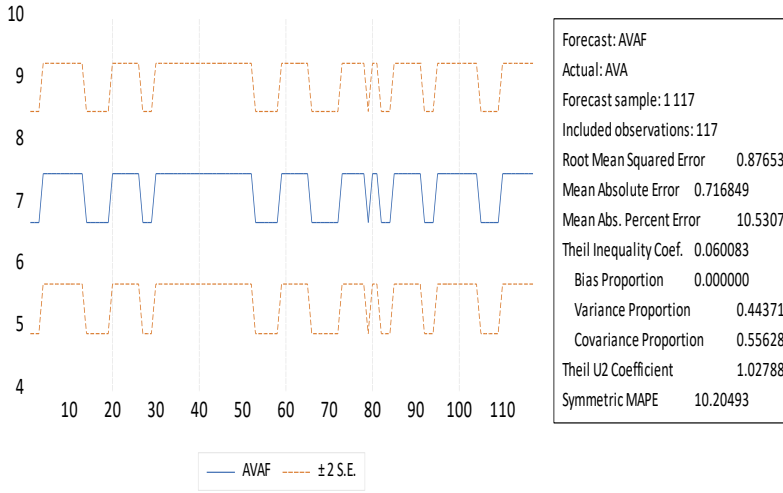


Figure 3.11. Actual, Fitted, and Residual Values of Agricultural Economic Value Added in the Second Regression Model.

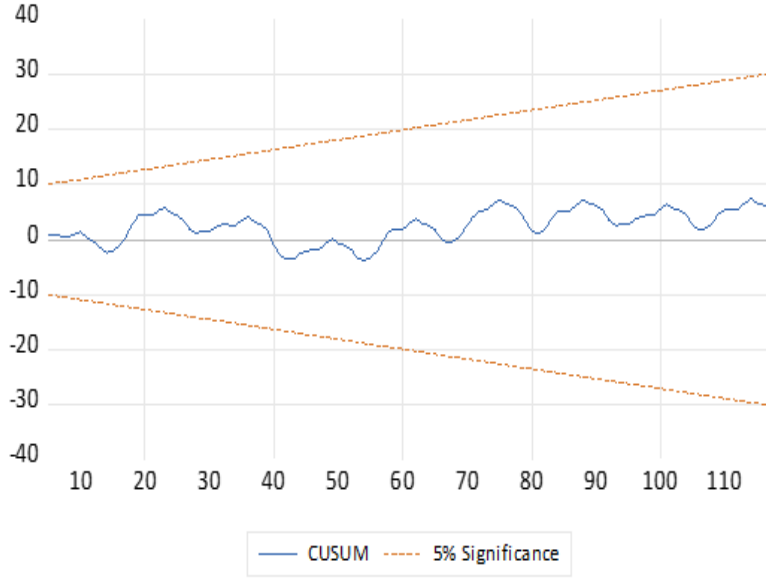


Figure 3.12. CUSUM Test for Structural Stability of the Second Regression Model.

Figure 3.12 shows that the cumulative fluctuations remain within the established critical bounds throughout the period analyzed. This behavior provides evidence of structural stability in the second regression model, indicating that the estimated relationship between the agricultural commodity exchange and the economic value added of the agricultural sector remains stable over time. No significant structural break is therefore detected during the study period. This result supports the temporal stability of the estimated relationship, while the existence of a long-run equilibrium relationship is further assessed through cointegration analysis.

To strengthen the econometric assessment and reduce the possibility of spurious regression, the analysis was subsequently extended to examine the short- and long-run dynamics between the agricultural commodity exchange and agricultural economic value added. For this purpose, cointegration and Granger causality

analysis, error correction modeling, and impulse-response analysis were employed. Together, these procedures make it possible to identify the direction of the dynamic relationships, evaluate short-run adjustments, and determine whether the variables converge toward a stable long-run equilibrium.

Given the existence of a cointegrating relationship between the variables in the second model, the cointegration equation was first estimated to identify the long-run relationship. An Error Correction Model (ECM) was then employed to examine the short-run dynamics and the speed at which deviations from long-run equilibrium are corrected.

The adjustment coefficient measures the proportion of short-run disequilibrium that is corrected in each period and therefore indicates the speed at which the system returns to its long-run equilibrium following a disturbance. This framework integrates short-run adjustments with the long-run relationship between the agricultural commodity exchange and agricultural economic value added, providing a more comprehensive understanding of the dynamics connecting both variables. The estimation results for the second model are presented below.

$$EVA = -4.57 + 3.91 * EXCHANG(-1)$$

The estimated adjustment coefficient associated with the agricultural commodity exchange is 3.91. According to the reported model results, this coefficient reflects the magnitude of the adjustment following a short-run shock and indicates the system's tendency to move back toward its long-run equilibrium path. However, because an adjustment coefficient of 3.91 is unusually large for a conventional error correction mechanism, its magnitude should be interpreted cautiously and verified against the original estimation output before drawing conclusions about the precise speed of convergence.

The error correction term is statistically significant ($T = 8.03 > 1.96$), providing evidence of a significant

adjustment mechanism linking the variables to agricultural economic value added. This finding is consistent with the Granger causality results and supports a causal relationship running from the agricultural commodity exchange toward the economic value added of the agricultural sector. Overall, the results provide evidence that the commodity exchange contributes to the dynamic adjustment of agricultural economic value added toward its long-run equilibrium (Table 3.16).

Table 3.16. Estimated Error Correction Model for Agricultural Economic Value Added.

Cointegration equation	Coefficient
EVA (-1)	1.000000
Exchange _(-1)	3.918843
	(0.48765)
	[8.03623]
C	-4.578770

The unrestricted vector autoregressive (VAR) method was subsequently applied to examine the dynamic relationships between the agricultural commodity exchange and the economic value added of the agricultural sector. Within the VAR framework, all variables are treated as endogenous, meaning that each variable is modeled as a function of its own lagged values and the lagged values of the other variables included in the system.

Selecting the optimal lag length is a critical step in VAR estimation because it directly influences the model's ability to capture the temporal interactions among the variables. Increasing the number of lags may improve explanatory capacity by incorporating additional information from previous periods; however, it also increases the number of parameters to be estimated and consequently reduces the available degrees of freedom. The optimal lag structure must therefore

achieve an appropriate balance between capturing the dynamics of the system and maintaining model parsimony.

Given the interdependent structure of the VAR model, interpretation is complemented by impulse-response functions and variance decomposition analysis. Impulse-response functions trace the magnitude, direction, and persistence of the response of agricultural economic value added to shocks originating from the commodity exchange, whereas variance decomposition determines the relative contribution of these shocks to fluctuations in agricultural economic value added over successive periods. Together, these procedures provide a comprehensive assessment of the short- and long-run dynamics between the agricultural commodity exchange and agricultural economic value added.

Table 3.17. Vector Autoregressive Model Estimation Results for the Second Model.

	Agricultural Economic Value Added (EVA)	Agricultural Commodity Exchange (EXCHANGE)
EVA(-1)	0.703269	0.094570
	(0.09764)	(0.04602)
	[7.20240]	[2.04026]
EVA(-2)		0.091961
	-0.153218	(0.04572)
	(0.09700)	[2.01144]

Table 3.17 presents the short-run dynamic relationships between the variables included in the second model, estimated using the VAR framework with an optimal lag length of two periods. The analysis covers the

2012–2024 period and includes 117 observations. Within each cell, the first value represents the estimated coefficient, the value in parentheses corresponds to the standard error, and the value in brackets represents the t-statistic.

The results indicate that the agricultural commodity exchange has a statistically significant positive effect on the economic value added of the agricultural sector. At the first lag, the t-statistic associated with the commodity exchange variable is 2.04 ($T = 2.04 > 1.96$), indicating a statistically significant positive effect on agricultural economic value added over the one-period horizon. At the second lag, the corresponding t-statistic is 2.01 ($T = 2.01 > 1.96$), confirming that the effect remains statistically significant over the two-period horizon. These findings demonstrate that the influence of the agricultural commodity exchange on agricultural economic value added persists across both lags considered in the model.

The dynamic behavior of this relationship was subsequently examined through impulse-response functions (IRFs), which measure how an endogenous variable responds over time to an unexpected shock affecting another variable within the system. Specifically, an impulse-response function traces the current and future effects of a one-standard-deviation innovation while accounting for the dynamic interactions among the endogenous variables incorporated into the model.

In the second model, impulse-response analysis makes it possible to determine the magnitude, direction, and persistence of the response of agricultural economic value added to shocks originating from the agricultural commodity exchange. This analysis therefore complements the VAR estimates by showing how the effects of commodity exchange shocks are transmitted and evolve across successive periods.

Table 3.18. Response of Agricultural Economic Value Added to Shocks in the Second Model.

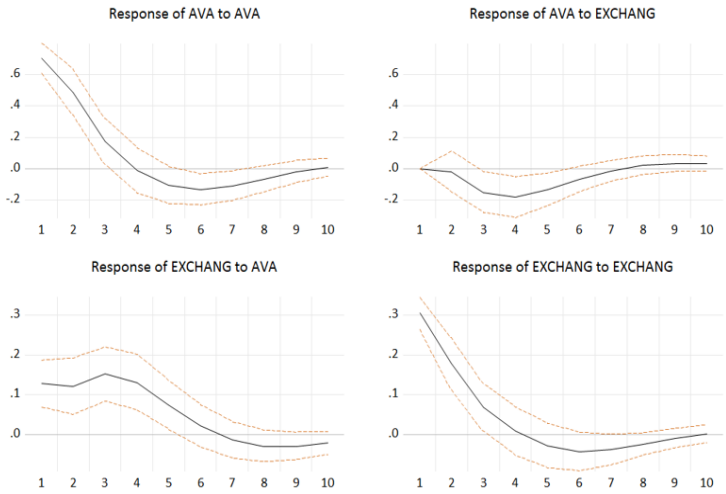
Period	AVA	EXCHANG
1	0.204321	0.000000
	(0.04543)	(0.00000)
2	0.486712	-0.018311
	(0.07308)	(0.04543)
3	0.126204	-0.105833
	(0.07340)	(0.06591)
4	-0.019917	-0.181884
	(0.07144)	(0.06398)
5	-0.105489	-0.133896
	(0.05901)	(0.05334)
6	-0.126604	-0.068133
	(0.04991)	(0.04016)
7	-0.108804	-0.013009
	(0.04336)	(0.03285)
8	-0.064321	0.027509
	(0.04309)	(0.02991)
9	-0.027073	0.035117
	(0.03502)	(0.02778)
10	0.009469	0.031965
	(0.02848)	(0.02386)

Table 3.18 presents the response of agricultural economic value added over a ten-period horizon to shocks originating from the variables included in the second model. The impulse-response analysis measures the effect of a one-standard-deviation innovation in the agricultural commodity exchange on the subsequent behavior of agricultural economic value added.

The results reveal a dynamic response that varies in magnitude and direction across the periods analyzed.

In the first period, a one-standard-deviation shock to the agricultural commodity exchange generates a positive response of 0.046 in agricultural economic value added. The response increases substantially to 0.48 in the second period and remains positive at 0.17 in the third period. In the fourth period, the response becomes slightly negative, reaching -0.01. In the eighth, ninth, and tenth periods, positive responses of 0.021, 0.034, and 0.031 are observed, respectively.

Overall, the results indicate that shocks originating from the agricultural commodity exchange produce a dynamic effect on agricultural economic value added, with the strongest positive response occurring during the initial periods. Although subsequent fluctuations alternate in magnitude and direction, their intensity generally diminishes over time. By the tenth period, the response approaches a stable trajectory, indicating that the effects of the initial commodity exchange shock are progressively absorbed by the system and that agricultural economic value added tends to return toward equilibrium.



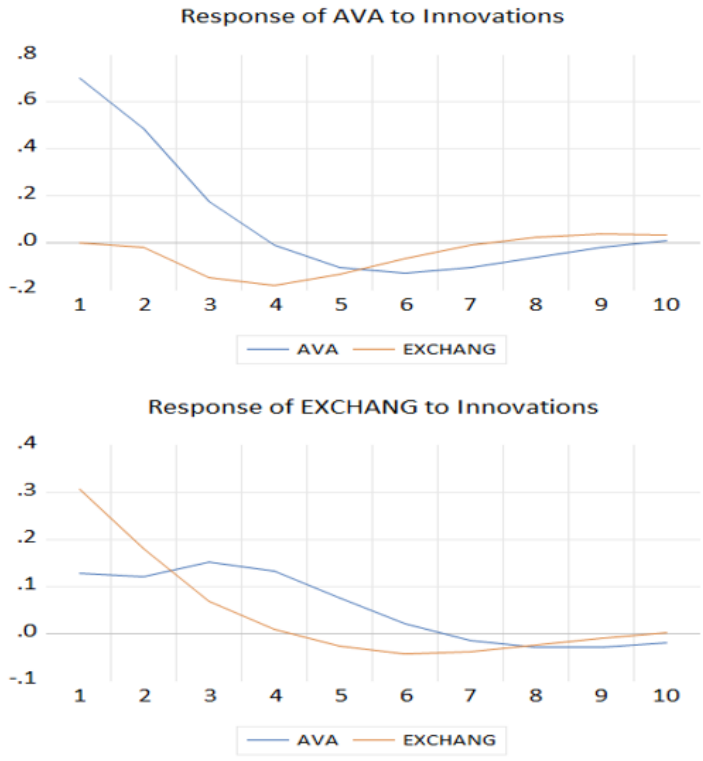


Figure 3.13. Response of Agricultural Economic Value Added to Shocks in the Second Model.

Figure 3.13 shows that agricultural economic value added responds dynamically to shocks originating from the variables included in the second model. During the initial periods, the response exhibits fluctuations of varying magnitude and direction. However, these effects gradually diminish as the forecast horizon expands. By approximately the tenth period, agricultural economic value added converges toward its equilibrium path, indicating that the effects generated by shocks to the agricultural commodity exchange are progressively absorbed. This convergence provides evidence that the variable returns to a stable trajectory following short-run disturbances.

Variance decomposition analysis was subsequently employed to determine the relative contribution of each shock to fluctuations in agricultural economic value

added over time. The results indicate that, in the short run, approximately 90 percent of the fluctuations in agricultural economic value added are explained by innovations in the variable itself. This finding reflects the strong persistence of its own dynamics. The remaining proportion is attributable to shocks originating from the other variables included in the second model, including the agricultural commodity exchange. As the forecast horizon expands, variance decomposition provides evidence of how the relative contribution of commodity exchange shocks evolves in explaining fluctuations in agricultural economic value added.

Table 3.19. Variance Decomposition of Agricultural Economic Value Added in the Second Model.

Period	S.E.	AVA	EXCHANG
1	0.704221	100.0000	0.000000
		(0.00000)	(0.00000)
2	0.856754	99.95432	0.045680
		(0.56063)	(0.56063)
3	0.887299	97.06770	2.932303
		(2.66069)	(2.66069)
4	0.905807	93.15611	6.843893
		(5.05109)	(5.05109)
5	0.921706	91.27985	8.720154
		(6.07004)	(6.07004)
6	0.933544	90.96689	9.033107
		(6.22313)	(6.22313)
7	0.939953	91.07051	8.929494
		(6.14577)	(6.14577)
8	0.942392	91.06482	8.935183
		(6.15867)	(6.15867)
9	0.943257	90.94650	9.053504
		(6.27371)	(6.27371)
10	0.943846	90.84310	9.156902
		(6.38686)	(6.38686)

Table 3.19 presents the variance decomposition of agricultural economic value added over a ten-period horizon. In the first period, 100 percent of the forecast error variance in agricultural economic value added is explained by innovations in the variable itself, indicating that its immediate short-run behavior is driven entirely by its own dynamics.

As the forecast horizon expands, the contribution of shocks originating from other variables gradually increases. By the tenth period, more than 90 percent of the fluctuations in agricultural economic value added continue to be explained by its own innovations, while approximately 10 percent are attributable to the other variables included in the model. In particular, the agricultural commodity exchange accounts for approximately 10 percent of the variation in agricultural economic value added over the ten-period horizon.

These findings indicate that agricultural economic value added is predominantly influenced by its own dynamics, particularly in the short run. Nevertheless, the explanatory contribution of the agricultural commodity exchange becomes more relevant over time. By the tenth period, commodity exchange shocks account for approximately 10 percent of the fluctuations in agricultural economic value added, providing additional evidence of the sustained influence of the commodity exchange on agricultural value creation over the longer-term horizon (Figure 3.14).

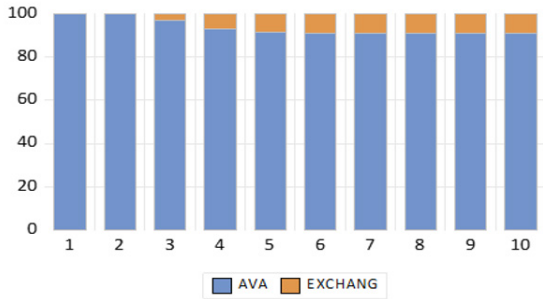


Figure 3.14. Contribution of the Agricultural Commodity Exchange to Changes in Agricultural Economic Value Added Based on Variance Decomposition.

The results demonstrate that the agricultural commodity exchange plays a significant role in agricultural production growth, with effects that extend across both the short and long run. The regression estimates confirm a statistically significant relationship, while the stability tests indicate that this relationship remains structurally consistent throughout the period analyzed.

The dynamic analysis further shows that changes in the commodity exchange generate significant effects on production growth across successive periods. The error correction mechanism indicates that approximately 36 percent of short-run disequilibrium is corrected in each period, supporting the existence of a gradual adjustment toward long-run equilibrium.

The impulse-response results reveal that shocks associated with the commodity exchange produce temporary fluctuations in agricultural production growth that are progressively absorbed, allowing production to return to a stable trajectory. Finally, variance decomposition confirms that production growth is predominantly explained by its own dynamics, although the contribution of the commodity exchange increases over time and accounts for approximately 10 percent of its variation by the tenth period. Taken together, these findings support the commodity exchange as a relevant mechanism for strengthening the dynamics and sustained growth of agricultural production.

3.5. Commodity Exchange as a Catalyst for Agricultural Export Capacity

To assess the contribution of the agricultural commodity exchange to the export capacity of the agricultural sector, a regression model was specified in which agricultural export capacity constitutes the dependent variable and the commodity exchange represents the principal explanatory variable. The model is designed to determine whether participation in the agricultural commodity exchange significantly strengthens the

sector's capacity to access and expand into export markets.

The estimation therefore provides an empirical basis for evaluating the magnitude and statistical significance of the relationship between commodity exchange activity and agricultural export capacity. The model is expressed as follows:

$$LnExpert_{i,t} = \beta_0 + \beta_1 * Exchange_{i,t} + * e_{i,t}$$

The third regression model examines the relationship between the agricultural commodity exchange and the export capacity of the agricultural sector. Agricultural export capacity is specified as the dependent variable, while the commodity exchange constitutes the principal explanatory variable. The estimation makes it possible to determine the magnitude and statistical significance of the commodity exchange's contribution to strengthening the sector's export capacity. The results of the third regression model are presented in Table 3.20.

Table 3.20. Results of the Third Regression Model for Agricultural Export Capacity.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.645346	0.091967	7.017151	0.0000
exchange	0.096281	0.046967	2.049978	0.0417
AR(1)	0.693131	0.049636	13.96435	0.0000
Effects Specification				
R-squared	0.470141	Mean dependent var	0.737864	
Adjusted R -squared	0.462271	SD dependent var	0.440868	
SE of regression	0.323288	Akaike info criterion	0.598681	
Sum squared remainder	21.11207	Schwarz criterion	0.663300	
Log likelihood	-57.66410	Hannan-Quinn criter .	0.624815	

F-statistic	59.74441	Durbin-Watson stat	1.943634	
Prob(F-statistic)	0.000000			

Table 3.20 presents the estimation results for the third regression model. The overall statistical significance of the model was assessed using the F-statistic. The associated probability value is below the 5 percent significance level (P-value < 0.05), indicating that the model is statistically significant as a whole and provides an appropriate basis for evaluating the relationship between the agricultural commodity exchange and agricultural export capacity.

The Durbin–Watson statistic is 1.94, which falls within the commonly accepted range of 1.50 to 2.50 and therefore indicates no evidence of serious first-order serial correlation in the residuals. Furthermore, the coefficient of determination (R^2) is 0.470, indicating that approximately 47 percent of the variation in agricultural export capacity is explained by the commodity exchange variable and the specification incorporated into the model.

The coefficient associated with the agricultural commodity exchange is statistically significant, with a probability value of 0.041 (P-value < 0.05). This result provides evidence that the agricultural commodity exchange has a statistically significant effect on the export capacity of the agricultural sector. Taken together, the findings indicate that commodity exchange activity contributes to explaining variations in agricultural export capacity and support its relevance as a mechanism for strengthening the sector's export performance (Figure 3.15 and 3.16).

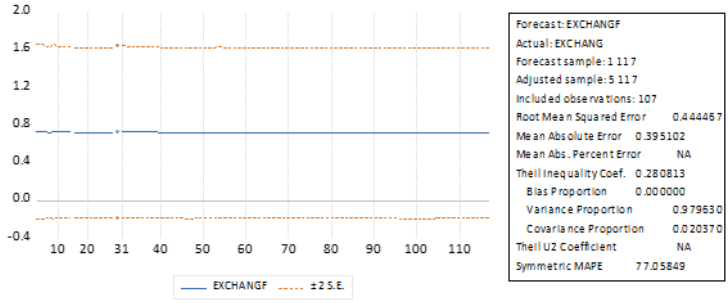


Figure 3.15. Predicted Values of Agricultural Export Capacity in the Third Regression Model.

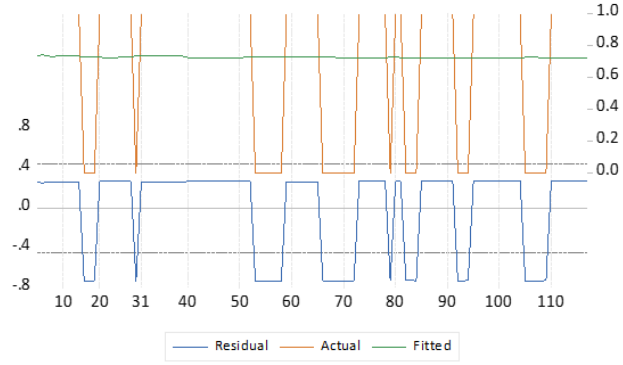


Figure 3.16. Actual, Fitted, and Residual Values of Agricultural Export Capacity in the Third Regression Model.

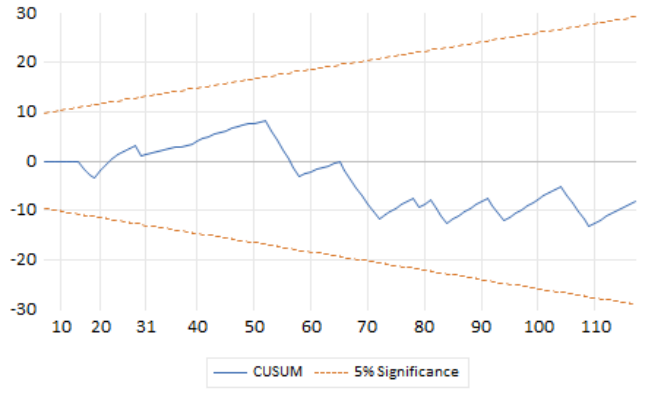


Figure 3.17. CUSUM Test for Structural Stability of the Third Regression Model.

Figure 3.17 shows that the fluctuations in agricultural export capacity remain within the established critical bounds throughout the period analyzed. This behavior provides evidence of structural stability in the third regression model, indicating that the estimated relationship between the agricultural commodity exchange and agricultural export capacity remains stable over time. No significant structural break is therefore detected during the study period. This result supports the temporal stability of the estimated relationship, while the existence of a long-run equilibrium relationship is further assessed through cointegration analysis.

To strengthen the econometric assessment and reduce the possibility of spurious regression, the analysis was subsequently extended to examine the short- and long-run dynamics between the agricultural commodity exchange and agricultural export capacity. For this purpose, cointegration and Granger causality analysis, error correction modeling, vector autoregressive analysis, and impulse-response functions were employed. Impulse-response functions measure how agricultural export capacity responds over successive periods to an unexpected shock originating from the commodity exchange or another variable within the system.

Given the existence of a cointegrating relationship between the variables in the third model, the cointegration equation was first estimated to identify the long-run equilibrium relationship. An Error Correction Model (ECM) was then employed to examine the short-run dynamics and determine the speed at which temporary deviations from long-run equilibrium are corrected.

The adjustment coefficient in the ECM measures the proportion of disequilibrium corrected in each period following a short-run disturbance. It therefore provides information on how rapidly agricultural export capacity moves back toward its long-run equilibrium path after a shock. By combining the long-run cointegrating relationship with short-run adjustments, the model

provides a comprehensive assessment of the dynamic relationship between the agricultural commodity exchange and agricultural export capacity. The estimation results for the third model are presented below.

$$LnExpert = -0827 + 0.08 * EXCHANG(-1)$$

The estimated adjustment coefficient associated with the agricultural commodity exchange is 0.08, indicating that approximately 8 percent of the disequilibrium generated by a short-run shock is corrected in each period. This adjustment process shows that deviations from the long-run equilibrium are progressively absorbed over time, allowing agricultural export capacity to return toward its long-run trajectory following temporary disturbances.

The error correction term is statistically significant (T = 3.93 > 1.96), providing evidence of a significant long-run adjustment mechanism between the agricultural commodity exchange and agricultural export capacity. This result is consistent with the Granger causality findings and supports the existence of a causal relationship running from the agricultural commodity exchange toward the export capacity of the agricultural sector. Taken together, the results indicate that commodity exchange activity contributes not only to short-run variations in agricultural export capacity but also to the process through which the sector adjusts toward its long-run equilibrium (Table 3.21).

Table 3.21. Estimated Error Correction Model for Agricultural Export Capacity.

Cointegration equation	Coefficient
EXCHANGE(- 1)	1.000000
LnExpert _(-1)	0.081433
	(0.02696)
	[3.93648]
C	-0.827868

The unrestricted vector autoregressive (VAR) method was subsequently applied to examine the dynamic relationships between the agricultural commodity exchange and agricultural export capacity. Within the VAR framework, all variables are treated as endogenous, meaning that each variable is modeled as a function of its own lagged values and the lagged values of the other variables incorporated into the system.

Selecting the optimal lag length is a critical step in VAR estimation because it determines how effectively the model captures the temporal interactions among the variables. Increasing the number of lags may improve the model's explanatory capacity by incorporating information from additional previous periods. However, an excessive number of lags increases the number of parameters to be estimated and reduces the available degrees of freedom. The appropriate lag structure must therefore balance the representation of dynamic relationships with model parsimony and estimation efficiency.

Given the interdependent structure of the VAR model, the estimated coefficients are complemented by impulse-response functions and variance decomposition analysis. Impulse-response functions trace the magnitude, direction, and persistence of changes in agricultural export capacity following shocks to the agricultural commodity exchange, while variance decomposition determines the relative contribution of these shocks to fluctuations in agricultural export capacity over successive periods. Together, these techniques provide a more comprehensive assessment of the dynamic relationship between commodity exchange activity and the export capacity of the agricultural sector. The VAR estimation results for the third model are presented in Table 3.22.

Table 3.22. Vector Autoregressive Model Estimation Results for the Third Model.

	EXCHANGE	Ln_Expert _
	0.740544	0.141445
EXCHANGE(-1)	(0.10300)	(0.06227)
	[7.18964]	[2.33190]
EXCHANGE(-2)	-0.114970	0.178101
	(0.10180)	(0.04061)
	[-1.12934]	4.25662]

Table 3.22 presents the short-run dynamic relationships between the variables included in the third model, estimated using the VAR framework with an optimal lag length of two periods. The analysis covers the 2012–2024 period and includes 117 observations. Within each cell, the first value represents the estimated coefficient, the value in parentheses corresponds to the standard error, and the value in brackets represents the t-statistic.

The results indicate that the agricultural commodity exchange has a statistically significant positive effect on agricultural export capacity. At the first lag, the t-statistic associated with the commodity exchange variable is 2.33 (T = 2.33 > 1.96), indicating a statistically significant positive effect over the one-period horizon. At the second lag, the corresponding t-statistic increases to 4.25 (T = 4.25 > 1.96), confirming that the effect remains statistically significant and becomes stronger over the two-period horizon. These findings provide evidence that the influence of the agricultural commodity exchange on agricultural export capacity persists across both lags considered in the model.

The dynamic behavior of this relationship was subsequently examined through impulse-response functions (IRFs). An impulse-response function traces the response of an endogenous variable over time following an unexpected innovation or shock within the VAR system. In this analysis, the functions measure

the current and future response of agricultural export capacity to a one-standard-deviation shock originating from the agricultural commodity exchange.

This approach makes it possible to identify the magnitude, direction, persistence, and eventual dissipation of the effects generated by commodity exchange shocks. It therefore complements the VAR estimates by providing a dynamic representation of how agricultural export capacity responds and adjusts across successive periods (Table 3.23).

Table 3.23. Response of Agricultural Export Capacity to Shocks in the Third Model.

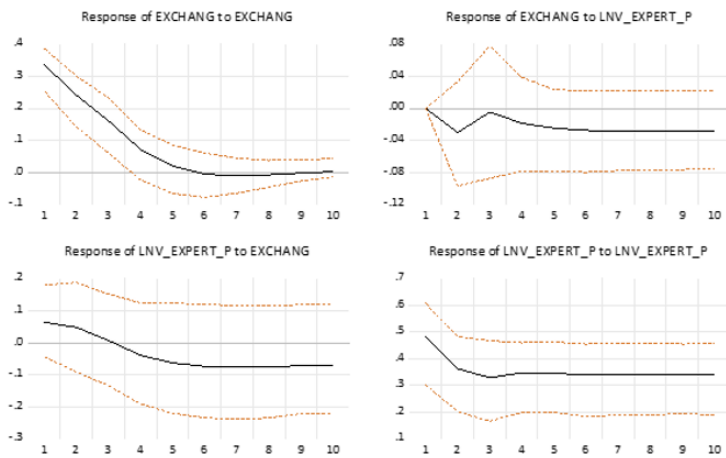
Period	EXCHANG	LNV_EXPERT_P
1	0.036994	0.481500
	(0.00333)	(0.00627)
2	0.048451	0.353328
	(0.00467)	(0.00521)
3	0.072908	0.339414
	(0.00535)	(0.00562)
4	-0.038875	0.348616
	(0.00673)	(0.00440)
5	-0.062754	0.345651
	(0.00801)	(0.00453)
6	-0.033616	0.340915
	(0.00845)	(0.00427)
7	-0.075940	0.341168
	(0.00832)	(0.00444)
8	-0.074202	0.341336
	(0.00809)	(0.00458)
9	-0.075009	0.341310
	(0.00783)	(0.00461)
10	-0.069994	0.341498

Table 3.23 presents the response of agricultural export capacity over a ten-period horizon to shocks originating from the variables included in the third model. The impulse-response analysis measures the effect of a

one-standard-deviation innovation in the agricultural commodity exchange on the subsequent behavior of agricultural export capacity.

The results reveal a positive and persistent response throughout the periods analyzed. In the first period, a one-standard-deviation shock to the agricultural commodity exchange generates an increase of 0.48 in agricultural export capacity. The response remains positive in the second and third periods, with increases of 0.36 and 0.32, respectively. In the fourth period, the response reaches 0.34. From the fifth period onward, the effect stabilizes at approximately 0.34, indicating that the response becomes increasingly persistent and converges toward a stable level.

Overall, the results indicate that shocks originating from the agricultural commodity exchange exert a sustained positive effect on agricultural export capacity. The adjustment is particularly pronounced during the first five periods, after which the magnitude of the response stabilizes. This pattern suggests that the effects of commodity exchange shocks are not merely transitory but persist over the ten-period horizon, providing additional evidence of the commodity exchange's contribution to strengthening the export capacity of the agricultural sector (Figure 3.18).



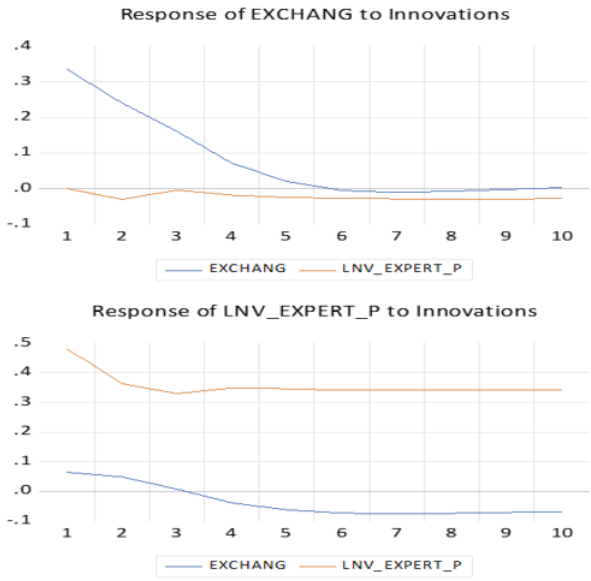


Figure 3.18. Impulse-Response Functions Between the Agricultural Commodity Exchange and Agricultural Export Capacity.

The impulse-response results show that the effects of shocks originating from the agricultural commodity exchange gradually stabilize over the forecast horizon. By approximately the tenth period, fluctuations in agricultural export capacity converge toward a stable trajectory, indicating that the dynamic response to commodity exchange shocks becomes increasingly stable over time. This pattern suggests that the system progressively absorbs the initial disturbances and approaches its long-run equilibrium path.

Variance decomposition analysis was subsequently employed to determine the relative contribution of different shocks to fluctuations in agricultural export capacity. The results presented in Table 3.24 indicate that, in the short run, approximately 97 percent of the forecast error variance in agricultural export capacity is explained by innovations in the variable itself. This finding reflects the strong persistence of agricultural export capacity and the predominance of its own dynamics during the initial periods.

The remaining proportion is attributable to shocks originating from other variables in the third model, including the agricultural commodity exchange. Examining how these contributions evolve across successive periods makes it possible to determine whether the explanatory importance of commodity exchange shocks increases as the forecast horizon expands.

Table 3.24. Variance Decomposition of Agricultural Export Capacity in the Third Model.

Period	S.E.	EXCHANG	LNV_EXPERT_P
1	0.485739	1.735690	98.26431
2	0.608553	1.739692	98.26031
3	0.692027	1.356159	98.64384
4	0.775852	1.330007	98.66999
5	0.851680	1.646625	98.35338
6	0.920327	2.049964	97.95004
7	0.984461	2.386687	97.61331
8	1.044592	2.624409	97.37559
9	1.101263	2.782895	97.21711
10	1.155082	2.890531	97.10947

Table 3.24 presents the variance decomposition of agricultural export capacity over a ten-period horizon. In the first period, 100 percent of the forecast error variance in agricultural export capacity is explained by innovations in the variable itself, indicating that its immediate short-run behavior is entirely dominated by its own dynamics.

As the forecast horizon expands, agricultural export capacity continues to account for the predominant share of its forecast error variance. By the tenth period, more than 97 percent of the fluctuations in agricultural export capacity are explained by its own innovations, while approximately 3 percent are attributable to shocks originating from the other variables included in the third model.

In particular, the agricultural commodity exchange accounts for approximately 3 percent of the variation in agricultural export capacity by the tenth period. Although this contribution is relatively modest compared with the variable's own dynamics, it indicates that commodity exchange shocks retain explanatory power over the longer-term horizon. These results therefore suggest that agricultural export capacity is characterized by strong internal persistence, while the agricultural commodity exchange provides an additional, albeit smaller, contribution to explaining its fluctuations over time (Figure 3.19).

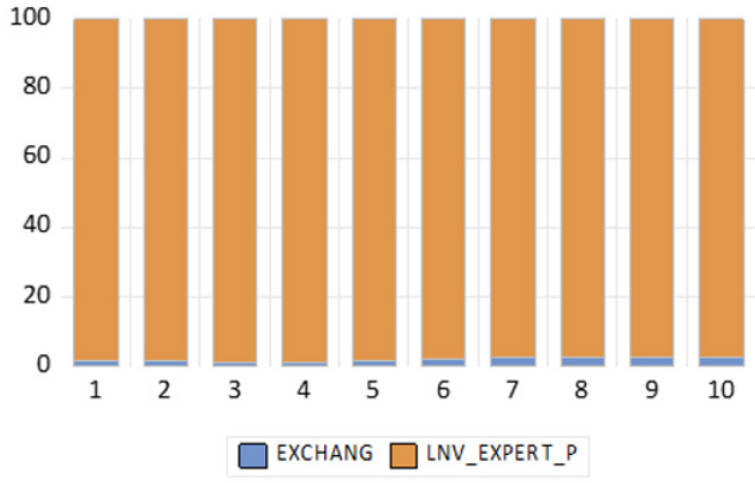


Figure 3.19. Contribution of the Agricultural Commodity Exchange to Changes in Agricultural Export Capacity Based on Variance Decomposition.

The findings indicate that the agricultural commodity exchange can enhance the sector's ability to participate more effectively in external markets. Beyond its immediate commercial function, the exchange appears to create conditions that favor greater export potential, providing an institutional mechanism capable of supporting the international projection of agricultural production.

The temporal evidence suggests that this contribution is not confined to an isolated period. Adjustments

following short-term disturbances are gradually incorporated into the system, while the significant error correction mechanism demonstrates that export capacity maintains a connection with its longer-term trajectory.

A particularly relevant finding is the persistence of the response to commodity exchange shocks. Rather than disappearing rapidly, their influence remains positive throughout the analyzed horizon and reaches a comparatively stable level after the initial adjustment periods. At the same time, export capacity exhibits strong internal persistence, with the exchange explaining a smaller but identifiable proportion of its longer-term fluctuations. These results suggest that strengthening commodity exchange mechanisms can complement broader agricultural policies aimed at improving market access, commercial organization, and the sustained international competitiveness of the agricultural sector.

CONCLUSIONS

The present study examined the role of the agricultural commodity exchange in the development and economic performance of the agricultural sector in Iran during the 2011–2024 period. The analysis was designed to determine whether the operation of an organized commodity market is associated with significant changes in agricultural production growth, economic value added, and export capacity. These dimensions provide complementary perspectives on agricultural development because they capture changes in productive performance, economic value creation, and the sector's capacity to participate in broader markets.

The study was conducted within the specific economic and institutional context of Iran, where agriculture occupies an important position in national production, employment, food supply, rural development, and trade. Within this environment, the agricultural commodity exchange represents more than a mechanism for buying and selling products. It constitutes an organized market structure through which agricultural commodities can be commercialized under more standardized conditions, potentially contributing to greater transparency, improved price discovery, reduced information asymmetries, and stronger connections between producers, traders, processors, and other market participants.

The empirical analysis considered agricultural products admitted to and physically traded through the commodity exchange and examined their relationship with major indicators of agricultural-sector performance. Information on agricultural production, exports, gross domestic product, and economic value added was obtained from official Iranian

statistical and agricultural sources, including the National Statistics Portal and the Ministry of Agricultural Jihad. The integration of commodity exchange information with national agricultural indicators provided the empirical basis for evaluating the contribution of organized commodity trading to the development of Iran's agricultural sector.

A comprehensive econometric strategy was employed to strengthen the reliability of the findings. In addition to descriptive statistics and regression estimation, the analysis incorporated tests of normality, stationarity, autocorrelation, homogeneity of variance, cointegration, and structural stability. Dynamic relationships were further examined through error correction modeling, vector autoregressive models, impulse-response functions, and variance decomposition. The combination of these methods made it possible to move beyond the identification of contemporaneous statistical relationships and examine how the effects evolve, persist, and adjust over time.

The overall results provide evidence that the agricultural commodity exchange is significantly related to the three dimensions of agricultural performance examined in Iran. Nevertheless, the magnitude and dynamic characteristics of these relationships differ across agricultural production growth, economic value added, and export capacity. This distinction is important because it demonstrates that commodity exchange development does not affect all components of agricultural performance in exactly the same manner.

The first empirical model examined the relationship between the agricultural commodity exchange and agricultural production growth. The results showed that the coefficient associated with the commodity exchange is statistically significant (P-value = 0.000 < 0.05). This provides evidence of a significant relationship between commodity exchange activity and agricultural production growth in Iran.

The coefficient of determination (R^2 = 0.436) indicates that approximately 43.6 percent of the variation in agricultural production growth is explained by the estimated model. This represents a substantial explanatory capacity and suggests that commodity exchange activity constitutes a relevant component in understanding changes in agricultural production during the period analyzed.

The dynamic results reinforce the regression findings. The vector autoregressive analysis showed that the agricultural commodity exchange has a statistically significant positive effect at both the first and second lags. The t-statistic associated with the commodity exchange was 3.32 at the first lag and 5.60 at the second lag, both exceeding the critical value of 1.96. These results indicate that the relationship between commodity exchange activity and agricultural production growth persists across successive periods rather than being limited to an immediate effect.

Impulse-response analysis provided additional evidence regarding the temporal behavior of this relationship. Shocks originating from the agricultural commodity exchange generated measurable responses in agricultural production growth, although the magnitude and direction of the responses varied during the initial periods. As the forecast horizon expanded, these fluctuations progressively approached a more stable trajectory, indicating that the effects of the initial shock were gradually absorbed by the agricultural system.

Variance decomposition further showed that agricultural production growth is predominantly determined by its own dynamics. Nevertheless, the contribution of the agricultural commodity exchange increases over time and accounts for approximately 10 percent of the variation in agricultural production growth by the tenth period. Consequently, although internal production dynamics remain dominant, commodity exchange

activity retains a meaningful explanatory contribution over the longer forecast horizon.

These results are particularly important in the Iranian context because the agricultural commodity exchange may influence production through several interconnected market mechanisms. Greater transparency in agricultural transactions can improve the information available to producers, while more organized price formation can provide clearer signals regarding market demand and expected returns. Improved commercialization conditions may also reduce uncertainty and facilitate production planning. Consequently, the relationship identified in the empirical models may reflect not only the direct effect of exchange transactions but also broader improvements in market organization.

Previous research has predominantly examined the relationship between financial-market or capital-market development and economic growth rather than specifically addressing agricultural commodity exchanges and agricultural production. Nevertheless, the existing literature provides evidence that organized financial and market institutions (Algaeed, 2021; Bello et al., 2022; Chang and Li, 2024) can influence productive and economic performance (Huda et al., 2023; Lenee & Oki, 2017; Nuhiu & Hoti, 2011). The present study extends this discussion by providing evidence specifically related to the agricultural commodity exchange and production dynamics within Iran.

The second empirical model examined the relationship between the agricultural commodity exchange and the economic value added generated by Iran's agricultural sector. The results showed a statistically significant relationship (P-value = 0.000 < 0.05), confirming the relevance of commodity exchange activity to agricultural value creation.

The coefficient of determination (R^2 = 0.44) indicates that approximately 44 percent of the variation in agricultural economic value added is explained by the

estimated model. This finding is particularly significant because agricultural development cannot be assessed exclusively through increases in physical production. The capacity of agriculture to generate economic value represents another fundamental dimension of sectoral performance.

The short-run VAR results further demonstrated that the agricultural commodity exchange has statistically significant effects across the first two lags. The corresponding t-statistics of 2.04 and 2.01 exceeded the critical value of 1.96. This indicates that the relationship persists beyond the contemporaneous period and that commodity exchange activity is dynamically associated with agricultural economic value added.

The impulse-response analysis showed that agricultural economic value added responds to shocks originating from the commodity exchange across successive periods. The response was positive during several of the initial periods, although some temporary fluctuations were observed. Over time, the magnitude of these fluctuations diminished and the response approached a stable trajectory, suggesting a gradual adjustment following the initial disturbance.

Variance decomposition provides further insight into this relationship. Agricultural economic value added is predominantly explained by its own innovations, particularly in the initial periods. However, the contribution of the agricultural commodity exchange becomes more visible as the forecast horizon expands. By the tenth period, commodity exchange activity accounts for approximately 10 percent of the variation in agricultural economic value added.

The economic significance of this finding extends beyond agricultural production itself. A more organized commodity market may contribute to value creation by improving commercialization conditions, increasing transparency, facilitating product standardization, strengthening connections among market participants,

and potentially reducing transaction inefficiencies. These mechanisms can increase the capacity of agricultural activity to generate economic value even when changes in physical production are comparatively limited.

The findings are consistent with previous studies that have identified important relationships between market development, financial institutions, value creation, and economic performance (Shahabadi et al., 2017). The contribution of the present study is to extend this relationship specifically to the agricultural commodity exchange and to demonstrate its relevance within the institutional and economic conditions of Iran's agricultural sector.

The third empirical model examined the relationship between the agricultural commodity exchange and the export capacity of Iran's agricultural sector. The estimated commodity exchange coefficient was statistically significant (P-value = 0.041 < 0.05), providing evidence that commodity exchange activity is significantly associated with agricultural export capacity.

The coefficient of determination (R^2 = 0.470) indicates that approximately 47 percent of the variation in agricultural export capacity is explained by the estimated model. Among the three regression models considered in the study, this represents the highest coefficient of determination. Nevertheless, the subsequent dynamic analysis demonstrates that export capacity is also characterized by strong internal persistence.

The VAR analysis revealed statistically significant positive effects of the commodity exchange at both the first and second lags. The t-statistic reached 2.33 during the first lag and increased to 4.25 during the second lag. These findings indicate that the effect of commodity exchange activity on agricultural export capacity persists across successive periods and is not restricted to an immediate market response.

Impulse-response analysis further showed that a one-standard-deviation shock originating from the agricultural commodity exchange produces a positive response in agricultural export capacity. The response remained positive throughout the periods analyzed and became increasingly stable after the initial adjustment. This suggests that commodity exchange shocks can produce persistent effects on the capacity of agricultural products to participate in broader markets.

The variance decomposition results, however, reveal an important difference between export capacity and the other dimensions examined. Agricultural export capacity is characterized by particularly strong internal persistence. By the tenth period, more than 97 percent of its forecast error variance is explained by its own innovations, while approximately 3 percent is attributable to commodity exchange shocks.

Although the 3 percent contribution is comparatively smaller than the approximately 10 percent observed for agricultural production growth and economic value added, it should not be interpreted as evidence that the commodity exchange is irrelevant to agricultural exports. The regression results and VAR estimates demonstrate statistically significant relationships. Rather, the variance decomposition indicates that export capacity depends on a wider range of forces and possesses stronger internal dynamics.

This result is particularly understandable within the Iranian context. Agricultural export performance can be influenced by international demand, exchange-rate movements, transportation costs, logistics infrastructure, border procedures, export regulations, quality standards, certification requirements, international agricultural prices, access to destination markets, and broader external economic conditions. The agricultural commodity exchange therefore constitutes one component of a considerably broader system determining export performance.

The contribution of the commodity exchange may nevertheless be strategically important. Greater product standardization, transparent price formation, improved market information, traceability, and more organized commercialization can facilitate the conditions necessary for agricultural products to become more competitive and better prepared for participation in international markets.

Taken together, the results of the three models reveal a consistent but differentiated pattern. The agricultural commodity exchange is significantly associated with agricultural production growth, economic value added, and export capacity in Iran. However, the strength and dynamic contribution of the exchange differ according to the dimension of agricultural development considered.

The results suggest a comparatively stronger longer-horizon contribution to agricultural production growth and economic value added, for which commodity exchange shocks account for approximately 10 percent of the variation by the tenth period. In contrast, the corresponding contribution to agricultural export capacity is approximately 3 percent. This difference indicates that the mechanisms connecting the commodity exchange with domestic agricultural performance may be more direct than those connecting it with international market participation.

Production growth can respond to improved market signals, greater commercialization opportunities, and more predictable market conditions. Economic value added can similarly benefit from improvements in commercialization, coordination, standardization, and market efficiency. Export capacity, however, depends not only on domestic market organization but also on numerous external factors that may lie beyond the direct influence of the commodity exchange.

The structural stability results strengthen the overall interpretation of the findings. The estimated relationships remained within the corresponding critical

bounds, providing no evidence of major structural instability in the models during the period analyzed. This suggests that the estimated relationships were not driven exclusively by isolated episodes or temporary structural disruptions.

The cointegration and error correction analyses also provide evidence of dynamic adjustment toward long-run equilibrium. Consequently, the relationships identified in the study should not be interpreted solely as contemporaneous correlations. The combined evidence from regression estimation, VAR analysis, impulse-response functions, variance decomposition, structural stability, and error correction modeling demonstrates that the agricultural commodity exchange is embedded within broader temporal relationships affecting agricultural-sector performance.

From a wider economic perspective, the findings support the interpretation of the agricultural commodity exchange as an institutional mechanism capable of contributing to agricultural modernization in Iran. Its importance derives not only from the volume of transactions conducted through the market but also from its potential contribution to transparency, information dissemination, price discovery, product standardization, commercialization, and coordination among agricultural market participants.

The findings have important implications for agricultural policy and commodity-market development in Iran. Since the agricultural commodity exchange is significantly associated with production growth, economic value added, and export capacity, strengthening the institutional conditions under which the exchange operates could contribute to improving agricultural-sector performance.

One priority should be to promote greater participation by agricultural producers. The benefits of an organized commodity exchange cannot be fully realized if participation remains concentrated among a limited

number of large producers, traders, or intermediaries. Farmers, cooperatives, producer associations, processors, and other agricultural actors should have adequate opportunities to access the exchange and understand its mechanisms.

Special attention should be given to small and medium-sized agricultural producers, who may face greater barriers related to information, transaction costs, transportation, minimum trading volumes, quality requirements, or limited knowledge of exchange procedures. Training and technical assistance programs could improve their understanding of pricing mechanisms, product standards, contractual conditions, market information, and the potential benefits and risks associated with commodity exchange participation.

Another priority is the prevention of excessive market concentration. The positive contribution of the commodity exchange to agricultural development may be weakened when monopolistic or highly concentrated market structures allow a limited number of participants to influence prices or restrict access. Regulatory authorities should therefore promote competitive conditions and monitor market behavior to ensure that the exchange functions as a transparent mechanism rather than reproducing existing market inequalities.

The results concerning agricultural production growth indicate that market organization should be incorporated into broader agricultural production policies. Production incentives are more effective when producers have access to reliable commercialization channels and transparent market information. Strengthening the connection between production planning and market signals could therefore help reduce mismatches between supply and demand and improve the allocation of agricultural resources.

The significant relationship with agricultural economic value added demonstrates that agricultural policy should not focus exclusively on increasing production

volumes. Greater attention should be directed toward the capacity of agriculture to generate value throughout the production and commercialization chain. Storage, processing, grading, packaging, quality control, transportation, and commercialization can substantially influence the final economic value generated by agricultural activity.

Investment in market infrastructure is consequently essential. The effective operation of an agricultural commodity exchange depends on adequate warehouses, storage facilities, transportation systems, product grading mechanisms, quality laboratories, digital platforms, settlement systems, and reliable market information. Weaknesses in any of these areas can reduce the capacity of the exchange to transmit its benefits to agricultural producers.

Product standardization should also receive particular attention. Standardized quality specifications facilitate transparent transactions because buyers and sellers can operate under clearly defined product characteristics. This is particularly important for agricultural products, whose quality can vary substantially depending on production, storage, and transportation conditions.

The significant relationship with export capacity also suggests the need for stronger coordination between commodity exchange development and Iranian agricultural export policy. Products with demonstrated production potential and adequate quality could be connected more systematically with export promotion initiatives. Such coordination should include product certification, traceability, packaging standards, logistics, market intelligence, and identification of potential destination markets.

The comparatively smaller contribution of commodity exchange shocks to export-capacity variance indicates that exchange development alone cannot guarantee stronger agricultural exports. Policies directed toward commodity-market development should therefore be

coordinated with exchange-rate policy, trade facilitation, transportation infrastructure, export regulations, international marketing, quality certification, and other components of export competitiveness.

Greater digitalization could further increase the reach and efficiency of the agricultural commodity exchange. Digital trading systems can facilitate access to price information, reduce geographical barriers, improve transaction speed, increase transparency, and potentially broaden producer participation. Digital infrastructure should therefore form part of the long-term strategy for commodity-market modernization in Iran.

Policymakers should also develop a broader framework for evaluating commodity exchange performance. Transaction volume and transaction value are important indicators, but they do not fully capture the economic contribution of the exchange. Performance assessment should additionally consider agricultural production growth, economic value added, producer participation, price transparency, transaction costs, export capacity, market concentration, and the stability of commercialization channels.

The results of this study consequently support an integrated approach in which the agricultural commodity exchange is treated as part of agricultural development policy rather than as an isolated financial or trading institution. Its effectiveness ultimately depends on its connection with production systems, logistics, quality infrastructure, agricultural organizations, processing activities, export mechanisms, and public agricultural policy.

The findings open several avenues for future research. First, subsequent studies should extend the temporal horizon as new information becomes available. A longer time series would make it possible to determine whether the relationships identified during 2011–2024 remain

stable as Iran's agricultural commodity exchange and agricultural economy continue to evolve.

Future research could also examine the effects of commodity exchange participation separately across different agricultural subsectors. Livestock, horticulture, crop farming, and aquaculture possess distinct production cycles, cost structures, commercialization requirements, storage possibilities, and exposure to market risk. Estimating separate models could reveal whether the effects identified in the present study are concentrated in particular areas of Iranian agriculture.

Product-level analysis represents another important research direction. The present results provide evidence at a broader sectoral level, but individual agricultural commodities may respond differently to exchange participation. Future studies could compare products according to perishability, production volume, price volatility, storage requirements, geographic concentration, domestic demand, and export orientation.

Further studies should also investigate the mechanisms through which commodity exchange activity affects agricultural performance. Rather than focusing exclusively on whether an effect exists, future research could examine whether the observed relationships operate through price transparency, lower transaction costs, reduced information asymmetry, improved product standardization, stronger bargaining conditions, better market access, or more efficient commercialization.

The export dimension deserves particularly detailed investigation. Future research could determine whether commodity exchange participation contributes to export diversification, entry into new destination markets, improved product quality, more stable export revenues, or greater international competitiveness.

Additional macroeconomic and sectoral variables could also be incorporated into future models. Inflation, exchange rates, agricultural credit, input costs,

international commodity prices, climatic conditions, water availability, transportation costs, technological adoption, trade policies, and external economic conditions may help explain additional variation in agricultural performance.

Comparative international research would also be valuable. Comparing Iran with countries possessing more mature or differently structured agricultural commodity exchanges could help identify the institutional characteristics that determine successful commodity-market development. Such research could examine differences in regulation, infrastructure, producer participation, digitalization, product standardization, and connections with international markets.

Future studies could additionally investigate the distributional effects of commodity exchange development. A significant aggregate relationship does not necessarily mean that all agricultural participants benefit equally. Research should determine whether the economic benefits are distributed among small farmers, cooperatives, medium-sized producers, large agricultural enterprises, processors, intermediaries, and exporters.

Another promising research direction concerns regional differences within Iran. Agricultural production conditions vary considerably across regions because of differences in climate, water availability, infrastructure, specialization, market access, and proximity to transportation networks. Regional analysis could reveal whether commodity exchange development produces different outcomes across agricultural territories.

Finally, future research could incorporate qualitative evidence from farmers, cooperatives, traders, exporters, exchange administrators, and policymakers. Combining econometric evidence with interviews or surveys would provide a deeper understanding of the institutional mechanisms underlying the statistical relationships identified in this study.

The findings should be interpreted in light of several limitations. The first concerns the temporal scope of the analysis. The study covers the 2011–2024 period. Although this period provides a substantial basis for examining the relationships among the variables, the agricultural economy and commodity-market environment may change as a consequence of new regulations, technological developments, economic conditions, or transformations in domestic and international markets. The findings should therefore be generalized to subsequent periods with appropriate caution.

A second limitation concerns the use of secondary data. The empirical analysis relies on information obtained from official Iranian statistical and agricultural sources and commodity exchange records. Consequently, the reliability of the econometric estimates depends on the accuracy, consistency, completeness, and continuity of the underlying information.

Changes in statistical definitions, measurement procedures, classifications, or data-collection methodologies may also affect comparability over time. Even when official information is used, long time series can incorporate methodological changes that are difficult to eliminate completely from empirical analysis.

A third limitation is associated with the scope of the agricultural commodities represented in the exchange. The analysis focuses on agricultural products admitted to or traded through the organized commodity exchange. Agricultural activities operating predominantly through informal markets or alternative commercialization channels may exhibit different characteristics. Consequently, the findings should not automatically be generalized to every agricultural product or market structure in Iran.

A fourth limitation concerns the complexity of agricultural-sector performance. Agricultural production growth, economic value added, and export

capacity are determined by numerous interacting factors. Climatic conditions, water availability, soil characteristics, agricultural inputs, energy costs, financing, technological development, labor availability, transportation infrastructure, domestic demand, international prices, exchange rates, and government policies can simultaneously influence agricultural outcomes.

Not all these determinants could be incorporated into the models. The statistically significant relationships identified between the agricultural commodity exchange and agricultural performance should therefore be interpreted within a broader system of economic, institutional, environmental, and commercial influences.

A fifth limitation relates to the aggregated nature of several variables. Agriculture encompasses activities with substantially different economic and productive characteristics. Crop farming, horticulture, livestock production, and aquaculture differ in production cycles, storage requirements, commercialization structures, market risks, and export opportunities. Aggregate sectoral indicators may therefore conceal heterogeneous responses among individual subsectors and products.

A sixth limitation concerns the interpretation of export capacity. Export performance is particularly sensitive to conditions beyond the domestic agricultural market. International demand, trade regulations, exchange-rate movements, transportation routes, quality requirements, certification, geopolitical developments, and access to destination markets may substantially influence agricultural exports. This helps explain why commodity exchange shocks account for a smaller proportion of the longer-horizon variance in export capacity than in production growth or economic value added.

A seventh limitation is associated with the interpretation of dynamic econometric relationships. VAR models, error correction mechanisms, impulse-response

functions, and variance decomposition provide valuable information regarding temporal interactions among variables, but their interpretation depends on model specification, lag selection, variable measurement, and the statistical properties of the series. The findings should therefore be interpreted jointly rather than relying on any single econometric indicator.

Finally, statistical significance should not be interpreted as implying that the agricultural commodity exchange is the sole determinant of agricultural development in Iran. The evidence demonstrates that commodity exchange activity constitutes a relevant component of the agricultural economic system and is significantly related to the dimensions examined. Agricultural development nevertheless emerges from the interaction of production capacity, institutions, infrastructure, technology, financing, environmental conditions, domestic markets, and international economic relationships.

Despite these limitations, the consistency of the findings across the different analytical techniques provides a strong empirical foundation for concluding that the agricultural commodity exchange plays a meaningful role in Iran's agricultural sector. The results demonstrate significant relationships with agricultural production growth, economic value added, and export capacity and reveal that these relationships extend beyond immediate market effects through dynamic adjustment processes over time. In this sense, strengthening the efficiency, transparency, accessibility, and institutional integration of the agricultural commodity exchange can constitute an important component of broader strategies aimed at improving the productivity, value creation, market organization, and competitiveness of Iranian agriculture.

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Agriculture stands at the intersection of food security, economic growth, rural livelihoods, international trade, and environmental sustainability. Yet its development depends not only on the capacity to produce, but also on the existence of transparent, efficient, and competitive markets capable of transforming production into sustainable economic value. This book examines the strategic role of agricultural commodity exchanges in this transformation, focusing on Iran as a significant case for understanding the relationship between organized markets and agricultural development. The study explores how commodity exchange activity relates to three fundamental dimensions of agricultural performance: production growth, economic value added, and export capacity during 2011–2024. Through an integrated econometric framework, it combines descriptive and regression analysis with stationarity and cointegration tests, error correction modeling, vector autoregressive models, impulse-response functions, variance decomposition, and structural stability assessment. The findings reveal significant relationships between organized commodity trading and all three dimensions, while demonstrating that its influence is stronger for production growth and economic value creation than for agricultural exports. Beyond statistical evidence, the book presents commodity exchanges as institutional mechanisms capable of strengthening price discovery, transparency, standardization, market coordination, and commercialization efficiency. It argues that their transformative potential depends on integration with infrastructure, financing, technology, logistics, inclusive producer participation, environmental responsibility, and effective public policy. Ultimately, the work offers a compelling vision of agricultural markets as engines of transformation, demonstrating that sustainable food systems require not merely greater production, but stronger institutions capable of connecting farmers, markets, value creation, competitiveness, and long-term development.

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