Article

Research on the Relationship between Price Mechanism and Short-Term Behavior in Chinese Farmland Trusteeships

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Abstract: After the policy of separating ownership rights, contract rights, and management rights to rural land, some Chinese farmers entrusted their land to agricultural social service providers. However, at present in land trusteeships, short-term behaviors exist, which are not good for the sustainable utilization of land. This article uses a dynamic game model to analyze the economic reasons for short-term behavior and to explore possible mechanisms. The study's results showed that fluctuations in trusteeship prices encouraged farmers to sign low-price, long-term contracts or high-price, short-term contracts that allowed agricultural social service providers choose short-term behaviors. A variable-price system may avoid short-term contracts as a result of fluctuations in trusteeship prices, allowing both sides to build a long-term stable partnership, encouraging long-term investment in land. To ensure the sustainable utilization of land, it is suggested that both sides adopt a variable price system.

Keywords: sustainable utilization of farmland; farmland trusteeship in China; variable price system; agricultural social service providers; dynamic game model

1. Introduction

1.1. Background, Purpose, and Significance

Land trusteeship and agricultural social services in China have been evolving. Due to the natural endowment of a big population and limited farmland, as well as the household responsibility land system, Chinese farmers have a scale of production per capita that makes it hard to get satisfactory profits from agricultural activity. Thus, a large proportion of the young rural adult population seek jobs in cities rather than engaging in agricultural production. For-profit entities such as agricultural machinery operators, families who farm on a large scale, and agricultural cooperatives who provide farmers working in cities in sowing, irrigation, fertilization, pesticide application, harvesting, and other farmland-related services with tractors, drones, and other agricultural equipment are called agricultural social service providers, and the services they offer are called land trusteeship services. Scholars hold that by providing services on a large scale, a land trusteeship solves problems of fragmentation with respect to family-based land management and blazes a trail for moderately large-scale agricultural management in China [1], which attaches great importance to raising agricultural productivity and maintaining social stability. The Report of the 19th National Congress of the Communist Party of China (CPC) pointed out that to support the development of land trusteeship, the second round of land contracts in China will, upon expiry, be renewed for 30 years, and China will practice a land system in which ownership rights, contract rights, and management rights are separated to ensure collective ownership rights, stabilize farmers' contract rights, and invigorate land management rights. With the

support of this policy, substantial progress has been made on the development of land trusteeship and agricultural social services.

Currently, however, there are such problems with land trusteeship, such as short-term contracts and short-term behaviors, causing adverse effects on the sustainable utilization of land. There are two major steps in the process of land trusteeship: First, a farmer and an agricultural social service provider sign a trusteeship contract that includes trusteeship fees and terms among other things. Second, the agricultural social service provider carries out trusteeship operations. Related studies and this survey conducted in Shangshui County, Henan Province, show that many farmers breached the long-term trusteeship contracts they had signed or directly signed oral and short-term trusteeship contracts [2], and some agricultural social service providers involved in agricultural production were not willing to make a long-term investment in land and even adopted short-term behaviors such as flood irrigation and fertilizer and pesticide overuse [3], resulting in adverse effects on the sustainable utilization of land.

The significance of this study is to examine the game relations in land trusteeship between farmers and agricultural social service providers, analyze reasons for short-term contracts and short-term behaviors from an economic point of view, and design proper contractual mechanisms against short-term behaviors so as to promote long-term investment in land, guarantee the sustainable utilization of land, and ultimately, drive the healthy development of land trusteeship and agricultural social services in China.

1.2. Current Research

Following the adoption of the system for separating the ownership rights, contract rights, and management rights to rural land, short-term behaviors in agricultural production have drawn the attention of Chinese academics. It is generally accepted that at present in China, problems exist with land such as inadequate protection and the low efficiency of land utilization [4] and that a large area of land, a long period of trusteeship, and low specificity of assets purchased [5], among other factors, help to stabilize the expectations of operators [6] and to increase long-term land investment with respect to terracing, afforestation [7], purchase of agricultural machines [8], etc. In addition, factors such as a higher level of education on the part of operators [9] and the inclusion of punishment clauses in contracts are useful to reduce the use of fertilizers and pesticides and inhibit short-term behaviors.

Short-term contracts, which have a direct effect on agricultural social service providers' long-term investment in land [10], have become a hot topic in related studies. One view holds that economic factors are the main reasons behind short-term contracts: Farmers who enjoy having no endowment and unemployment insurance are inclined to use short-term contracts, while those with a strong ability to do non-agricultural jobs, with a high percentage of non-agricultural income, or with a highly stable non-agricultural job tend to choose long-term contracts [11,12]. Agricultural social service providers that offer low trusteeship prices are likely to secure a long-term contract, while factors such as unstable land management rights [13], incomplete contracts [14], and breaches of contract [15] result in short-term contracts. Land quality is an intermediate variable of the term and price of a contract [16]. Another view argues that trust is the main reason behind short-term contracts [17], with some farmers allowing their land to be operated by their relatives through verbal contracts or short-term ones to ensure their control over the land [18]. In practical land trusteeships, the term of trusteeship often varies depending on prices and on how closely the contracting parties are related [19].

The behaviors of sustainable land utilization and land ownership arrangements [20] are closely linked to the organization of farmers [21], and they are the result of the interactions between regular institutions of the country and irregular institutions in villages [22]. In the past, similar policies such as anti-desertification in Northwestern China [23], afforestation on the Loess Plateau [24], and land reclamation projects [25], have produced positive effects. Regarding land trusteeship at the national policy level, at present, China has officially set in motion a system for separating ownership rights, contract rights, and management rights to rural land, and policies relating to farmers such as income

insurance, endowment insurance, and relocation to cities, which are now being planned or improved, but with respect to irregular institutions involved in the organization of farmers among other things, no mature cooperation mechanism has been established between farmers and agricultural social service providers [26].

It is obvious, based on results from studies by Chinese and foreign academics, that foreign academics place more of their focus on the effects that tillage [27], cultivation [28], stakeholders' knowledge [29], biofuels [30], and sustainable development ideas [31] have on sustainable land utilization behaviors than on problems with China's present land policy. While Chinese academics have noted that economic factors such as unsound contracts, high risk of breach of contract, and the instability of management rights are primary reasons behind the use of short-term contracts and short-term behaviors in land trusteeship in China, no effective contract system has yet been developed. Therefore, it is still necessary to further study cooperation mechanisms with respect to trusteeship prices, terms, and behavior so as to aid in the formation of stable and mutually beneficial cooperative relations between farmers and agricultural social service providers [32].

1.3. Main Aim and Principle Conclusions

This study used a dynamic game approach that analyzed the game's process of land trusteeship between farmers and agricultural social service providers, built game models concerning both sides under fixed-price and variable-price systems, looked into the economic reasons behind short-term contracts and short-term behaviors by comparing the results of the game equilibrium under the two price systems, and identified an appropriate trusteeship mechanism that could solve problems such as short trusteeship terms, fierce interest conflict between the two sides, and unsustainable land management. Results from the game model show that fluctuations in trusteeship prices are the primary reason behind short-term contracts and that a variable-price system can help to establish a stable and mutually beneficial relationship of cooperation between farmers and agricultural social service providers. In this way, it can effectively suppress short-term behaviors, encourage sustainable development and utilization of land, and guarantee the healthy development of land trusteeship and agricultural social services.

2. Materials and Methods

2.1. Game Model Description and Assumptions

Assume that there is a farmer and an agricultural social service provider. The farmer does not farm himself but chooses to entrust his land to the agricultural social service provider. The farmer pays certain trusteeship fees to the agricultural social service provider, who then finishes jobs such as sowing, irrigating, fertilizing, pesticide spraying, and harvesting on the farmer's behalf. All land output and facilities that the agricultural social service provider constructs on the farmers' land are owned by the farmer.

A farmer may choose to sign a T-year trusteeship contract with an agricultural social service provider or a short-term trusteeship contract, i.e., deciding each year whether or not to entrust his land and whom to entrust it to. After signing the land trusteeship contract, the agricultural social service provider may choose to save costs in a way that is good for the sustainable utilization of land. The so-called long-term behaviors include building fertilizing and irrigating facilities and preparing land for mechanized farming. In contrast, the agricultural service provider may choose not to make any long-term investment and may even reduce labor costs by adopting flood irrigation and spraying a large amount of pesticide fewer times; these are called short-term behaviors. Long-term behaviors usually require a certain amount of money to be invested, but they can continuously lower farming costs and improve land quality. Short-term behaviors do not require a fixed investment, but they help little to reduce costs and, in the long run, harm land fertility and even cause irreversible pollution.

In this article, two types of trusteeship fees were considered under a two price system: A fixed-price system and a variable-price system. Here, a fixed-price system means that the farmer and the agricultural social service provider sign a contract that specifies trusteeship terms and a trusteeship price, and with these terms, the farmer pays a fixed trusteeship fee each year to the agricultural social service provider. The variable price system means that within an agreed trusteeship term, the farmer pays the agricultural social service provider a variable trusteeship fee each year that is determined based on market supply and demand. The characteristics of the long-term contract, short-term contract, fixed price, and variable price are shown in Table 1.

Table 1. Characteristics of a long-term contract and short-term contract.

	Term of Trusteeship	Trustee	Trusteeship Price	
			Fixed Price	Variable Price
Long-term contract	T years of trusteeship by the farmer.	The farmer entrusts his land to the same agricultural social service provider.	The same price for each of the T years of trusteeship.	The current market price for each year of trusteeship.
Short-term contract	1 year of trusteeship by the farmer.	The farmer chooses an agricultural social service provider each year.	The current market price for each year of trusteeship.	The current market price for each year of trusteeship.

Since the farmer and the agricultural social service provider affect one another in terms of returns, there is a game relationship between both parties over land trusteeship. In this article, problems with short-term behaviors in land trusteeship were reduced to a two-stage dynamic game between one farmer and one agricultural social service provider. In the first stage of the game, the farmer had two strategies to choose from: T-years trusteeship (T) and 1-year trusteeship (1). In the second stage, the agricultural social service provider chose one of the two strategies: Long-term behaviors (L) or short-term behaviors (S).

There are four game scenarios altogether. When the farmer chooses T-year trusteeship and the agricultural social service provider chooses long-term behaviors—a scenario called T-L for short—the farmer will get a return π_{f1} and the agricultural social service provider will earn π_{a1} . When the farmer chooses T-year trusteeship and the agricultural social service provider chooses short-term behaviors—a scenario called T-S for short—the former will get a return π_{f2} and the latter will earn π_{a2} . When the farmer chooses 1-year trusteeship and the agricultural social service provider chooses long-term behaviors—a scenario called 1-L for short—the former will get a return π_{f3} and the latter will earn π_{a3} . When the farmer chooses a 1-year trusteeship and the agricultural social service provider chooses short-term behaviors—a scenario called 1-S for short—the former will get a return π_{f4} and the latter will earn π_{a4} . See Figure 1 for details.

Figure 1. Game relationship between the farmer and the agricultural social service provider.

To quantitatively analyze relations in the game between farmers and agricultural social service providers, in November 2018, a week was spent interviewing more than 20 farmers and 3 agricultural

social service providers in Shangshui County, Henan Province. The interviews mainly focused on the effects that long-term behaviors and short-term behaviors in land trusteeship have on the returns of farmers and agricultural social service providers. According to the survey's findings, on the one hand, if the agricultural social service provider adopted long-term behaviors such as constructing irrigation facilities and improving land and soil conditions, it entailed a certain fixed cost and brought about no obvious change in land output in the short run but may have lowered machine operating costs each year and improved land output in the long run. If, on the other hand, the agricultural social service provider adopted short-term behaviors like flood irrigation and excessive use of fertilizer and chose not to build facilities and improve land conditions among other things, no fixed cost was required and a relatively high land output could be guaranteed in the short run, but such behaviors involved fairly high operating costs and, in the long run, weakened soil fertility and even caused soil to harden and decrease crop yields.

To build profit functions for the farmer and the agricultural social service provider, the following four assumptions were made based on the survey conducted in Shangshui County.

Assumption 1: If the agricultural social service provider chooses long-term behaviors, then the land output follows Equation (1):

$$y_l(t) = \frac{1}{1 + e^{-(t-\alpha)}} * \beta + \gamma \quad (1)$$

where t refers to year t of trusteeship, $y_l(t)$ means the land output in year t if the agricultural social service provider chooses L, and α , β , and γ are related output parameters. Assumption 1 indicates that if the agricultural social service provider chooses long-term behaviors, land fertility increases gradually. As t increases, the growth of land output is divided into three stages. In the first stage, land output grows slowly to near γ ; the second stage sees land output grow fast, from γ to near $\beta + \gamma$; and in the third stage, land output stabilizes gradually at a $\beta + \gamma$ level.

Assumption 2: If the agricultural social service provider chooses short-term behaviors, then the land output follows Equation (2):

$$y_s(t) = \frac{2 * t^2}{t^4 + 1} * \beta + \gamma \quad (2)$$

where $y_s(t)$ means the land output in year t if the agricultural social service provider chooses S. Assumption 2 indicates that if the agricultural social service provider chooses long-term behaviors, land is developed in a predatory way. As t increases, land output grows quickly to near $\beta + \gamma$ and then decreases rapidly and stabilizes at a level near γ .

Assumption 3: If the agricultural social service provider chooses L, they need to make a fixed investment of z and the variable cost of production each year is c_l . If the agricultural social service provider chooses S, then no fixed investment is needed and the variable cost of production each year is c_s ; $c_s < c_l$.

Assumption 3 suggests that to the agricultural social service provider, long-term investment in land can reduce costs more effectively than short-term behaviors do.

Assumption 4: The trusteeship price x fluctuates as the state of market competition changes, and the expected value of the trusteeship price for T years is $E(x)$.

In this study, two game models were built: One based on a fixed-price system and the other on a variable-price system. Currently, in land trusteeship practices in China, the fixed-price system is largely adopted and it is probably the main economic reason for farmers to enter into short-term contracts and for agricultural social service providers to adopt short-term behaviors. This study tried, through a comparison of results from the two models, to unravel relations among the fixed-price system, short-term contracts, and short-term behaviors in land trusteeship and to explain how the variable price system works on long-term contracts and long-term behaviors in land trusteeship. Thus, it aimed to encourage farmers and agricultural social service providers to adopt the variable price system, build a good cooperative relationship, and improve the sustainable utilization of land.

2.2. Game Model Based on the Fixed-Price System

Considering a situation where the farmer and the agricultural social service provider adopted the fixed-price system, this study established profit and loss functions regarding both parties in four game scenarios: T-L, T-S, 1-L, and 1-S.

Scenario 1: The farmer chooses T-year trusteeship and the agricultural social service provider chooses long-term behaviors.

In this scenario, the profit function for the farmer, π_{ff1} , is shown in Equation (3) and that for the agricultural social service provider, π_{fa1} , is shown in Equation (4).

$$\pi_{ff1} = \sum_{t=1}^T y_l(t) - x * T + z. \quad (3)$$

In Equation (3), $\sum_{t=1}^T y_l(t)$ is good land output that the farmer gets in T years when the agricultural social service provider chooses long-term behaviors, and $x * T$ is the trusteeship fees that the farmer pays in T years when the variable price system is adopted. Equation (3) shows that, given the fixed-price system, the farmer's return in this scenario is the difference between the good land output and the fixed trusteeship fees for T years, as well as the investment in land that the agricultural social service provider makes.

$$\pi_{fa1} = x * T - c_l * T - z. \quad (4)$$

In Equation (4), $x * T$ is the accumulated income in T years of using the agricultural social service provider when the fixed-price system is adopted, and $c_l * T + z$ is the sum of variable costs and fixed investment each year when the agricultural social service provider chooses long-term behaviors. According to Equation (4), given the fixed-price system, the agricultural social service provider's return in this scenario is the difference between trusteeship fees and operating costs related to the long-term behavior minus the fixed investment.

Scenario 2: The farmer chooses T-year trusteeship, and the agricultural social service provider chooses short-term behaviors.

In this scenario, the profit function for the farmer, π_{ff2} , is shown in Equation (5) and that for the agricultural social service provider, π_{fa2} , is shown in Equation (6).

$$\pi_{ff2} = \sum_{t=1}^T y_s(t) - x * T. \quad (5)$$

In Equation (5), $\sum_{t=1}^T y_s(t)$ is the bad land output that the farmer gets in T years when the agricultural social service provider chooses short-term behaviors, and $x * T$ is the trusteeship fees that the farmer pays in T years when the fixed-price system is adopted. Equation (5) shows that given the fixed-price system, the farmer's return in this scenario is the difference between the bad land output and the trusteeship fees for T years.

$$\pi_{fa2} = x * T - c_s * T. \quad (6)$$

In Equation (6), $x * T$ is the total expected income in T years of using the agricultural social service provider when the fixed-price system is adopted and $c_s * T$ is the sum of variable costs each year when the agricultural social service provider chooses short-term behaviors. According to Equation (6), given the fixed-price system, the agricultural social service provider's return in this scenario is the difference between the trusteeship fees and operating costs related to short-term behaviors.

Scenario 3: The farmer chooses a 1-year trusteeship and the agricultural social service provider chooses long-term behaviors.

In this scenario, the profit function for the farmer, π_{ff3} , is shown in Equation (7) and that for the agricultural social service provider, π_{fa3} , is shown in Equation (8).

$$\pi_{ff3} = \sum_{t=1}^T y_l(t) - E(x) * T + z. \quad (7)$$

In Equation (7), $\sum_{t=1}^T y_l(t)$ is the good land output that the farmer gets in T years when the agricultural social service provider chooses long-term behaviors and $E(x) * T$ is the trusteeship fees that the farmer expects to pay in T years when he chooses to entrust an agricultural social service provider each year. Equation (7) shows that given the fixed-price system, the farmer's return in this scenario is the difference between the good land output and the expected trusteeship fees for T years as well as the investment in land that the agricultural social service provider makes.

$$\pi_{fa3} = E(x) * n - c_l * n - z. \quad (8)$$

In Equation (8), n is the number of years of trusteeship that the agricultural social service provider expects to get in T years ($T \geq n$) when the farmer chooses to entrust an agricultural social service provider each year, $E(x) * n$ is the total income that the agricultural social service provider expects to earn in T years, and $c_l * n + z$ is the sum of variable costs and fixed investment in T years when the agricultural social service provider chooses long-term behaviors. According to Equation (8), given the fixed-price system, the agricultural social service provider's return in this scenario is the difference between the expected trusteeship fees and operating costs related to short-term behaviors minus the fixed investment.

Scenario 4: The farmer chooses a 1-year trusteeship and the agricultural social service provider chooses short-term behaviors.

In this scenario, the profit function for the farmer, π_{ff4} , is shown in Equation (9) and that for the agricultural social service provider, π_{fa4} , is shown in Equation (10).

$$\pi_{ff4} = \sum_{t=1}^T y_s(t) - E(x) * T. \quad (9)$$

In Equation (9), $\sum_{t=1}^T y_s(t)$ is the bad land output that the farmer gets in T years when the agricultural social service provider chooses short-term behaviors, and $E(x) * T$ is the trusteeship fees that the farmer expects to pay in T years when he chooses to entrust an agricultural social service provider each year. Equation (9) shows that given the fixed-price system, the farmer's return in this scenario is the difference between the bad land output and the trusteeship fees for T years.

$$\pi_{fa4} = E(x) * n - c_s * n. \quad (10)$$

In Equation (10), $E(x) * n$ is the total expected income of the agricultural social service provider in T years when the farmer chooses to entrust an agricultural social service provider each year and $c_s * n$ is the sum of variable costs each year when the agricultural social service provider chooses short-term behaviors. According to Equation (10), given the fixed-price system, the agricultural social service provider's return in this scenario is the difference between the expected trusteeship fees and operating costs related to short-term behaviors.

2.3. Game Model Based on the Variable-price System

Considering the situation where the farmer and the agricultural social service provider adopt the variable price system, this article establishes profit and loss functions regarding both parties in four game scenarios: T-L, T-S, 1-L, and 1-S.

Scenario 1: The farmer chooses T-year trusteeship, and the agricultural social service provider chooses long-term behaviors L.

In this scenario, the profit function for the farmer, π_{vf1} , is shown in Equation (11), and that for the agricultural social service provider, π_{va1} , is shown in Equation (12).

$$\pi_{vf1} = \sum_{t=1}^T y_l(t) - E(x) * T + z. \quad (11)$$

In Equation (11), $\sum_{t=1}^T y_l(t)$ is the good land output that the farmer gets in T years when the agricultural social service provider chooses long-term behaviors and $E(x) * T$ is the trusteeship fees that the farmer expects to pay in T years when the variable-price system is adopted. Equation (11) shows that given the variable-price system, the farmer's return in this scenario is the difference between the good land output and the expected trusteeship fees for T years, as well as the investment in land that the agricultural social service provider makes.

$$\pi_{va1} = E(x) * T - c_l * T - z. \quad (12)$$

In Equation (12), $E(x) * T$ is the total income that the agricultural social service provider expects to earn in T years when the variable-price system is adopted and $c_l * T + z$ is the sum of the variable cost and fixed investment each year when the agricultural social service provider chooses long-term behaviors. According to Equation (12), given the variable price system, the agricultural social service provider's return in this scenario is the difference between his expected trusteeship fees and operating costs related to long-term behaviors minus the fixed investment.

Scenario 2: The farmer chooses T-year trusteeship and the agricultural social service provider chooses short-term behaviors.

In this scenario, the profit function for the farmer, π_{vf2} , is shown in Equation (13) and that for the agricultural social service provider, π_{va2} , is shown in Equation (14).

$$\pi_{vf2} = \sum_{t=1}^T y_s(t) - E(x) * T. \quad (13)$$

In Equation (13), $\sum_{t=1}^T y_s(t)$ is the bad land output that the farmer gets in T years when the agricultural social service provider chooses short-term behaviors and $E(x) * T$ is the trusteeship fees that the farmer expects to pay in T years when the variable price system is adopted. Equation (13) shows that given the variable-price system, the farmer's return in this scenario is the difference between the badland output and the trusteeship fees for T years.

$$\pi_{va2} = E(x) * T - c_s * T \quad (14)$$

In Equation (14), $E(x) * T$ is the total expected income in T years of using the agricultural social service provider when the variable price system is adopted and $c_s * T$ is the sum of variable costs each year when the agricultural social service provider chooses short-term behaviors. According to Equation (14), given the variable price system, the agricultural social service provider's return in this scenario is the difference between the expected trusteeship fees and operating costs related to short-term behaviors.

Scenario 3: The farmer chooses a 1-year trusteeship and the agricultural social service provider chooses long-term behaviors L.

In this scenario, the profit function for the farmer, π_{vf3} , is shown in Equation (15) and that for the agricultural social service provider, π_{va3} , is shown in Equation (16).

$$\pi_{vf3} = \sum_{t=1}^T y_l(t) - E(x) * T + z \quad (15)$$

In Equation (15), $\sum_{t=1}^T y_l(t)$ is the good land output that the farmer gets in T years when the agricultural social service provider chooses long-term behaviors L and $E(x) * T$ is the trusteeship fees that the farmer expects to pay in T years when the variable price system is adopted. Equation (15) shows that given the variable price system, the farmer's return in this scenario is the difference between the good

land output and the expected trusteeship fees for T years, as well as the investment in land that the agricultural social service provider makes.

$$\pi_{va3} = E(x) * n - c_l * n - z. \quad (16)$$

In Equation (16), $E(x) * n$ is the total income that the agricultural social service provider expects to earn in T years when the variable-price system is adopted and $c_l * n + z$ is the sum of the variable cost and fixed investment in T years when the agricultural social service provider chooses long-term behaviors. According to Equation (16), given the variable price system, the agricultural social service provider's return in this scenario is the difference between the expected trusteeship fees and operating costs related to short-term behaviors minus the fixed investment.

Scenario 4: The farmer chooses a 1-year trusteeship and the agricultural social service provider chooses short-term behaviors.

In this scenario, the profit function for the farmer, π_{vf4} , is shown in Equation (17) and that for the agricultural social service provider, π_{va4} , is shown in Equation (18).

$$\pi_{vf4} = \sum_{t=1}^T y_s(t) - E(x) * T. \quad (17)$$

In Equation (17), $\sum_{t=1}^T y_s(t)$ is the bad land output that the farmer gets in T years when the agricultural social service provider chooses short-term behaviors L and $E(x) * T$ is the trusteeship fees that the farmer expects to pay in T years when the variable price system is adopted. Equation (17) shows that given the variable-price system, the farmer's return in this scenario is the difference between the bad land output and the trusteeship fees for T years.

$$\pi_{va4} = E(x) * n - c_s * n \quad (18)$$

In Equation (18), $E(x) * n$ is the total expected income in T years of the agricultural social service provider when the variable-price system is adopted and $c_s * n$ is the sum of the variable costs each year when the agricultural social service provider chooses short-term behaviors. According to Equation (18), given the variable price system, the agricultural social service provider's return in this scenario is the difference between the expected trusteeship fees and operating costs related to short-term behaviors.

3. Results

3.1. Results of Equilibrium under the Fixed-Price System

The game between farmers and agricultural social service providers is a dynamic game. This study applied backward induction to estimate, first, the agricultural social service provider's strategic choices and then, the farmers' decisions.

3.1.1. Strategic Choices of the Agricultural Social Service Provider

When the farmer chose the T-year-trusteeship strategy (T), the social service provider had to choose between long-term behaviors and short-term behaviors. His choice depended on the returns from the two options, π_{fa1} and π_{fa2} , respectively, i.e., whichever was the higher one. According to the Equations (4) and (6), from $\pi_{fa1} - \pi_{fa2} \geq 0$, we get $T \geq \frac{z}{c_s - c_l}$. This is noted as $T' = \frac{z}{c_s - c_l}$, and its economic significance is that if the social service provider chose long-term behaviors, it would pay a fixed investment amount z that takes T' to recover but could save operating costs of $c_s - c_l$ each year. The result suggests that if the farmer chose the T-year-trusteeship strategy and if $T \geq T'$, the social service provider would choose long-term behaviors; if the contrary was true, they would choose short-term behaviors.

When the farmer chose the 1-year-trusteeship strategy (1), the social service provider had to choose between long-term behaviors and short-term behaviors, which he would choose depending on

returns from the two options, π_{fa3} and π_{fa4} respectively, i.e., whichever was the higher one. According to Equations (8) and (10), from $\pi_{fa3} - \pi_{fa4} \geq 0$, we get $n \geq \frac{z}{c_s - c_l}$. This result suggests that if the farmer chose the 1-year trusteeship strategy and if the agricultural social service provider thought that their years of trusteeship out of T years are $n \geq T'$, the social service provider would still choose long-term behaviors; if the contrary was true, they would choose short-term behaviors.

3.1.2. Strategic Choices of the Farmer

The agricultural social service provider's strategic choices and the farmer's countermeasures are discussed in terms of three circumstances with respect to the lengths of T , n , and T' , namely $T \geq n \geq T'$, $T \geq T' \geq n$, and $T' \geq T \geq n$, respectively shown in Table 2.

Table 2. Results of the game equilibrium and conditions for their occurrence under the fixed-price system.

Decision Condition for the Farmer	The Farmer's Decision	Decision Condition for the Agricultural Social Service Provider	The Agricultural Social Service Provider's Decision	Result of Equilibrium
$E(x) \geq x$	T	$T \geq n \geq T'$	L	T-L
$E(x) \geq x$	T	$T' \geq T \geq n$	S	T-S
$x - E(x) \leq \beta + \frac{z}{T}$	T	$T \geq T' \geq n$	L	T-L
$x - E(x) > \beta + \frac{z}{T}$	S	$T \geq T' \geq n$	S	1-S
$E(x) < x$	S	$T \geq n \geq T'$	L	1-L
	S	$T' \geq T \geq n$	S	1-S

When $T \geq n \geq T'$, the agricultural social service provider would choose long-term behaviors and the farmer's return when choosing the T -year trusteeship strategy and the 1-year trusteeship strategy would be π_{ff1} and π_{ff3} , respectively, based on which the farmer would make their strategic choice. According to Equations (3) and (7), from $\pi_{ff1} \geq \pi_{ff3}$, we get $E(x) \geq x$. Its economic significance is that if the farmer could entrust their land long enough, the agricultural social service provider would be certain to choose long-term behaviors, and if the agreed trusteeship price x was lower than the expected trusteeship price for T years $E(x)$, the farmer would choose a long-term contract, and the result of the game equilibrium will be T-L. If the contrary was true, the farmer would choose a short-term contract and the result of game equilibrium will be 1-L.

When $T \geq T' \geq n$, the agricultural social service provider would choose their strategy according to the farmer's strategic choice. If the farmer chose the T -year-trusteeship strategy, the agricultural social service provider would choose long-term behaviors. If the farmer chose a 1-year-trusteeship strategy, the agricultural social service provider would choose short-term behaviors. The farmer's returns in the two circumstances are π_{ff1} and π_{ff4} . They would make their strategic choice depending on whichever was larger. According to Equations (3) and (9), from $\pi_{ff1} \geq \pi_{ff4}$, we get $x - E(x) \leq \frac{1}{T} * \left[\sum_{t=1}^T y_l(t) + z - \sum_{t=1}^T y_s(t) \right]$. $y_l(t)$ is the monotonically increasing function of t in the neighborhood of T , whose range is $(\gamma, \beta + \gamma)$, and $y_s(t)$ is the monotonically decreasing function of t in the neighborhood of T , whose range is $(\gamma, \beta + \gamma)$. Therefore, $x - E(x) \leq \beta + \frac{z}{T}$, whose economic significance is that if the sum of the output return and fixed investment as a result of the agricultural social service provider seeking long-term behaviors was not lower than the possible loss due to fluctuations in trusteeship prices, the farmer would choose T -year trusteeship, and the result of the game equilibrium would be T-L, otherwise the farmer would choose the trusteeship once a year, and the result of the game equilibrium would be 1-S.

When $T' \geq T \geq n$, the agricultural social service provider would choose short-term behaviors and the farmer's return when choosing the T -year trusteeship strategy and the 1-year trusteeship strategy would be π_{ff2} and π_{ff4} , respectively, based on which the farmer would make his strategic choice. According to Equations (5) and (9), from $\pi_{ff2} \geq \pi_{ff4}$, we get $E(x) \geq x$, and its economic significance is that if the farmer entrusted their land for a time that was short enough, the agricultural social

service provider would be certain to choose short-term behaviors, and if the agreed trusteeship price x was lower than the expected trusteeship price for T years $E(x)$, the farmer would still choose T -year trusteeship and the result of the game equilibrium would be T-S. If the contrary is true, the farmer would choose a short-term contract, and the result of the game equilibrium would be 1-S.

3.2. Results of Equilibrium under the Variable Price System

The calculation of game results under the variable-price system is similar to that under the fixed-price system, namely estimating the agricultural social service provider's strategic choices first and then the farmer's strategic choices.

3.2.1. Strategic Choices of the Agricultural Social Service Provider

When the farmer chooses the T -year-trusteeship strategy, the social service provider has to choose between long-term behaviors and short-term behaviors. They would make their choice based on the return from the two options, π_{va1} and π_{va2} , i.e., whichever was the higher one. According to Equations (12) and (14), from $\pi_{va1} - \pi_{va2} \geq 0$, we get $T \geq \frac{z}{c_s - c_l} = T'$. The result suggests that if the farmer chose the T -year-trusteeship strategy, and if $T \geq T'$, the social service provider would choose long-term behaviors. If the contrary is true, they would choose short-term behaviors.

When the farmer chooses the 1-year-trusteeship strategy, the social service provider has to choose between long-term behaviors and short-term behaviors, which he would choose depending on the return from the two options, π_{va3} and π_{va4} , i.e., whichever was the higher one. According to Equations (16) and (18), from $\pi_{va3} - \pi_{va4} \geq 0$, we get $n \geq \frac{z}{c_s - c_l} = T'$. This result suggests that if the farmer chose the 1-year trusteeship strategy, and if the agricultural social service provider thinks that their years of trusteeship out of T years are n , the social service provider would still choose long-term behaviors. If the contrary was true, they would choose short-term behaviors.

It is obvious that the conditions required for the agricultural social service provider to choose long-term behaviors or short-term behaviors under the variable-price system are similar to those under the fixed-price system, with the term of trusteeship still being the primary economic factor that the agricultural social service provider considers when deciding what behaviors to choose. When the relation between T , n , and T' is $T \geq n \geq T'$, the agricultural social service provider chose long-term behaviors. When $T \geq T' \geq n$, they chose their strategy according to the farmer's strategic choice. If the farmer chose the T -year-trusteeship strategy, the agricultural social service provider chose long-term behaviors. If the farmer chose the 1-year-trusteeship strategy, the agricultural social service provider chose short-term behaviors. When $T' \geq T \geq n$, the agricultural social service provider chose short-term behaviors.

3.2.2. Strategic Choices of the Farmer

The agricultural social service provider's strategic choices and the farmer's countermeasures are discussed considering three circumstances with respect to the lengths of T , n , and T' , namely $T \geq n \geq T'$, $T \geq T' \geq n$, and $T' \geq T \geq n$, respectively shown in Table 3.

Table 3. Results of the game equilibrium and conditions for their occurrence under the variable-price system.

Decision Condition for the Farmer	The Farmer's Decision	Decision Condition for the Agricultural Social Service Provider	The Agricultural Social Service Provider's Decision	Result of Equilibrium
$E(x) = x$	T/1	$T \geq n \geq T'$	L	T-L/1-L
$E(x) = x$	T	$T \geq T' \geq n$	L	T-L
$E(x) = x$	T/1	$T' \geq T \geq n$	S	T-S/1-S

When $T \geq n \geq T'$, the agricultural social service provider will choose long-term behavior, and the farmer's return when choosing the T-year trusteeship strategy and the 1-year trusteeship strategy will be π_{vf1} and π_{vf3} , respectively, based on which the farmer will make their strategic choice. According to Equations (11) and (13), $\pi_{vf1} = \pi_{vf3}$, which means that when there is no difference in return when choosing the T-year trusteeship strategy or 1-year trusteeship strategy, the farmer may either choose a long-term contract so that the result of the game equilibrium is T-L or a short-term contract so that the result of the game equilibrium is 1-L.

When $T \geq T' \geq n$, the agricultural social service provider will choose their strategy according to the farmer's strategic choice. If the farmer chooses the T-year-trusteeship strategy, the agricultural social service provider will choose long-term behaviors. If the farmer chooses a 1-year-trusteeship strategy, the agricultural social service provider will choose short-term behaviors. The farmer's return under the two circumstances is π_{vf1} and π_{vf4} , and they will make their strategic choice depending on whichever is larger. According to Equations (11) and (17), from $\pi_{vf1} \geq \pi_{vf4}$, we get $\sum_{t=1}^T y_l(t) - \sum_{t=1}^T y_s(t) + z \geq 0$. Since $y_l(t)$ is the monotonically increasing function of t in the neighborhood of T , whose range is near $\beta + \gamma$, and $y_s(t)$ is the monotonically decreasing function of t in the neighborhood of T , whose range is γ , the condition for $\pi_{vf1} \geq \pi_{vf4}$ is $T * \beta + z \geq 0$. This inequality is certain to be tenable since T , β , and z are all positive numbers. This means that the farmer will choose the T-year trusteeship strategy, the result of the game equilibrium will be T-L.

When $T' \geq T \geq n$, the agricultural social service provider will choose short-term behaviors and the farmer's return when choosing the T-year trusteeship strategy and the 1-year trusteeship strategy will be π_{vf2} and π_{vf4} , respectively, based on which the farmer will make their strategic choice. According to Equations (13) and (17), $\pi_{vf1} = \pi_{vf4}$, which means that, when there is no difference in return when choosing a T-year trusteeship strategy or 1-year trusteeship strategy, the farmer may either choose a long-term contract so that the result of the game equilibrium is T-S or a short-term contract so that the result of the game equilibrium is 1-S.

4. Discussion

4.1. Discussion of Results under the Fixed-Price System

Both the survey findings and model conclusions showed that the fixed-price system was one of the important factors that led to short-term contracts between the farmer and agricultural social service provider and to the latter's short-term behaviors.

It is obvious that from the results of equilibrium under the fixed-price system, the key to addressing short-term behaviors in land trusteeship is to address the farmer's expectations of the fluctuations in prices and the agricultural social service provider's expectations of the term of trusteeship. To the farmer, it was the price fluctuation that was the primary economic factor behind their behavioral choice. To guarantee their own return, when the trusteeship price ran low (i.e., $x \leq E(x)$ or $x - E(x) \leq \beta + \frac{z}{T}$), the farmer was more inclined to choose a long-term contract with the intention of reducing trusteeship fees. When the trusteeship price ran high (i.e., $E(x) < x$ or $x - E(x) > \beta + \frac{z}{T}$), they were more likely to sign a short-term contract so that they could flexibly control the trusteeship price. To the agricultural social service provider, on the other hand, the term of trusteeship was the primary factor behind their behavioral choice. If the term of trusteeship was so long as to allow the agricultural social service provider to save costs within the term that were higher than the fixed investment in infrastructure (i.e., $T \geq T'$ or $n \geq T'$), the agricultural social service provider would choose long-term behaviors, or else they would choose short-term behaviors.

The survey conducted in Shangshui County, Henan Province showed that, when it came to fixed-price land trusteeship contracts, farmers tended to sign a short-term trusteeship contract when trusteeship prices were high and a long-term trusteeship contract when trusteeship prices were low. A short-term contract may have made the agricultural social service provider feel uncertain about the

term of trusteeship and thus fear spending money on building facilities on the land. The findings of the survey are in accordance with the conclusions drawn from the theoretical model.

4.2. Discussion of Results under the Variable-Price System

Both the survey findings and the model conclusions show that the variable-price system could help coordinate relations of interest between the farmer and agricultural social service provider and could encourage the farmer to sign a long-term contract and the agricultural social service provider to construct infrastructure on the land.

It is clear that, from the results of equilibrium under the variable-price system, adopting the variable-price system could encourage the farmer to sign a long-term contract and the agricultural social service provider to make long-term land investment. Under the variable-price system, the price that the farmer paid for T -year trusteeship, x , was the same as the expected price of 1-year trusteeship, $E(x)$. This avoided the profit and loss caused by fluctuations in prices, making it unnecessary for the farmer to choose a short-term contract. To the agricultural social service provider, on the other hand, it was the term of trusteeship that was still the primary factor behind their behavioral choice. If the term of trusteeship was so long as to allow the agricultural social service provider to save costs within the term that were higher than the fixed investment in infrastructure (i.e., $T \geq T'$ or $n \geq T'$), the agricultural social service provider would choose long-term behaviors or else they would choose short-term behaviors. For variable-price land trusteeship contracts, therefore, so long as the term of trusteeship was $T \geq T'$, the farmer and the agricultural social service provider could arrive at the equilibrium result of T-L.

According to the survey conducted in Shangshui County, Henan Province, while no definite variable-price trusteeship contracts were formed locally, some farmers who signed long-term trusteeship contracts when trusteeship prices were high would choose to breach their contracts and renegotiate trusteeship prices with agricultural social service providers. Breach of contract and renegotiation behaviors by farmers could be seen as precursors of a variable-price system, allowing farmers to alter trusteeship prices without replacing their agricultural social service providers and avoid the effects of price fluctuations on trusteeship decision-making. Additionally, they could ensure a stable land trusteeship on the part of agricultural social service providers to a certain degree. The findings of the survey are in accordance with the conclusions drawn from the theoretical model.

5. Conclusions

The variable-price system should be put in place between farmers and agricultural social service providers to discourage short-term contracts and short-term behaviors in land trusteeship. It was evident from the model analysis that the variable-price system could aid in the removal of the effects of fluctuation in trusteeship prices on decision-making by farmers and encourage farmers to sign long-term contracts and conduct stable cooperation relations with agricultural social service providers. It could also help to remove the effects of the trusteeship term on decision-making by agricultural social service providers and incentivize them to choose long-term behaviors and promote the sustainable utilization of land.

The Chinese government should continue to improve land policy and legislation to enable the separation of ownership rights, contract rights, and management rights for contractual rural land, with a view toward guaranteeing the healthy development of land trusteeship and the sustainable utilization of land. The model analysis showed that the reason for the presence of short-term contracts and short-term behaviors in land trusteeship was not the land policy of separating the ownership rights, contract rights, and management rights for contractual rural land, but rather due to the flawed contract system that governs farmers and agricultural social service providers. To guarantee the healthy development of land trusteeship and the sustainable utilization of land, it is necessary to not only continuously follow the policy direction of separating the ownership rights, contract rights,

and management rights for contractual rural land but also to make efforts to constantly, under this framework, improve institutional, legal, and management systems.

This study may provide some reference for East Asian countries where smallholders have a dominant role in solving their land issues. Like China, countries such as Japan and South Korea also have big populations with limited farmland. With smallholders playing a dominant role, these countries have to take certain economic and administrative measures towards large-scale and modern management of agriculture. To ensure the sustainable utilization of land, such countries should, when it comes to large-sale land management, pay attention to coordinating the relations between stakeholders from an economic point of view and build appropriate wealth creation and distribution mechanisms so as to provide institutional and administrative support for sustainable land utilization.

The “Introduction” section mentioned that some studies attributed short-term contracts to incomplete contracts among other economic factors, but those studies failed to identify problems with contracts and did not provide solutions. This study points out, unprecedentedly, that the fluctuations in trusteeship prices and the fixed-price system were important reasons that led to short-term contracts and short-term behaviors in land trusteeship. We also note, through game model analysis, that the variable-price system may have removed the effects that the fluctuations in trusteeship prices had on the contract term, thus ensuring, at an institutional level, a long-term stable cooperation relationship between farmers and agricultural social service providers and encouraging the sustainable utilization of land.

In land trusteeship, besides prices and terms of trusteeship, the contiguous farmland entrusted also had quite strong effects on fertilizer irrigation, soil improvement, land management, and other long-term behaviors, a subject that has rarely been studied. It is still necessary to design proper mechanisms regarding farmers and agricultural social service providers and it is suggested that future research should be focused on the impact that contiguous farmland entrusted by multiple farmers has on the sustainable utilization of land.

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