Exploring Cooperative Mechanisms in the Chinese Agricultural Value Chain: A Game Model Analysis Based on Leading Enterprises and Small Farmers

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Abstract: In the context of agricultural modernization in China, this paper examines the micro-level perspective of agricultural value chains. Drawing from three primary models of agricultural value chain cooperation—namely, “leading enterprises + small farmers”, “leading enterprises + cooperatives + small farmers”, and “corporate integration”—it establishes four game models: the decentralized decision-making game model, the two revenue-sharing game models, and the centralized decision-making game model. It systematically analyzes the cooperation mechanisms between leading enterprises and small farmers in upstream production links of the agricultural value chain, aiming to improve the cooperation strategy between leading enterprises and small farmers, elevate the status of small farmers in the agricultural value chain, promote increased income for farmers, and strengthen the agricultural value chain. The research findings are as follows: Firstly, the traditional contract of “leading enterprise + smallholder farmers” is incomplete, which makes it difficult to avoid opportunism and moral hazard that may arise between the two parties. By comparing multiple parameter values, it is found that this model is at a lower level of agricultural value chain development. Secondly, the model of “leading enterprise + cooperative + smallholder farmers” improves the tightness and stability of cooperation between leading enterprises and smallholder farmers. This model explains to some extent the operability of smallholder farmers sharing the value of the agricultural value chain. Compared with various parameter values, this model is at a medium level between other models. Finally, the model of “corporate integration” is a fully vertical integration model. Compared with various parameter values, this model is at an advanced stage of agricultural value chain development. Therefore, agricultural value chains will ultimately develop toward the direction of corporate integration. This study has positive practical significance for enhancing the status and claim rights of small farmers, promoting increased income for farmers, enhancing the consistency of values between leading enterprises and small farmers, strengthening the stability of the agricultural value chain, and ultimately achieving common prosperity and agricultural modernization in China.

Keywords: agricultural value chain; game analysis; leading enterprise; small farmers

1. Introduction
1.1. Research Background

Since the 1990s, various models of agricultural industrialization have continually been emerging in China, with the “leading enterprises + farmers” model becoming one of the important models in the development of agricultural industrialization [1]. Over time, derived models such as “company vertical integration” [2] and “leading enterprises + cooperatives + farmers” have also been widely practiced [3,4]. The vertical cooperation between leading enterprises and farmers has effectively driven the development of farmers, alleviating the contradiction between “small-scale farming” and “socialized large-scale...
production” [5]. Moreover, it has also improved the efficiency and quality of the agricultural industry [6], playing a crucial role in ensuring food security and promoting the transformation and upgrading of the agricultural industry in China. In essence, leading enterprises and farmers should be interdependent, symbiotic communities [7]. However, agricultural products are vulnerable to market influences, with large price fluctuations, and the contractual nature between leading enterprises and farmers is relatively fragile [5], which is prone to opportunism and adverse selection risks [1,8]. Based on the rational economic mindset of maximizing their own interests, the interests of both parties are often inconsistent [9], leading to frequent breaches of contract of traditional agricultural industry organizations [10]. What’s more, traditional agricultural industry organizational models also face challenges such as loose interest connections, unstable chains, low income for farmers, and the difficulty of fully exploiting the chain effects [11]. The main reason is that leading enterprises pay too much attention to organizational management methods and do not pay enough attention to the upstream interest mechanism. There are still differences in the distribution of interests between leading enterprises and farmers in agricultural production [12]. As is well known, the motivations and behaviors of rational economic individuals are greatly influenced by economic factors. Therefore, Porter first proposed the concept of the value chain to explain business production behavior in 1985 [13]. Porter believed that the value chain, which unfolds with the goal of maximizing value creation, consists of a series of economically interrelated yet distinct activities, also known as value-added activities. The sum of these activities constitutes the “value chain” [13,14]. The core of the value chain lies in value creation and value distribution [13,15]. Other scholars have extended and expanded the concept of the value chain [16], and it has been widely applied in the agricultural sector, gradually forming the agricultural value chain. The agricultural value chain (AVC) not only includes leading enterprises and small farmers, but also includes traders, transporters, sellers, and consumers [17], and even includes stakeholders such as the government, service agencies, or intermediary organizations [18]. Among them, the agricultural production process in which small farmers participate in cooperation with leading enterprises is the weakest part of China’s agricultural value chain [12]. To address the conflicts of interest existing in agricultural production processes, scholars have introduced game theory into the analysis of agricultural value chains [6,8,15,19], aiming to improve cooperative mechanisms within agricultural value chains. Therefore, studying the benefit mechanisms between Chinese leading enterprises and farmers can provide theoretical and methodological support for the practice and evolution of the agricultural value chain. This is of significant importance for promoting the resilience of agricultural production processes, reducing default rates, strengthening the agricultural value chain, increasing farmers’ income, and achieving agricultural modernization in China.

1.2. Research Gap

What are the internal interest mechanisms of the agricultural value chain linking the farmers, and can they be improved relative to the traditional industrial organization of agriculture? Existing research has explored the main models and benefit mechanisms of the agricultural value chain, focusing mainly on two aspects: the game analysis of the players in the agricultural production process in the upstream of the agricultural value chain and the game analysis from the perspective of the entire agricultural value chain.

The game in the production process of the agricultural value chain mainly revolves around the organizational models of the actors and their game analysis. Some scholars argue that the vertical cooperation contract model between leading enterprises and farmers is not a stable collaborative model and suggest that the model with introducing “the cooperative” may be more effective [11]. Some scholars have also summarized three models, “company + farmers”, “company + intermediary organization + farmers”, and the “integration of farmer cooperatives”, and analyzed the game contractual relationship between leading enterprises and farmers. They believe that intermediary organizations can effectively supervise the performance of both parties, and an integrated organizational
model is most conducive to improving the stability of vertical relationships in the agricultural industry [6,20]. Another study compared three main models under single-period and multi-period conditions: “farmers + market”, “leading enterprises + farmers”, and “leading enterprises + farms”. The analysis considered dimensions such as the number of game iterations, property rights, and risk attitudes, examining their impact on the optimal agricultural contract [21]. In the upstream production of the agricultural value chain, leading enterprises, as the chain leader, are not only responsible for the seed selection, processing, and sales of agricultural products, but also need to coordinate various participating actors and continuously improve their collaboration level [3,6]. The involvement of cooperatives can also help improve farmers’ bargaining power [22], reduce trust costs [19], enable farmers to fully obtain chain-value-added benefits, and thus enhance farmers’ value claim in the agricultural value chain [3,23]. The bargaining power of farmers mainly depends on the production factors controlled by farmers or the standard setting and pricing power of products [4]. In this context, farmers act as independent decision-making units participating in agricultural production within the agricultural value chain, establishing vertical linkages between farmers and the agricultural value chain [24]. In practice, farmers also contribute to other stages of the agricultural value chain, such as some smallholder farmers often participating in post-harvest activities such as processing, transportation, and sales [25], without making independent agricultural production management decisions in the upstream of the agricultural value chain, which can be referred to as horizontal linkages. These post-harvest stages are often areas where most agricultural enterprises excel, and will not be analyzed in this paper.

With the continuous development of agricultural industrialization, competition among agricultural enterprises has shifted toward competition within the agricultural value chain [26]. Consequently, there is a growing focus on exploring the game theory of the agricultural value chain from a chain perspective. The relatively large price fluctuations of agricultural products are a characteristic of the agricultural industry, but the biggest problem facing agricultural product transactions is information asymmetry [27]. As leading enterprises possess more market information and sales resources, it is easy to lead to inequality in transactions between farmers and leading enterprises [28], reducing the stability of the chain. Some scholars have established dynamic game optimization models under asymmetric information in agricultural product value chains to calculate the conditions required to achieve Nash equilibrium and seek solutions to the problem of low stability in the agricultural product value chain [19,29,30]. This helps to reduce information asymmetry and thus alleviate the problem of transaction inequality. Some scholars have conducted dynamic game analyses separately on the production and sales stages of the agricultural value chain, solving the key constraining factors affecting stable cooperation among chain operators [7,8,25]. Additionally, international scholars have analyzed the degree of greening and sales pricing in various game models of agricultural supply chains [26,30,31], offering parameter-rich models that contribute to stable and continuous cooperation among supply chain partners. Many downstream entities in the agricultural value chain will rebate to other upstream entities [15,32], or purchase farmers’ products at a higher than market prices to ensure the quality and quantity of agricultural products, thus forming a value-sharing mechanism throughout the entire chain. This seemingly unfair trading behavior increases farmers’ income and thus strengthens the stability of the chain. In short, fair trade within the agricultural value chain is relative, not absolute. The value-sharing mechanism has also become a distinctive feature of agricultural value chains that distinguishes them from traditional agricultural industry organization models and other industrial chains [31,32].

In summary, international research has placed more emphasis on the supply and sales phases, with very limited research on the production phase [25,26,30,32]. This is due to the fact that the agricultural production internationally is primarily managed by large farmers, and the agricultural economic environment is relatively stable with well-developed association organizations. Even when small farmers participate in contract farming, they are well protected. Most of China’s research on the game theory of the
Agricultural value chain employs the matrix game model to examine the playing between the participating parties in the agricultural production. However, the parameters of this matrix model are very limited, and while it can offer insights into the “prisoner’s dilemma”, it falls short in capturing the overall impact of the game on the chain. Consequently, it cannot fully explain the mechanism of cooperation and mutual success between the two parties involved. The game model, which is based on payment functions or demand equations, is well suited for exploring the impact of the agricultural value chain. However, there are limited studies in China that utilize this approach for analyses. Additionally, the fundamental reason for the limitations in existing research lies in the fact that previous studies primarily relied on industrial organization management theory instead of value chain theory [15]. As economic factors are the primary drivers of behavioral decision making, industrial organization management theory falls short in fully explaining the decision-making behaviors of participating parties. Furthermore, the limited availability of leading enterprises and challenging data collection contribute to the gaps in research. The micro-level analysis of the agricultural value chain remains underdeveloped, and the application of game theory in agricultural upstream production involving leading enterprises and farmers is insufficient.

1.3. Research Purpose

Based on the micro-perspective of the agricultural value chain, this paper theoretically analyzes and mathematically deduces the value mechanism of the agricultural value chain. The aim is to improve the cooperation strategy between leading enterprises and small farmers, elevate the status of small farmers within the agricultural value chain, promote increased income for farmers, enhance the claim rights of farmers in the agricultural value chain, promote the convergence of values between both parties, avoid the prisoner’s dilemma, strengthen the resilience of the agricultural value chain in the production process, and optimize the agricultural value chain. This study provides theoretical and methodological guidance for the agricultural value chain and small farmers to share various forms of secondary distribution, which helps improve the compliance rate of both parties and provides theoretical and methodological support for fully realizing the chain effect of “1 + 1 > 2”.

1.4. Research Contribution

The contribution of this paper lies in two aspects: On the one hand, there is the innovation of theoretical application. This paper analyzes the game relationship between leading enterprises and farmers from the perspective of the value chain, focusing on the distribution of value. By analyzing indicators such as price, profit, and shared revenue, it deduces the evolution direction of the agricultural value chain, expands the analytical framework of agricultural value chain theory, and enriches the theoretical foundation of the agricultural value chain. On the other hand, there is the innovation of method application. Based on the three main models of the agricultural value chain, this article establishes four game models through demand function. It can not only examine the important parameters of the game between Chinese enterprises and farmers in agricultural production links, but also analyze the chain profits, which makes up for the deficiency that existing research can only analyze the game between leading enterprises and farmers in agricultural production links without taking into account the chain effect. It expands the applicability of game theory in the field of agricultural value chain research in China. In addition, the strict mathematical derivation of the game model analysis not only supports the theoretical analysis, but also makes it possible for farmers to share the value-added chain and ensure that the value-added chain is in methodology through the value-sharing model.

2. Research Method

This paper is based on the Asian Development Bank (ADB) Inclusive Agricultural Value Chain Project. Through the observation of the actual operation of the agricultural
value chain during the research survey, it abstracts and refines the practical situations. Focusing on the production link of agricultural products in the upstream of the AVC, starting from the commonality and universality principles of the agricultural value chain production link, it conducts a theoretical discussion, game hypothesis, and game analysis. This article draws on the value chain game methodology adopted in international research. Through the demand function, it establishes four game models for the game analysis. It can not only explore the game between leading enterprises and small farmers, but also derive the profits of the chain, fully explaining the mechanism of win–win cooperation between both parties. The parameters derived from the demand function primarily include indicators related to profit, price, and profit distribution. These parameters not only closely approximate actual production situations but also offer a more powerful explanation of decision making from the perspective of the value chain. In addition, this paper also conducts a case analysis, an empirical theoretical analysis, and game modeling. The specific methods are shown in Section 5.

2.1. Member Selection

As the main suppliers of raw materials in the agricultural value chain, agricultural producers mainly include small-scale farmers, large-scale agricultural producers, family farms, or agricultural cooperatives, which are composed of various production entities in China [5]. Small farmers account for the largest number and are the basic members of various agricultural business entities. According to data from the third agricultural census in China, there are 230 million rural households. Among them, smallholder households nationwide account for over 98% of agricultural operators, constituting approximately 90% of the agricultural workforce. Various large-scale agricultural producers are mostly developed from small farmers. Therefore, this paper selects small farmers as representatives of producers to play in the game.

As agricultural enterprises specializing in the processing and sales of agricultural products, they often serve as the leaders and drivers of the agricultural value chain [33], and can coordinate with other actors. Leading enterprises are the main force in the processing and marketing of agricultural products, generally in the form of whole-chain organizations, and are also important players in driving the link between smallholder farmers and modern agriculture. They are typical examples of the agricultural value chain, and are also the micro-actors that realize agricultural modernization [2]. By the end of 2021 in China, there were 90,000 leading enterprises at or above the county level nationwide, including 1959 national key leading enterprises. In 2020, on average, each leading enterprise drove the development of more than 23,000 rural households, purchasing primary agricultural products worth CNY 168 billion throughout the year, and creating employment opportunities for 332,000 people, including 203,000 farmers in China. Therefore, this paper selects leading agricultural enterprises as representatives of agricultural enterprises to play in the game.

By the end of 2021, there were 2.2 million farmer cooperatives in China. The cooperatives, as common agents of both leading enterprises and small farmers, also potentially participated in agricultural production. On the one hand, they represent small farmers in negotiations with leading enterprises, playing cooperatives’ professional advantages in terms of price, quality, and benefit distribution, preventing possible default behaviors of enterprises, improving the market bargaining power of small farmers, and safeguarding the interests of farmers. On the other hand, they represent leading enterprises to organize small farmers, spreading the technical services provided by enterprises to small farmers, regulating and supervising the production process of small farmers, and avoiding possible speculative behaviors of small farmers. In practice, cooperative members are often rooted in the location of small farmers or come from neighboring villages, with similar living backgrounds and knowing each other [34]. Due to convergent cultural, trust, and reputation informal institutional arrangements between cooperative members and small farmers, it is conducive to mutual supervision and joint restraint, and it is easier to motivate small farmers. It improves the performance rate and organizational level of small farmers, and
the contractual relationship is more stable [3,22]. Whether cooperatives participate in the cooperation of “leading enterprises + small farmers” as agents depends mainly on the comparison and trade-off between agency costs and market transaction costs.

It should be noted that when agricultural producers sell directly to consumers or sell to distributors, the main parameters of the game between the two parties are the price of agricultural products or whether they comply with their agreements, which are single variables. There are already a large number of documents in China that have presented detailed research on this type of situation [19,29,35], and this paper will not analyze and explore them further.

2.2. Basic Assumption

2.2.1. Inside Man

Assuming that the players in the agricultural value chain act rationally and aim for long-term cooperation, they strive to achieve mutual benefits. The players in the game analysis in this paper are mainly leading enterprises and small farmers or cooperatives (if any), who act as decision makers in the cooperative game. Furthermore, suppose both parties are bounded rational economic individuals, in which each player expects to pursue their own long-term profit maximization based on their own resource endowments and costs.

2.2.2. The Demand Functions

Drawing upon the international game theory method of agricultural value chain cooperation entities, this article establishes a demand function from the perspective of agricultural value chains to analyze the game between leading enterprises and small farmers in the production process [26,31,32]. It is assumed that cooperatives primarily provide intermediary services and do not participate in production decisions.

Suppose that the demand function of agricultural products is

\[ q = (p, \theta) = a - bp + \alpha \theta \]

where the actual market demand \( q \) is a linear function of the market sales price \( p \) and the quality coefficient \( \theta \). The better the quality of agricultural products \( \theta \) is, the lower the price \( p \) is, and the greater the actual demand of the market \( q \) will be. Assume that \( a \) is the potential market demand for such agricultural products, \( b \) is the sensitivity coefficient of consumers to the price of products, \( \alpha \) is the sensitivity coefficient of consumers to the quality of agricultural products, and \( \theta \) is the quality of agricultural products (for example, the crop is pollution-free, green, organic, etc.). The quality of agricultural products \( \theta \) is mainly decided by the markets, local resource endowment, small farmers’ acceptance, and input costs; \( p \) is determined by the leading enterprises based on market competition, cost, and other relevant factors [30].

Suppose the profits of small farmers [31,32]:

\[ \pi_F = (w - c)q - I\theta^2 \]  \hspace{1cm} (1)

where \( w \) is the agricultural order (wholesale or acquisition) price. In practice, agricultural producers, represented by small farmers, also have a certain degree of influence on order prices. This paper assumes that both parties agree on the order price determined by the firm and do not default. The research on default in contract farming has been quite detailed [36,37], and will not be discussed in this study. The main implementation body of agricultural production is small farmers, and the technology, management, and other costs related to agricultural production invested by leading enterprises are ultimately shared by small farmers in essence. Therefore, it is assumed that the cost of all the production factors (land, labor, and capital) of agricultural products borne by small farmers is \( c \). Suppose \( I \) is the proportion of R&D expenditure on technology purchased by smallholder farmers from leading enterprises, \( \theta^2 \) representing R&D and the environmental protection of agricultural
products. So, $I\theta^2$ represents the product quality caused by R&D investment in agricultural products and the cost of environmental protection in agricultural production. It can also be understood as the cost paid by small farmers for the development and application of new technologies and environmental protection in the process of agricultural production.

The operation costs of the leading enterprises are very complicated, so in order to simplify the game, the processing or operation costs of the leading enterprises are not considered as the key content. It is assumed that the main cost of the production stage of the leading enterprises is the purchase of agricultural products, but the gross profit obtained from other links, such as processing, transportation, and sales, is regarded as the profit of the leading enterprise. In addition, the model does not involve taxes on corporate income. Suppose the profits of the leading firms are

$$\pi_M = (p - w)q$$

(2)

Also, assume chain profits:

$$\pi_{SC} = (p - c)q - I\theta^2$$

(3)

This paper establishes game models based on the above basic demand function model and its assumptions, focusing on different agricultural value chain models. It then analyzes these models and compares their parameters of each. Finally, the paper deduces the development trend of agricultural value chains.

3. Game Model Analysis

Drawing upon field research and existing literature, this paper aims to analyze the game relationships among the three main models of agricultural value chains, namely, “leading enterprise + small farmers”, “leading enterprise + cooperative + small farmers”, and “corporate integration”, corresponding to the establishment of game models, namely, the decentralized decision-making game model, two value-sharing game models, and centralized decision-making game model. Based on the institutional characteristics of “leading enterprise + cooperative + small farmers”, this paper further analyzes two scenarios of value-sharing game models, namely, the leading-enterprise-led value-sharing game model and bargaining value-sharing game model.

3.1. Game Analysis of Leading Enterprises and Small Farmers

Analyze the institutional characteristics of the “leading enterprise + small farmers” agricultural value chain model, and then establish a decentralized decision-making model game.

3.1.1. Institutional Characteristics of “Leading Enterprises + Small Farmers” Cooperation

The model of “leading enterprises + small farmers” emerged earlier and was more common in practice in the process of industrialization in China [5]. Small farmers supply agricultural products to leading enterprises, which spread modern production factors such as technology, information, management, and capital to the agricultural industry, promoting the transformation of traditional agriculture to modern agriculture. Leading enterprises take the lead in negotiating with small farmers to determine agricultural orders, agree on the quantity, quality, or purchase price of agricultural products, and initially form vertical cooperation in the agricultural value chain. Under this model, the economic interests of leading enterprises and small farmers are relatively independent. Essentially, they still have the ownership, use right, and disposal right over their means of production, and the relationship between the two parties is usually limited to the transaction relationship of agricultural products [7,9]. Due to different value demands, agricultural contracts of leading enterprises and small farmers tend to have low fulfillment rates, high execution costs, and incomplete contracts [38,39]. In general, the “leading enterprises + small farmers” model is largely closer to a fully market-oriented division of labor. Due to the advantages
of capital, information, technology, brand, and market, leading enterprises tend to take advantage in the game and occupy a dominant position in profit distribution and risk sharing, while small farmers are weak. To a certain extent, small farmers are affected by the negative effect of squeezing and crowding out \[6,10,40,41\]. Smallholder farmers, driven by the rational pursuit of maximizing profits, may engage in non-compliant practices during agricultural production to achieve short-term gains. This often results in short-term contracts between the parties, which are not conducive to long-term cooperation.

3.1.2. The Hypothesis and Game Theory Derivation of “Leading Enterprises + Small Farmers” Cooperation

The property right between leading enterprises and small farmers in vertical cooperation is clear, and both parties have independent market economy status. Under the assumption of limited rationality, both parties aim to pursue profit maximization. This mode emphasizes the selfishness of both sides of the transaction and weakens the enthusiasm of long-term cooperation [38]. In order to facilitate the observation of the game between the two parties, the game of “leading enterprises and small farmers” is assumed to be an extreme situation: both parties intend to cooperate and undertake production, purchase, and market sales activities based on market demand and their respective resource endowments. In this scenario, they are not subject to penalties for breach of contract and moral constraints, and information sharing is disregarded [29]. The two sides only trade agricultural products, do not involve property rights, and mainly operate through the market mechanism. Under the assumption of market specialization and complete competition, a decentralized decision-making model (Stackelberg game model) is established to solve the profits of both parties in the game and the profits of the agricultural value chain, as well as variables such as acquisition price, market price, and agricultural product quality. This facilitates a comparative analysis with other game models.

Let \( p - w = m \); the gross profit per unit product of leading enterprises can also be understood as the gross profit margin. From Formula (2), the profits of leading enterprises can be obtained:

\[
\pi_M(m) = (p - w)q = m(a - b(m + w) + \alpha \theta)
\]

The first derivative and second derivative of \( m \) are obtained, and the gross profit margin is obtained by setting the first derivative to 0:

\[
m(\theta, w) = \frac{a - bw + \alpha \theta}{2b}
\]

Then, from (1), to find the small-scale farmer profit function,

\[
\pi_F = (w - c)q = (w - c)(a - b(w + m) + \alpha \theta) - I \theta^2
\]

Take \( m \) into the small farmer profit and find the first and second partial derivatives of \( w \) and \( \theta \). Let the first derivative of \( w \) and \( \theta \) be zero, and when \( 2bI - \frac{I^2}{b^2} > 0 \), \( \pi_F \) is a strictly concave function of \( w \) and \( \theta \). Then, let the first derivative of \( w \) and \( q \) be zero, which obtains the optimal quality of agricultural products and the optimal order price (wholesale price); that is, the optimal \( \theta_F^* \) and \( w_F^* \) for small farmers can be obtained.

\[
\theta_F^* = \frac{\alpha(a - bc)}{8bl - \alpha^2}
\]

\[
w_F^* = \frac{4l(a - bc)}{8bl - \alpha^2} + c
\]

Take the above two results into Equation (5); the maximum gross profit margin of the leading enterprise can be obtained:

\[
m_F^* = \frac{2l(a - bc)}{8bl - \alpha^2} + c
\]
And regarding the best agricultural prices,
\[ p_F^* = m_F^* + w_F^* = \frac{6I(a - bc)}{8bI - \alpha^2} \tag{10} \]

Finally, we put \( \theta_F^* \), \( w_F^* \), and \( P_F^* \) into Formulas (1)–(3) to obtain the optimal profits of small farmers, leading enterprises, and agricultural value chains, respectively:
\[ \pi_F^* = \frac{I(a - bc)^2}{8bI - \alpha^2} \]
\[ \pi_M^* = \frac{4b^2I^2(a - bc)^2}{(8bI - \alpha^2)^2} \]
\[ \pi_{Favc}^* = \frac{I(a - bc)^2(12lh - \alpha^2)}{(8bI - \alpha^2)^2} \]

3.2. Game Analysis of “Leading Enterprise + Cooperatives + Small Farmers”

Based on the analysis of institutional characteristics of the “leading enterprise + cooperative + smallholder” value chain model, the value-sharing game model is established for deduction. The value-sharing model is divided into two situations: the proportion of value-sharing dominated by leading enterprises and the proportion of value-sharing formed through bargaining. Among them, the proportion of value-sharing through bargaining is further derived using a Nash equilibrium model.

3.2.1. Institutional Characteristics of “Leading Enterprises + Cooperatives + Small Farmers” Cooperation

In order to overcome the limitations of the “leading enterprises + small farmers” contract, mitigate the impact of opportunism and adverse selection, and reduce internal transaction costs and default rates [27], the cooperative mode of “leading enterprises + cooperatives + small farmers” has gradually emerged in the industrialization of agriculture. This model has both enterprise attributes and market attributes, which is between the complete marketization and vertical integration of companies [6], and it is also one of the main models to promote the development of small farmers. Due to the involvement of cooperatives and other intermediary organizations, the trading relationship between leading enterprises and small farmers has gradually evolved into a dual principal–agent relationship. The cooperative organizations not only facilitate the transmission mechanism of “hard information” such as order information and actual transaction information, but also play a pivotal role in “soft information” [3]. This mode of cooperation reduces the high cost of direct transactions between leading enterprises and small farmers, but it also leads to high principal–agent costs. Digitalization and network technology may alleviate the high costs brought by cooperatives to some extent [42,43]. In practice, in the process of organizing small farmers, a few cooperatives are prone to alienating behaviors such as interference that exceeds the power and infringes on the interests of farmers [20]. With the establishment of independent legal personality of cooperatives, their behavior becomes more and more corporate, risk sharing and value-sharing are effectively balanced, and the public domain of property rights is greatly reduced [39]. Compared to the “enterprise + farmers” model, improvements in cooperatives are more likely to enhance the sustainability of cooperation between agricultural enterprises and farmers.

3.2.2. The Hypothesis and Game Theory Derivation of “Leading Enterprise + Cooperative + Small Farmers”

Due to the involvement of cooperatives, the game relationship between leading enterprises and small farmers has become more complicated, resulting in the game between leading enterprises and cooperatives, and the game between cooperatives and small farm-
ers. Since cooperatives and small farmers mostly originate from the same village or township or nearby neighbors, and the contractual relationship is relatively stable [3,22], this paper does not analyze the game relationship between cooperatives and small farmers.

To facilitate the examination of the game process, let us assume that the cooperative is entirely composed of smallholder farmers and represents their interests fully. Therefore, essentially, the cooperative’s interests are aligned with those of the smallholder farmers and can be considered as an independent entity acting collectively on behalf of them. The involvement of cooperatives does not generate agency fees and public property rights. Therefore, the game relationship in this part is assumed to be the negotiation and game between small farmers as a whole and leading enterprises. In reality, small farmers often adopt the way of “voting with their feet” and adverse selection to deal with the game conditions of enterprises [44]. On the basis of maximizing their own profits, the two parties share value-added income through negotiation, and determine the sharing proportion in two ways. Both parties share the value-added benefits of the chain while pursuing their own profit maximization. This paper aims to find the internal logic and mechanism for increasing the income of smallholder farmers by analyzing the game model of value-sharing.

In this paper, the value-sharing game model is divided into the value-sharing model dominated by leading enterprises and the value-sharing model obtained by bargaining.

First, the value-sharing game model dominated by leading enterprises is as follows:

Based on the premise of maximizing the interests of both parties, the leading enterprises decide the sales price \( p \) according to the market demand, and provide a value-sharing coefficient, \( \lambda (0 < \lambda < 1) \), indicating that the leading enterprises will share the profit obtained from the market terminal sales price with the small farmers. The proportion of value-sharing by leading enterprises is \( \lambda \), and the remaining proportion of value \((1 - \lambda)\) is shared with small farmers, so as to achieve coordinated profit distribution, encourage small farmers to join the agricultural value chain, ensure the supply of primary agricultural products, improve quality, and reduce opportunity cost. Smallholders receive the order (wholesale) price \( w \) and are responsible for the quality level of their product.

Suppose that the profit of leading enterprises is

\[
\pi_M = \lambda (p - w)q
\]  
(11)

The profit of small enterprises is

\[
\pi_F = (w - c)q - I\theta^2 + (1 - \lambda)(p - w)q
\]  
(12)

The profit of leading enterprises is

\[
\pi_M = \lambda (p - w)q = \lambda (p - w)(a - bp + a\theta)
\]  
(13)

Find the first and second derivatives of \( p \), set the first derivative to 0, and obtain

\[
p(w, \theta) = \frac{a + a\theta + bw}{2b}
\]  
(14)

The profit of small enterprises:

\[
\pi_F = (w - c)(a - bp + a\theta) - I\theta^2 + (1 - \lambda)(p - w)(a - bp + a\theta)
\]  
(15)

Substitute (14) into (15) and calculate the first and second partial derivatives with respect to \( w \) and \( \theta \). When \( \frac{\partial^2 \pi_F}{\partial w^2} \times \frac{\partial^2 \pi_F}{\partial \theta^2} - \left( \frac{\partial^2 \pi_F}{\partial w \partial \theta} \right)^2 > 0 \), then \(-\lambda^2 a^2 - \alpha^2 + 4bI\lambda + 4b\alpha \alpha^2 > 0\).

\( \pi_F \) is a strictly concave function of \( w \) and \( \theta \). Let the first derivative of \( w \) and \( \theta \) be zero, then

\[
w(\theta) = \frac{bc + \lambda(a + a\theta)}{(1 + \lambda)b} \]
(16)
\[ \theta(w) = \frac{a(a - bc - \lambda a + \lambda bw)}{(1 + \lambda)b} \]  

(17)

From Equations (16) and (17), we obtain

\[ w(\lambda) = \frac{4l + (\lambda a + bc) - a^2c}{(1 + \lambda)4bl - a^2} \]  

(18)

\[ \theta(\lambda) = \frac{a(a - bc)}{(1 + \lambda)4bl - a^2} \]  

(19)

Thus, the optimal retail price is

\[ p(\lambda) = \frac{2l + (2\lambda a + bc + a) - a^2c}{(1 + \lambda)4bl - a^2} \]  

(20)

Substitute Equations (18)–(20) into Equation (15) and calculate the first derivative with respect to \( \lambda \).

\[ \frac{\partial}{\partial \lambda} \pi_M = \frac{4bI^2 + (a - bc)(h^2 - 4bl + 4\lambda bl)}{(4bl + 4\lambda bl - a^2)^3} \]  

(21)

Then, further find the second derivative with respect to \( W \):

\[ \frac{\partial^2}{\partial \lambda^2} \pi_M = \frac{64b^2I^3 + (a - bc)^2(a^2 - 4bl + 2\lambda bl)}{(4bl + 4\lambda bl - a^2)^4} \]  

(22)

when \( a^2 - 4bl + 2\lambda bl < 0 \), \( \pi_M \) is a strictly concave function about \( \lambda \), so that the first derivative is 0:

\[ \lambda^{opt} = \frac{4bl - a^2}{4bl} \]  

(23)

Insert \( \lambda^{opt} \) into the above equation and then derive \( \pi^{opt}, \theta^{opt}, p^{opt}, m^{opt}, \pi^{opt}_F, \pi^{opt}_M, \pi^{opt}_c \) (the results are shown in Table 1).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Decentralized Decision Model</th>
<th>Centralized Decision-Making Model</th>
<th>Leading Enterprises-Led Value-Sharing</th>
<th>Value-Sharing through Bargaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \lambda )</td>
<td>( a(a - bc) )</td>
<td>( a(a - bc) )</td>
<td>( \frac{4bl - a^2}{4bl - a^2} )</td>
<td>( \frac{4bl - a^2}{4bl - a^2} )</td>
</tr>
<tr>
<td>( \theta )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
</tr>
<tr>
<td>( w )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
</tr>
<tr>
<td>( p )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
</tr>
<tr>
<td>( m )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
<td>( \frac{4bl}{4bl - a^2} + c )</td>
</tr>
<tr>
<td>( \pi^*_F )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
</tr>
<tr>
<td>( \pi^*_M )</td>
<td>( \frac{4bl}{(4bl - a^2)^2} )</td>
<td>( \frac{4bl}{(4bl - a^2)^2} )</td>
<td>( \frac{4bl}{(4bl - a^2)^2} )</td>
<td>( \frac{4bl}{(4bl - a^2)^2} )</td>
</tr>
<tr>
<td>( \pi^{opt}_F )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
<td>( \frac{4bl}{4bl - a^2} )</td>
</tr>
<tr>
<td>( \pi^{opt}_M )</td>
<td>( \frac{4bl}{(4bl - a^2)^2} )</td>
<td>( \frac{4bl}{(4bl - a^2)^2} )</td>
<td>( \frac{4bl}{(4bl - a^2)^2} )</td>
<td>( \frac{4bl}{(4bl - a^2)^2} )</td>
</tr>
</tbody>
</table>

Second, the game model of value-sharing in bargaining is as follows:

The value-sharing coefficient \( \lambda \) is no longer determined by the leading enterprises alone, but is determined by the small farmers and the leading enterprises through bargaining. Leading enterprises need to make compromises in order to secure stable quality and output of agricultural raw materials. They no longer decide the proportion of value-sharing income themselves, but rather the two sides determine the proportion of value-sharing income through bargaining.
income according to the market mechanism and the result of the game through full consultation. Although small farmers may be in a weak position in the practice of the game, they will “vote with their feet”, or even give up agricultural production, thereby forcing enterprises to make concessions. On the other hand, if small farmers want to obtain stable and relatively high agricultural production returns, they need to carry out production in accordance with standardized requirements to avoid moral hazard. In fact, the two sides bargain for the purpose of long-term cooperation, so as to achieve the proportion of value-sharing and achieve a balance.

This paper uses the Nash equilibrium game model [32] to establish Equation \( \max \pi_B(\lambda) = \pi_M \pi_F \) and simulate the game process. When \( \pi_B \) is maximized, \( \lambda \) is the optimal value of the game model. By applying Equations (18)–(20) to (12) and (13), respectively, we obtain

\[
\pi_F(\lambda) = \frac{1(a - bc)^2}{4bl\lambda + 4bl - \alpha^2}
\]

\[
\pi_M(\lambda) = \frac{4bI^2\lambda(a - bc)^2}{(4bI\lambda + 4bl - \alpha^2)^2}
\]

So,

\[
\max \pi_B(\lambda) = \pi_M \pi_F = \frac{4bI^3\lambda(a - bc)^4}{(4bI\lambda + 4bl - \alpha^2)^3}
\]

Find the first and second derivatives of \( \lambda \), set the first derivative to 0, and obtain the optimal \( \lambda^b \) of the model:

\[
\lambda^b = \frac{4bI - \alpha^2}{8bl}
\]

Taking \( \lambda^b \) back to the above equation, we obtain \( w^b, \theta^b, p^b, m^b, \pi_M^b, \pi_F^b, \pi_{sc}^b \) (the results are shown in Table 1).

3.3. The Game Analysis of Corporate Integration

Using the “corporate integration” value chain model, an analysis of institutional characteristics is conducted by considering the agricultural production process as an internal department upstream in the company’s value chain, and then establishing a centralized decision-making model game for deduction.

3.3.1. The Institutional Characteristics of “Corporate Integration”

“Corporate integration” is a complete vertical integration organization, which is an advanced form of agricultural industrialization development, commonly seen in developed countries such as Europe and America. This model coordinates the transaction relationship of the participants in the agricultural value chain through the internal administrative management system [39], while other models mainly coordinate the member relationship through market mechanisms such as price signals. Leading enterprises internalize market transactions by purchasing land production management rights [21]. In practice, there are various forms of vertical integration. Some farmers participate in the value chain of leading enterprises through the form of land investment or capital investment [45]. Some leading enterprises acquire the land of a large number of small farmers for a long period of time to establish production bases or agricultural parks [5], and hire farmers to become industrial workers of enterprises. “Corporate integration” realizes the complete substitution of internal management for market transactions or external contracts, and the relationship between leading enterprises and small farmers has changed from the relationship of agricultural product transactions to the relationship of factor contracts and division of labor [2]. In this model, the agricultural department becomes a primary agricultural product production department or industrial raw material supply department of leading enterprises. From agricultural production to field management, from production materials to industrial operation planning, and from warehousing and transportation to market sales, all have achieved unified management and high control, improved product
standardization, significantly reduced internal market transaction costs, and maximally avoided moral hazard and adverse selection. But it also incurs high internal management costs. The efficiency of leading enterprises and agricultural value chains depends on the comparison of internal management costs and market coordination costs [6].

3.3.2. The Hypothesis and Game Theory Derivation of “Corporate Integration”

Under rational assumptions, the leading enterprises and small farmers in the “corporate integration” model no longer make separate decisions, but make centralized decisions in order to pursue the profit maximization of the entire agricultural value chain. Based on the centralized decision-making game model, the profit equation of the agricultural value chain is

\[ \pi_{avc}(p, \theta) = (p - c)q - 1\theta^2 = (p - c)(a - bp + a\theta) - 1\theta^2 \]  

(28)

Find the first and second partial derivatives of \( m \) and \( \theta \), when

\[ \frac{\partial^2}{\partial m^2} \pi_{SC} > 0, 4bI - \alpha^2 > 0, \pi_{SC} \text{ is a strictly concave function of } p \text{ and } \theta. \]

Let the first derivatives of \( m \) and \( \theta \) be 0, and the optimal retail price \( p^* \) and the optimal quality \( \theta^* \) of agricultural products are obtained:

\[ p^* = \frac{2I(a - bc)}{4bI - \alpha^2} + c \]  

(29)

\[ \theta^* = \frac{\alpha(a - bc)}{4bI - \alpha^2} \]  

(30)

The gross profit margin of agricultural products is

\[ m^* = p^* - c = \frac{2I(a - bc)}{4bI - \alpha^2} \]

Bring Equations (29) and (30) into (28) to obtain the profit \( \pi_{avc}^* \) of the agricultural value chain:

\[ \pi_{avc}^* = \frac{I(a - bc)^2}{4bI - \alpha^2} \]

4. Comparative Analysis of Different Game Model Variables

Combining the optimal variables solved by the above four game models (see Table 1) and conducting a comparative analysis, the following five analysis results are obtained:

4.1. Comparative Analysis of the Proportion of Value-Sharing Model

In the value-sharing game models, there is a share revenue proportion in the two models: the share revenue proportion dominated by the leading enterprise and the share revenue proportion obtained by bargaining between the two sides:

\[ \lambda^b = \frac{4bI - \alpha^2}{8bI} < \lambda^{opt} = \frac{4bI - \alpha^2}{4bI}, \text{ that is } \lambda^b < \lambda^{opt}, \]

It indicates that the proportion of shared revenue led by leading enterprises is higher than that obtained by bargaining between the two sides, and \( \lambda \) is inversely proportional to the sensitivity coefficient \( a \) of consumers to the quality of agricultural products. It can be seen that the proportion of shared revenue \( (1 - \lambda) \) obtained by small farmers in the bargaining model is higher than that in the value-sharing model dominated by leading enterprises. This conclusion is consistent with the research of Song [32] on the mechanism of revenue-sharing between producers and suppliers, as well as the game analysis of Wang and Tang [6] on the principle of discounting.

In order to improve the level of the agricultural value chain, small farmers and leading enterprises should fully consult and determine the sharing value of both sides.
through negotiations and market mechanisms for the purpose of long-term mutual benefit and win–win cooperation, so that small farmers can not only benefit from agricultural production links, but also benefit from the value added in the agricultural value chain. The value-sharing model of bargaining not only benefits small farmers, but also improves the quality of agricultural products and increases the profits of the chain, as detailed in Sections 4.2 and 4.5 of this paper.

4.2. Comparative Analysis of Optimal Quality of Agricultural Products in Different Game Models

It is found that the quality \( \theta \) of agricultural products is the highest under the centralized decision-making model and the lowest under the condition of the decentralized decision-making model. In the value-sharing model, the quality of agricultural products in the bargaining model is higher than that in the value-sharing model dominated by leading enterprises. In addition, the quality of agricultural products in the value-sharing game model is higher than that in the decentralized decision model. To prove it,

\[
\theta^* = \frac{a(a - bc)}{4bI - a^2}, \quad \theta^b = \frac{2a(a - bc)}{3(4bI - a^2)} = 3 : 2 > 1 \therefore \theta^* > \theta^b
\]

\[
\theta^p = \frac{2a(a - bc)}{3(4bI - a^2)}, \quad \theta^{opt} = \frac{a(a - bc)}{2(4bI - a^2)} = 4 : 3 > 1 \therefore \theta^b > \theta^{opt}
\]

\[
\theta^{optp} = \frac{a(a - bc)}{2(4bI - a^2)} \quad \therefore \theta^p > \theta^{optp}
\]

To sum up, \( \theta^* > \theta^b > \theta^{opt} > \theta^{optp} \).

Compared to Ghosh and Shah [31] and Jamali and Rasti [26], who only used two models for their derivations, this paper has more robust research results on the quality of agricultural products. At the same time, the result that the quality of the bargaining model is higher than that of the decentralized decision-making model is highly consistent with their research results.

Under the condition of complete marketization, the participants mainly pursue economic benefits, and the quality of agricultural products has not been paid enough attention. The cooperative mechanism of value-sharing between small farmers and leading enterprises is between vertical integration and marketization, and the value-sharing mechanism will help to improve the quality of agricultural products. Three distinct organizational models demonstrate the process of improving the development level of agricultural product quality within the agricultural value chain. Therefore, from the perspective of improving the quality of agricultural products, the agricultural value chain model of deep vertical industrial integration will greatly improve the quality of agricultural products.

4.3. Comparative Analysis of Optimal Agricultural Order Prices in Different Game Models

By comparing the optimal agricultural order prices between the decentralized decision-making game model and the value-sharing game model (divided into two cases), it is found that in the decentralized decision game model, the agricultural order price (wholesale price) is the highest, and the agricultural order price in the value-sharing game model is lower than the decentralized decision game model. Among them, in the value-sharing game model, the agricultural order price in the value-sharing game model dominated by leading enterprises is higher than that in the bargaining game model. The proof is as follows:

\[
w^*_F - w^{opt} = \frac{4I(a - bc)}{8bI - a^2} + c - \frac{a + bc}{2b} = \frac{a^2(a - bc)}{2b(8bI - a^2)} \text{ greater than or less than } 0
\]

\[
\therefore \theta^* = \frac{a(a - bc)}{4bI - a^2} > 0 \therefore (a - bc) > 0,
\]
It means that the market demand is greater than the cost of improving the quality of agricultural products. The following is due to the constraints of $\theta^* > 0$, where $4bI - \alpha^2 > 0$, $\therefore 8bI - \alpha^2 > 0$:

We have $w_F^* - w_{opt} > 0$, that is, $w_F^* > w_{opt}$.

$\therefore w_{opt} - w^b = \frac{a+bc}{2b} - \frac{a+2bc}{3b} = \frac{a-bc}{6b} > 0$

$\therefore w_{opt} > w^b$

To sum up, $w_F^* > w_{opt} > w^b$

The price (wholesale price) of agricultural orders in the value-sharing game model is relatively low, indicating that the cost of production in the agricultural value chain is relatively low, which helps to improve the market competitiveness of agricultural products and expand market share. This conclusion contradicts the findings of Ghosh and Shah [26] and Jamali and Rasti-Barzoki [31], possibly due to different national contexts. In their cases, improving product quality led to an increase in market prices of a product. However, in China, smallholder farmers rely heavily on leading enterprises for technology to raise agricultural product prices, making it challenging to increase the wholesale price (order price) of agricultural products. Nonetheless, this conclusion is basically consistent with the research of Song [32], which suggests that the relatively low wholesale (order) price of the value-sharing revenue model increases the profits of leading enterprises and the chain.

It needs to be emphasized that, according to $\theta^* > \theta^b > \theta_{opt}^* > \theta_F^*$ and $w_F^* > w_{opt}^* > w^b$, both parties engage in bargaining to establish a mechanism for benefit distribution. This approach not only reduces costs but also enhances product quality, highlighting the advantages of a value-sharing mechanism and the unique characteristics of the agricultural value chain.

Under the market-oriented model of “leading enterprises + small farmers”, the wholesale prices of agricultural products for small farmers are relatively high, which may lead to higher market sales prices and lower market competitiveness. So, for leading enterprises, adopting the cooperation mode of “leading enterprises + cooperatives + small farmers”, especially establishing the value-sharing model through the bargaining mechanism, can not only improve the quality of agricultural products, but also reduce the procurement cost, which is conducive to improving the competitiveness of the agricultural value chain.

4.4. Comparative Analysis of Optimal Market Prices of Agricultural Products in Different Game Models

By comparing the four game models, it is found that the market price of agricultural products is the highest in the decentralized decision game model and the lowest in the centralized decision game model. The market price of agricultural products in the value-sharing game model is between the other two game models. Among them, in the value-sharing game model, the price of agricultural products in the value-sharing game model dominated by leading enterprises is higher than the market price of agricultural products in the bargaining game model. The proof is as follows:

Due to $a^2 - 4bI + 2abI < 0$,

$\pi_M$ is a strict concave function constraint with respect to $\lambda$,

$\therefore \lambda < 2 - \frac{a^2}{2b}$

$\therefore 0 < \lambda < 1$

$\therefore 2 - \frac{a^2}{2b} > 1$

$\therefore a^2 < 2bI$, $\therefore 2bI - a^2 > 0$

Also $\therefore 4bI - a^2 > 0$, $\therefore 8bI - a^2 > 0$

$p_F^* - p_{opt} = \frac{6I(a-bc)}{8bI-a^2} + c - \left( \frac{a}{2b} + \frac{c}{4bI-a^2} \right) = \frac{a^2(2bI-a^2)(a-bc)}{2b(4bI-a^2)(8bI-a^2)} > 0$
where, \((a - bc) > 0\)

\[
p^{\text{opt}} - p^* = \frac{a}{2b} + \frac{c}{3} + \frac{4I(a-bc)}{3(4bI-\alpha^2)} - \frac{4I(a-bc)}{3(4bI-\alpha^2)} = \frac{(2bI-a^2)(a-bc)}{6b(4bI-\alpha^2)} > 0
\]

\[
p^* > p^{\text{opt}}
\]

\[
p^b - p^* = \frac{a}{2b} + \frac{c}{3} + \frac{4I(a-bc)}{3(4bI-\alpha^2)} - \frac{2I(a-bc)}{3(4bI-\alpha^2)} + \frac{c}{3} = \frac{(2bI-a^2)(a-bc)}{3b(4bI-\alpha^2)} > 0
\]

\[
p^b > p^*
\]

To sum up, \(p_F^{\text{opt}} > p^{\text{opt}} > p^* > p^b\)

The research conclusion is consistent with the analysis conclusion of Ghosh and Shah [31] and Song [32] on product prices of different game models. However, Ghosh and Shah [31] only compared the market prices of the value-sharing model and the decentralized decision-making model. The conclusion of this article not only includes these two models, but also analyzes the market prices of more agricultural products. The value-sharing model not only helps farmers improve the product quality and share-income ratio, but also reduces the default rate and enhances the stability of the value chain. This perspective is in line with the game analysis conclusion of Wang and Tang [6].

It is worth noting that, in comparison to \(w_F^{\text{opt}} > w^{\text{opt}} > w^b\), there is a positive correlation between the agricultural market price and the wholesale price (order price). A higher wholesale price results in a higher market price, which is consistent with the research conclusion of Jamali and Rasti-Barzoki [26]. Combined with \(\theta^{*} > \theta^{b} > \theta^{\text{opt}} > \theta^F\) (Section 4.2), it is found that the comparison result of agricultural product market prices is opposite to the conclusion of comparing the optimal quality of agricultural products. In the decentralized decision-making model, the market price of agricultural products is the highest, but the quality of agricultural products is the lowest and the competitiveness is the weakest. The market price of the centralized decision game model is the lowest, but the quality of agricultural products is the highest, indicating that the market competitiveness is the strongest. The price and quality of agricultural products of the value-sharing model are between the other two models, and the performance is moderate. Among them, in the value-sharing game model, the market sales price in the bargaining game model is lower than that in the value-sharing game model dominated by leading enterprises, but the product quality is relatively high, so the cost performance of agricultural products in the bargaining game model is relatively higher.

Through a comparative analysis of prices and product quality, the conclusion suggests that the agricultural value chain possibly shifts from a market-oriented and specialized division of labor to the integration of cooperatives to enhance cooperation and share value. Ultimately, this may lead to the development of vertically integrated companies in the agricultural sector.

### 4.5. Comparative Analysis of Optimal Profits of Agricultural Value Chain in Different Game Models

Among the four models, the optimal profit of the chain of the centralized decision game model is the highest, and the optimal profit of the chain of the decentralized decision game model is the lowest. The optimal total profit of the chain in the value-sharing game model is between the other two models. Among them, in the value-sharing game model, the optimal chain profit in the bargaining game model is higher than that in the value-sharing game model dominated by leading enterprises. The proof is as follows:
According to the principle of selecting only one enterprise per sub-sector, and excluding smallholder farmers and improving agricultural product quality will continue to reduce internal transaction costs, which is conducive to improving the profitability and market competitiveness of the agricultural value chain.

Therefore, strengthening the vertical cooperation between leading enterprises and smallholder farmers and improving agricultural product quality will continue to reduce internal transaction costs, which is conducive to improving the profitability and market competitiveness of the agricultural value chain.

5. Case Study: Taking the Value Chain of Organic Edible Mushrooms in Guangling County as an Example

The study team of the Asian Development Bank Inclusive Agricultural Value Chain Development Project conducted research and developed guidance on 11 prefecture-level cities in Shanxi Province as well as 19 leading agricultural enterprises and their agricultural value chains between 2019 and 2022. The 19 enterprises became project enterprises in the following ways: first, on the premise of voluntary enterprise participation, local governments in Shanxi Province recommended and applied to the provincial project management office; then, the expert team of ADB conducted value chain assessment on the applying enterprises, the main indicators including business indicators of the enterprises; the number of farmers they drive, including the number of female farmers; the number of impoverished people; environmental assessment; social impact; and other indicators. According to the principle of selecting only one enterprise per sub-sector, and excluding state-owned and foreign-funded enterprises, 19 project enterprises were ultimately selected. These enterprises span the southern, central, and northern regions of Shanxi.

ADB hired 11 professors from China Agricultural University and relevant Ph.D. students to form an agricultural value chain consulting team, responsible for providing project
enterprise consulting services, guiding enterprise development, and discovering the typical demonstration of agricultural value chains.

The agricultural value chain case selected in this paper, BY Company’s organic edible mushroom value chain, is one of the typical demonstrations among project enterprises, which has a good driving effect on farmers. The model is replicable and scalable, and the value chain is sustainable. This case has characteristics of agricultural value chain transformation and development stage representation, location specificity, greening, and model integration, but also has certain limitations. The transformation development stage representation is that Guangling County is a typical central and western region of Shanxi, where the county’s economy and agriculture account for more than the secondary industry, and characteristic agriculture accounts for a considerable proportion. The region is in the process of transforming from traditional agriculture to modern agriculture, and the agricultural value is in the transition and growth stage, which is convenient to observe the cooperation and game between leading enterprises and small farmers. The specificity of location is that Guangling County is located in the cold area of northeastern Shanxi Province. Due to the unique geographical climate, the fruiting season of edible fungi in this region primarily occurs during summer and autumn, coinciding with the main fruiting season of edible fungi in the southern region. This phenomenon constitutes off-season production, offering the advantages of increased demand and off-season pricing. The greening lies in the innovative core technology of the company, and the edible mushrooms produced are certified organic products. The unique production characteristics of organic edible mushrooms ensure the greenness of the entire production process, with zero pollution to the surrounding environment and excellent competitiveness of the products. In addition, the integration aspect lies in the fact that this case is generally a model of integrated development of the company, but from the perspective of driving farmers, it is a shared interest connection mechanism of “leading enterprise + cooperative + small farmer”, which has a certain degree of integration and represents the development direction of the agricultural value chain. The limitation lies in the fact that the agricultural value chain involves a wide range of industries and agricultural industrialization models, and this single case cannot fully cover all cooperation modes and game models of the agricultural value chain. Additionally, due to limited information available, some data involve corporate secrets and are difficult to obtain completely. Therefore, the case analysis must be conducted solely based on data provided by the enterprise and public information.

Starting from 2019, for three consecutive years, three professors and two Ph.D. students from China Agricultural University jointly conducted field interviews and research in Guangling County, where the enterprise is located. According to the technical requirements of the ABD project, the interview outline was designed in advance, which mainly includes local economic and social development, agricultural development, farmers’ situation, agricultural enterprise operation, and farmers’ income. The interviewees include local government leaders, cooperatives, leading-enterprise-driven farmers, and other stakeholders. The number of survey participants is about 30. In addition, relevant information and data provided by the enterprise were collected, and analyzed in combination with the enterprise’s ABD project application materials and public information. All research information was submitted to the provincial project office and ABD every six months for tracking the development of the agricultural value chain.

The purpose of this case is to demonstrate, from an industrial practice perspective, the feasibility of the proposed model of value-sharing mechanisms and the accuracy of the agricultural value chain’s development direction as outlined in the previous sections.

5.1. Basic Information of the Case

The location of the BY enterprise, Guangling County, has more mountains and less rivers, with high terrain in the west and low terrain in the east, covering an area of 1283 square kilometers and cultivated land of 460,000 mu. The county has a population of 185,000, including a 150,000 agricultural population. Guangling County belongs to a
temperate continental monsoon climate, with an average annual temperature of 7 °C and it is relatively cold. Its main crops are mushroom, millet, and other famous agricultural and sideline products. The county has earned the titles of “China’s Green Famous County”, “One of the First Batch of Counties for Organic Product Certification and Creation”, and “China’s Excellent Edible Mushroom Production Base County”. Overall, it has a good agricultural industry foundation.

BY Company was founded in 2004 with a registered capital of CNY 9.88 million. It has built three parks with a total area of about 1100 acres. The company currently has 1 strain production line, 2 package production lines, 3 product processing production lines, 15 fresh-keeping cold storage rooms, and 550 mushroom greenhouses. It has an annual output of 20 million sticks of mushroom packages and 20,000 tons of fresh mushrooms. It is a leading agricultural enterprise in the local area. Guangling County BY Company takes the National Agricultural Science and Technology Demonstration Park as its platform. In addition to being responsible for building mushroom sheds and park infrastructure, it is mainly responsible for the research and development of edible mushroom species, cultivation, research and development of mushroom rods, production technology, and mushroom cultivation technology in the upstream of the value chain, with advanced technology. Free technical guidance and productive services can be provided in the mushroom production process in the middle reaches, and the production process is fully green. Downstream, responsible for recycling shiitake mushrooms and conducting preliminary processing, packaging, and building organic brands for sales through channels, a vertical development model of the entire chain has been initially formed, with strong market demand and sustainable value chain development.

Due to the company’s promising growth potential, environmentally friendly production processes, and significant contributions to poverty alleviation among the local populace, the local government has wholeheartedly supported its entry into the ADB project. This support has come in the form of funding and expert guidance, enabling the company to expand its operations to a scale of 1500 acres, increase production capacity through additional production lines, and drive forward local agricultural modernization while fostering shared prosperity with farmers. However, a key challenge lies in the limited availability of skilled and youthful laborers within the local area. As the company scales up its operations, ensuring an adequate supply of effective labor has become paramount. To address this issue, the company must continually refine its collaboration model with farmers to encourage greater participation.

5.2. The Formation and Characteristics of BY Company’s Organic Edible Fungus Value Chain Cooperation Model

BY Company gradually forms industrial advantages and economies of scale by integrating the funds of the local land, labor force, and surrounding small farmers, and forms a multi-dimensional interest connection with small farmers. The main feature of this model is the mechanism of value-sharing through secondary dividend distribution in production and operation with farmers joining the mushroom production process.

5.2.1. Integration of the Three Major Production Factors, Creating Scale Effects

The company creates industrial advantages and economies of scale by integrating land, labor, and capital from surrounding smallholder farmers. Through land transfer, the company integrates the surrounding land of about 1000 mu, forming a large-scale advantage of land. The company can provide employment and job opportunities for a wide range of farmers in the upstream mushroom rod production process, the midstream mushroom production process, the downstream initial processing process, and other auxiliary work such as park production services. It has attracted more than 2000 farmers to participate in the mushroom value chain, indirectly benefiting 8000 surrounding farmers, and achieving a year-round development drive for small farmers. In order to quickly form economies of scale, the company absorbs funds from some village collective economic
organizations and small farmers when the policy allows, and pays the annual dividend of "shareholding" with an annualized rate of return of 8%, realizing the multiplier effect of capital to promote industrial development. The company optimizes the allocation of three major factors and deepens the connection between production factors and farmers.

5.2.2. Multi-Dimensional Interest Connection Mechanism, Increasing the Stability of Agricultural Value Chain

The company has established multi-dimensional interest connections with small farmers, who will receive three main types of direct benefits (quantitative data seen in Table 2). During the non-mushroom season, the company organizes small farmers to produce mushroom sticks. In the primary processing of shiitake mushrooms, the company organizes small farmers to sort, dry, and package shiitake mushrooms. All of the processes provide piecemeal wages for small farmers. During the mushroom production stage, large farmers (cooperatives) contract multiple greenhouses to organize and guide small farmers in rod placement, mushroom production management, and harvesting. The company buys shiitake mushrooms at a price higher than the local market price, and the small farmers obtain production and operational benefits. In addition, the company will, at the end of the year, based on the production situation, grant a second dividend for production and operations, which is the main feature of the company’s cooperation model with farmers. This is also an important feature of the value-sharing in the agricultural value chain, which is reflected in the cooperation model between the company and farmers. The company has gradually formed a full-chain development model of “company + agricultural park + large farmers (cooperatives) + small farmers + multi-dimensional revenue-sharing”.

Table 2. List of farmers’ revenue from participating in edible mushroom value chain.

<table>
<thead>
<tr>
<th>Income Type</th>
<th>Income Standard</th>
<th>Per Household Income</th>
<th>Identity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income from production</td>
<td>Farmers contract greenhouses for mushroom production management, with a net income of about CNY 20,000 per shed. In addition, operating income dividends will be obtained at the end of the year based on market conditions.</td>
<td>About CNY 150,000</td>
<td>Large farmers (cooperatives) who contract multiple mushroom sheds</td>
</tr>
<tr>
<td>and operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage income</td>
<td>Small farmers participate in the production of mushroom sticks or other production and service.</td>
<td>CNY 25,000</td>
<td>Workers or employees in the agricultural industry</td>
</tr>
<tr>
<td>Asset income</td>
<td>The capital return is a guaranteed dividend of 8% per year, and the land transfer is 800 CNY/mu per year.</td>
<td>CNY 50,000 × 8% × 10 acres</td>
<td>People who invest in production factors</td>
</tr>
</tbody>
</table>

Sources: Research group enterprise survey.

5.3. The Game between Leading Enterprises and Small Farmers

The company has established a multi-dimensional interest connection with small farmers through long-term game theory, providing preferential conditions to attract farmers to participate. The company leverages the scale advantage of the park, with low unit production costs; utilizes the “acquaintance society” in rural areas, with low supervision costs; utilizes advanced edible mushroom technology, organic products, and off-season advantages to gain strong competitiveness, achieving an economic foundation for revenue contribution. The value-sharing mechanism between the two sides is the outcome of long-term game theory interactions between the leading enterprise and the majority of small farmers. In reality, the company’s value-sharing mechanism aligns more closely with the value-sharing game model led by leading enterprises (see Table 3).
Table 3. Comparison of game variables in BY Company’s edible mushroom value chain.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Leading Enterprises</th>
<th>Small Farmers Joining the Edible Mushroom Value Chain</th>
<th>Small Farmers Who Are Not Joining Agricultural Value Chains</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D</td>
<td>The yield of strain technology is as high as 98%, the patented technology in greenhouse and the technology of mushroom yield in mushroom bag is improved by 20%, the technology of high-quality mushroom rate is improved by 30%, the organic production control technology is a high-tech enterprise. Planting techniques are spread to farmers.</td>
<td>Comply with the technical requirements for mushroom production of leading enterprises and learn organic edible mushroom technology.</td>
<td>Only master traditional technology, without advanced technology. The strain is prone to decline.</td>
</tr>
<tr>
<td>Labor Allocation</td>
<td>The average age is around 50 years old, and over 80% are women. There are various positions available throughout the year. If the average age of participating farmers is reduced to 40 years old, the average annual income of participating farmer households needs to be increased to more than CNY 200,000.</td>
<td>Participate in the management positions or processing workshops of enterprises and receive position wages. Participate in the edible mushroom cultivation process and obtain the production benefits of edible mushrooms. The young and high-quality labor force in the family can be employed in the non-agricultural field. With the expansion of scale, more young and high-quality labor force will participate in the edible mushroom value chain.</td>
<td>Agricultural, other leading enterprises, or non-agricultural employment.</td>
</tr>
<tr>
<td>Land Income</td>
<td>Provide farmers with a land transfer fee of CNY 800 per mu per year for the transfer of land, sign a 20-year contract, and pay rent annually.</td>
<td>Circulation to enterprises or cooperation, with high fixed land rental income per year.</td>
<td>Self-management or circulation among farmers, with low income.</td>
</tr>
<tr>
<td>Capital Income</td>
<td>Expand scale through external financing to achieve economies of scale.</td>
<td>The “share” income is a guaranteed dividend of 8% per year.</td>
<td>Mainly the interest rate of the bank.</td>
</tr>
<tr>
<td>Edible Mushroom Production</td>
<td>Scale effects, brand effects, off-season sales, and product prices higher than the market average.</td>
<td>Edible mushroom cultivation income; management of secondary dividends; priority of expanding the scale; stable income.</td>
<td>There are industry investment thresholds, technical thresholds, low quality, unstable production, and unstable income.</td>
</tr>
<tr>
<td>Income</td>
<td>Brand advantages, products are exported to developed areas and overseas, prices are far higher than local prices, and the purchase price is high.</td>
<td>Directly sell to leading enterprises, due to high-quality and stable production; wholesale prices are higher than the local average price.</td>
<td>Generally sell to local wholesalers or trade fairs for self-sale. Local market prices or wholesale prices; sales volume is unstable.</td>
</tr>
<tr>
<td>Marketing Sales</td>
<td>Farmers can earn CNY 150,000 in mushroom cultivation income, CNY 25,000 in wage income, and CNY 12,000 in other income every year.</td>
<td>The income from independent agricultural production and operation or non-agricultural income is low.</td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Cont.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Leading Enterprises</th>
<th>Small Farmers Joining the Edible Mushroom Value Chain</th>
<th>Small Farmers Who Are Not Joining Agricultural Value Chains</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The form of enterprise-led farmers participating in benefit sharing.</td>
<td>If you live around the agricultural value chain, you can obtain spatial spillover benefits from the value chain: infrastructure construction; the development of surrounding related industries, such as transportation; and human capital and technology spillovers.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Participant in the agricultural value chain can enter with no capital threshold, receive free infrastructure, strain technology, planting technology, and free productive services, and receive operating dividends at the end of the year.</td>
<td>Gaining spatial spillover welfare in the value chain: subsidies for elderly households aged 60 and above, and public infrastructure in surrounding areas, such as road or bridge construction.</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Research group enterprise survey. Note: In practice, farmers often choose to “vote with their feet”, so this table also lists the situation of farmers who do not participate in the agricultural value chain.

5.3.1. The Game Conditions of Leading Enterprises

Core advantage: BY Company has a strong competitive advantage in product development and marketing. The advanced mushroom seed and mushroom package technology of BY Company has a high yield rate of 98%. Coupled with the patented mushroom cultivation greenhouse, the yield of mushroom packages increases by 20%, and the rate of high-quality mushrooms increases by 30%. BY Company has obtained organic certification and has become a high-tech enterprise. The products of BY Company are exported to both developed cities in China (such as Beijing and Shanghai) and to other areas like South Korea and Europe. The market price of BY Company’s products is much lower than the market price in the sales location, but higher than the market price in the production location, achieving a high quality and low price, which is very competitive in the market. The technical and marketing advantages provide a guarantee for joining farmers to achieve stable income and share revenue.

The conditions for farmers to participate: In order to ensure the labor supply in the edible mushroom value chain, the company has significantly lowered the threshold for engaging in edible mushroom cultivation, allowing zero capital participation, in order to attract more eligible farmers to participate. At the same time, it has increased various positions to ensure that farmers can earn relatively high incomes.

In recent years, the rural hollowing-out has become more serious, and the majority of the rural surplus labor force is composed of the elderly, the infirm, and women. The company has certain requirements for the technical level and standardization of operation of farmers. Currently, the average age of farmers participating in the company’s edible mushroom value chain is around 50 years old, and more than 80% are women. The company is constantly improving the total household income of participating farmers, so as to attract a more young labor force to participate. This means that it is necessary to increase the order price of farmers in the future, and increase the proportion of value-sharing, so as to promote small farmers to continue to increase their incomes, which is also conducive to achieving common prosperity.

Edible mushroom trading conditions: In order to prevent moral hazard and opportunism among farmers, the company adopts a “guaranteed minimum + higher than market price” approach to the acquisition of organic mushrooms from farmers, ensuring the basic income of farmers in the mushroom production process. Based on product quality, it divides the products into different grades, with the acquisition price of first-class products far exceeding the average market price, incentivizing farmers to continuously improve product quality. In addition, at the end of the year, the company also conducts operating
dividends (secondary dividends) based on the company’s operating conditions and market prices, realizing value-sharing in the value chain. This benefit sharing mechanism belongs to a leading-enterprise-led value-sharing mechanism, the behavior of leading enterprises.

The scale advantage of industrial parks: In order to ensure the contiguous land in the park, form a scale effect, and reduce unit costs, the company pays farmers a land transfer fee of CNY 800 per mu, which is significantly higher than the surrounding areas, where fees range from CNY 500 to 600 per mu per year. At present, the company has realized 1500 mu of industrial parks, with an annual output of 10,000 tons, upgraded to national agricultural parks, and obtained a lot of subsidies. In the research, it was found that if the company can reduce the average age of farmers participating in the edible mushroom value chain to 40 years old and achieve improvements in human capital, it needs to achieve the annual average comprehensive income of farmers’ families of more than CNY 200,000. This requires a further expansion of scale, reduction in unit costs, and improvement in product quality and product technology content, so as to obtain higher revenue.

Other service advantages: In order to ensure that farmers can operate according to technical standards, the company provides free technical training and production guidance for the majority of farmers. The company fully supports the development of small farmers, enabling them to grow into large farmers (cooperatives) as soon as possible, significantly increasing their overall income and serving as a demonstration of the prosperity of the rich. The endogenous cooperatives not only reduce the cost of supervision and management, but also improve the efficiency of technology diffusion.

5.3.2. The Choice Power of Small Farmers

Labor allocation: In order to meet the family’s necessary expenses and improve their living standards, the majority of farmers will choose between engaging in agricultural production and migrating for work. According to the hypothesis of limited economic rationality of farmers, farmers will decide whether to participate in agricultural production or go out to work based on the family’s resource endowment, or what kind of agricultural production to participate in to meet their family’s immediate needs. In the survey, it was found that if the economic returns of the two are not significantly different, farmers are more willing to work in their hometown. In addition to the local situation, social factors such as taking care of their families and avoiding family separation are also important considerations for farmers. If they choose to participate in the company’s edible mushroom value chain, in order to increase their overall income and greatly narrow the income gap with non-agricultural sectors, small farmers can participate in positions such as mushroom production or management services, and obtain wage benefits.

Investment of funds: Small farmers can provide land or capital “as a shareholder” to the park according to their actual family situation, thereby obtaining asset-based income. Otherwise, small farmers will use their funds for savings or consumption, or invest in non-agricultural operations and develop toward non-agricultural industries.

Land factor: Small farmers can obtain land rents by transferring their family land endowment to BY leading enterprises, cooperatives, or other farmers. However, the rents offered by enterprises are often higher, with longer lease periods and more stable income.

Production quality: In order to obtain sustained and stable benefits, small farmers need to produce according to the technical standards of leading enterprises and sell all products to leading enterprises according to the contract. In the process of development, in order to improve the income of those engaged in edible mushroom production, small farmers continuously improve their technical level, gradually develop into large farmers or cooperatives, and encourage more friends and relatives to participate in mushroom cultivation. Through technology diffusion, they continuously improve the quality and quantity of edible mushroom cultivation.
5.3.3. Results of Game

In the game case between BY Company and small farmers, the company mainly provides industrial platforms, technology research and development, funds, and sales channels, while the majority of farmers provide the land, labor force, and some funds. In order to ensure the output and quality of agricultural products, the company shares the value-added benefits of the chain with farmers and establishes a multi-dimensional benefit connection mechanism, which enhances the stability of the agricultural value chain in the production process and realizes sustainable development of the value chain. The majority of farmers produce according to technical standards and continuously improve product quality, not only obtaining economic benefits but also meeting local social life and family needs. The cooperation between the two parties will become closer, thus ensuring long-term mutually beneficial cooperation between both parties in the game, and realizing a win–win mechanism for participating parties and driving added value throughout the entire value chain.

5.4. Implications

The company has established a multi-dimensional cooperation model of interest convergence and value-sharing with farmers, which is more in line with the leading-enterprise-led value-sharing game model, providing empirical experience for the “company + cooperative + small farmer” model. At the same time, the company is integrated in property rights, but only conducts “market-oriented” independent accounting with farmers in the edible mushroom cultivation process. Overall, the edible mushroom value chain of this company is also developing toward the “company integration” model. The development trend of the organic edible mushroom value chain of this company is in line with the agricultural value chain development deduction based on various variables' comparison mentioned earlier.

In industrial practice, the benefit sharing mechanism is often reflected in various forms of “secondary distribution” rather than a single proportion of profit sharing. For example, BY Company also provides free technical guidance and some productive services for farmers who participate in organic edible mushroom cultivation, sells low-cost production materials with high-tech content to farmers, and bears the cost of infrastructure construction in the park, which greatly reduces the threshold for farmers to participate and the cost of operation. These are all innovative forms of the value-sharing mechanism in practice.

The company drives small farmers through large farmers (cooperatives), essentially strengthening the close cooperation with farmers, thus avoiding moral hazard and adverse selection, basically achieving the consistency of value orientation between leading enterprises and farmers, and achieving a reduction in unit costs, increasing both profits of both parties and profits of the chain, thus promoting the development of the value chain model to a higher stage to a certain extent. The value chain model of the company has largely verified the rationality of a theoretical analysis and model reasoning, and has great empirical value.

In addition, from the perspective of spatial spillover of industrial agglomeration formation [46], the company also subsidizes pension for the elderly above 60 years old in the surrounding rural areas, invests in public infrastructure projects in the surrounding area, such as road construction or bridge repair, and drives the development of related industries around, such as the transportation industry, which improves the welfare in the region. The company innovatively plays the “multi-round effect” of the agricultural value chain in industrial practice [15, 47].

BY Company, as a typical case of agricultural value chain value-sharing, provides valuable experience for the development of China’s agricultural value chain, and verifies the correctness of a theoretical analysis and mathematical deduction in this paper from the perspective of industrial practice. However, in the future development process, this company will also face market risks, such as the fluctuation of prices and sales of organic edible mushrooms, which will affect the value-sharing with farmers, thus affecting the
stability of upstream links of the agricultural value chain and affecting more excellent talents to join. How to use technological innovation to produce products that are more in line with consumers’ preferences and products with higher added value, improve the industrial value chain, achieve the integrated development of sixth industrialization (1 × 2 × 3), continuously expand market sales, and ensure the sustainable development of the agricultural value chain may be the issues that the company needs to further consider.

6. Conclusions

6.1. Research Conclusions

In the process of agricultural industrialization, the main actors in the agricultural value chain, such as leading enterprises and small farmers, hold different values and behavior patterns based on their rational pursuit of maximizing their own interests. The relationship between the main players is complex, and the target behaviors vary greatly. This paper, employing demand equations to establish four game models, analyzes multiple variables and introduces an important parameter of the revenue-sharing ratio for an in-depth analysis based on the three main agricultural value chain models: “leading enterprise + small farmers”, “leading enterprise + cooperative + small farmers”, and “corporate integration”. The research findings are as follows:

Firstly, the “leading enterprise + smallholder”, “leading enterprise + cooperative + smallholder”, and “corporate integration” are at the low, medium, and high levels of agricultural value chain development, respectively. By comparing the various parameters of the model, the evolution of the agricultural value chain is also moving from a low level to a high level.

Secondly, the model of “leading enterprise + cooperative + smallholder farmers” is currently a relatively effective model in China. Among them, cooperatives facilitate the formation of value-sharing mechanisms, helping farmers to obtain value-sharing. To a large extent, this model mitigates adverse selection and moral hazards among participating entities, reduces default rates, and promotes consistency in value orientation.

Thirdly, the revenue-sharing mechanism is mainly divided into two types: one is led by leading enterprises, and the other is formed through bargaining between small farmers and leading enterprises. The revenue-sharing mechanism formed through bargaining helps to increase the income of small farmers, resulting in production costs and benefits that are better than those of the leading-enterprise-led revenue-sharing model. Without the intermediary role of cooperatives, the formation of value-sharing mechanisms of the agricultural value chain would proceed very slowly, hindering the advancement in the agricultural value chain to higher stages of development.

Finally, corporate integration is an advanced stage of agricultural value chain development, but the conditions for its realization are high. Although this model is not the mainstream model of China’s agricultural value chain, it does represent the future direction of development of China’s agricultural value chain.

6.2. Recommendations

Based on the research findings, this paper proposes three recommendations for improving the agricultural value chain, targeting key participants such as agricultural enterprises, smallholder farmers, and cooperatives:

Firstly, strengthening technological innovation in agricultural enterprises is proposed. Leveraging technological innovation as a driving force, agricultural enterprises can enhance the competitiveness and value addition in the agricultural value chain, thereby providing a source for value distribution. Encourage leading enterprises to lower entry barriers for farmers to participate in the value chain, adopt various forms of value-sharing mechanisms, and attract more farmers to participate.

Secondly, encouraging farmers to integrate more deeply into the value chain is proposed. Farmers should be encouraged to contribute labor, land, capital, and other production factors to actively join the value chain, thereby increasing the proportion of
value-sharing for farmers and promoting income growth. Additionally, measures such as standardized contracts or technology diffusion, combined with digital technologies, should be implemented to ensure that smallholder farmers’ rights to value extraction in the agricultural value chain are enhanced.

Thirdly, further regulating the governance of cooperatives is proposed. Enhance the regulation of cooperatives’ legal status and governance to prevent deviation and reduce agency costs. Cooperatives should leverage their intermediary and organizational advantages to act as a bridge between leading enterprises and smallholder farmers.

6.3. Limitations and Future Studies

The paper did not incorporate relevant parameters for a sensitivity analysis through a simulation analysis but instead relied on case studies to compensate for overly idealized assumptions and maintain practical relevance. However, constraints such as the uniqueness of ADB projects within the same industry and the confidentiality of some enterprise data have resulted in missing data in the case study. Consequently, conducting a sensitivity analysis using enterprise data and data from surrounding farmers is not feasible, hindering the sensitivity analysis of the game model and resulting in the absence of a simulation analysis.

The authors and the research team will endeavor to increase the number of survey samples of leading enterprises and their small farmers nationwide, supplement more case studies, and obtain relevant data through coordination between ADB and relevant competent departments. These efforts’ aim is to conduct a data analysis and data simulation of model game processes, compensating for the limitations of this study in the next step of research. Additionally, future efforts will focus on the continuous observation of enterprise cases to generate relatively complete panel data, reflecting changes in the game and the development trends of the agricultural value chain. In the next stage of research, plans involve acquiring partial public data, combining them with survey data, and completing a quantitative study on the game between leading enterprises and small farmers. This will bridge the gap from a theoretical analysis to actual data, addressing the limitations of this study in future research.

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