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Price Signal of Tilled Land in Rural China: An Empirically Oriented Transaction Costs Study Based on Contract Theory

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Abstract: Prices are effective signals of many market conditions, while underpricing of tilled land in rural China poses a dilemma to this common sense. Using n = 191 imputed contracts in rural China, this paper aims to investigate the role of ambiguous property rights in the context of agricultural reforms. Using rank statistics, several candidate variables in the transaction costs function $f_c(\bullet)$ were identified, including BMI (Body Mass Index), Knowledge, Subtraction and Farming Experience. The results show clear evidence for underpricing to restrain competition under ambiguous property rights. More illuminatingly, non-parametric regression analysis specifies a well-founded transaction costs function: increasing Subtraction by one unit increases transaction costs by the equivalent of US$513.40, while a one-year increase of farming experience reduces transaction costs by US$116.20, ceteris paribus. It concludes that social costs behind underpricing are detrimental to China's rural reform. This study contributes to economic theory, with important implications for policy makers. To encourage smooth transmission of price signals, it is important to consider farmer characteristics and develop professional farmers.

Keywords: land use; new institutional economics; imputed contract

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1. Introduction

China's land reforms have led to a situation of ambiguous property rights, and agricultural land use driven by a transferal fees for tilled agricultural plots. The impacts of these reforms have been well-studied, though relatively little attention has been focused on the structural economic inefficiencies related to transactions costs and competitiveness. This paper aims to specify mechanism behind underpricing practice of Chinese farmers.

McGee's Outright Purchase Hypothesis was used to explain the well-known 1911 anti-trust case of Standard Oil Company's pricing strategy to gain monopolistic advantage and market control to effectively reduce competition [1]. According to this hypothesis, there are sufficient future gains available to enable predatory mergers and acquisitions by permitting former owners to share in the monopoly windfall. In this United States context with relatively few governmental restraints on market participants, McGee argued that a competing hypothesis—the Predatory Price Cutting Hypothesis—was invalid. According to that hypothesis, Standard Oil drove competitors from the market by selling below cost, engaging in war by attrition. Once competitors are expected to be unable to cover variable costs, they drop from the market. Notably, there exist several US court decisions based on the latter Predatory Price Cutting Hypothesis, and indeed this combative competition perspective still dominates in many international affairs, for example in the famous antitrust investigation on Microsoft [2]. Cheung examined a similar context—ticket pricing for better seats, and found that the threat of price reductions can restrain behavior [3]. Here, this paper

revisits these competing hypotheses in the context of rural land reform and ambiguous property rights in China.

Although there have been significant changes to agricultural land use and management in China, tilled land remains government owned. This disconnection between ownership and use right creates the potential for property rights-based inefficiencies. More recently, the failure of price signal transmission (i.e., zero rent) in rural China is a phenomenon of concern that lacks a cohesive explanation. Several studies have proffered suggestions, such as the role of farmer's characteristics in determining choice between monetary rent and non-pecuniary benefits when transferring tilled plot, ordinal transaction costs hypothesis related to zero rent in mountain area, and social network hypothesis [4–6]. While these studies focused on the factors driving low rental rates, they fail to consider an important one: reverse causation, in which the idiosyncratic and confusing price signal itself can be seen as an effective method to exclude competition from non-expert outsiders by adding ambiguity to the production context.

It appears that the price of land use in agriculture is undervalued considerably. Previous studies have relied on prevailing surveys to determine agricultural production [7]. These surveys are used in China to help direct policy, but their limitations are well known. Statistically, most researchers do not discuss measurement error involved. Economically, transaction costs are almost totally assumed away. A more reliable source of information on agricultural production is imputing contracts. This method of estimation can be used to understand the role of transaction costs in explaining the failure of price to align with value in a land transfer whether or not the transfer is based on monetary trade or non-pecuniary benefits.

Agricultural land reforms have had remarkable impacts on economic development where used. For example, the China case is comparable to the Japanese experience with the underpricing mirroring Japan's painstaking structural adjustment during 1961–1985, in which rent controls depressed free trade in tilled plots and resulted in institutional barriers to scaling up agricultural operations [8]. What makes underpricing in China outstanding is the idiosyncratic property rights arrangement that gives farmers a clear right to income and right to transfer with vague expression and an uncertain right to exclude. This underpricing behavior may have evolved as a response to the inefficient regulation, found previously in Japan and now in China.

Underpricing of tilled plots is a puzzle that merits serious consideration. The major aim of this study is to examine several competing factors driving transactions costs $f_c(\bullet)$. The novelty of this paper is shown in two aspects: First, to assess the role of rent dissipation in investment behavior, a state-of-the-art nonparametric technique is applied. Second, the novelty also lies in the estimation of transaction costs' function. In the following sections, this study is situated within the broader literature on property rights and transaction costs (Section 2), outline the hypotheses being tested (Section 4), and then describe the data and methods before presenting results (Section 5). Next, this paper discusses the findings in the context of the literature, and presents implications of the study for economic theory, agricultural economics practitioners, and for policy design in the China context. Section 6 concludes with a synthesis of findings.

2. Transaction Costs Background

Transactions costs have long been a major focus of economic theory and practice. Early contributions by Ronald Coase, Stephen Cheung, Oliver Williamson, and others helped to lay the analytical foundation [9–13]. These ideas sparkle and lead to a richer understanding of producer behavior (Tullock realized that free trade will reduce the resources invested in lobbying or attempting to organize monopolies (page 232, paragragh 1), a situation very comparable to disguised income transfer implied behind transaction costs criterion we investigate), social externalities, contract demand, and contract governance [14–16]. The Coasean–Cheungian contract theoretic paradigm emphasizes the role of transaction costs as a major factor in firm behavior. For example, Black and Scholes applied the transaction cost

idea to options pricing, computing approximating transaction costs for various scenarios, but do not link to the empirically-observed phenomena. While important, that approach misses the implication behind non-zero profit of writer or buyer. Giving the assumption of free entry in neo-classical tradition, competition can reduce writer's profit to zero. However, this is verified by significant profit documented in the stock market [17]. Agency costs matters in this "call (or straddle) buyer–writer–seller" contractual chain and help to reduce uncertainty in the stock market [18]. More recently, this paradigm has been instrumental when extended beyond a capitalist context from which it emerged to help predict and describe economic phenomena in centrally planned economies [19,20].

Critics of the Coasean–Cheungian paradigm cast some doubt on the power of transaction-costs economics. Samuelson vigorously objected to Coase's assertion that, if his objection to the Pigou Tax is accepted, then there would be infinite compensation terms governing externalities, which contradict the uniqueness of the equilibrium assumption in a neo-classical stationary state [21]. This is a rather strong critique in the context of transactions costs. It is easily to prove the existence and uniqueness of equilibrium in mathematics, eschewing the significance of transaction costs. Or put it in another way, critics like Samuelson and others seldom subjected their theory to hard facts in the real world, which explains their disability to restate equilibrium notion in the language of neo-institutional economics: equilibrium shall be thought to be the result of inter-individual negotiation in which many local equilibria are possible.

Transaction costs are particularly central to empirically oriented contract theory. Cheung's research on land leases in rural China in the 1930s is credited with the first study in this area. Further work by Cheung investigated the reciprocal trade between firms, for example between beekeeper and fruit grower in Washington State, and verified the inefficiency in this market that others conjectured. What some Cheungian scholars considered unimportant, have nonetheless evolved into key factors that compose a phenomenon typically linked to the price signal failing, and which merit further examination [22,23].

This paper contributes to this robust discourse over contract theory and transaction costs by assessing undervalued tilled plots (n = 191 imputed contracts) in rural China to derive an empirical transaction cost investment function, and use that to discuss the theoretical basis that produces the failure of the price signal in transmitting. Importantly, to directly engage the underpricing phenomenon, this study uses empirical yield data rather than expected yield to take windfalls into account. This analysis provides an important empirical grounding for this interesting phenomenon using data available in the context of rural farmers in China. This work fills two important gaps in the transaction costs literature. The first relates to the institutional context in which transactions occur. In practice, little is known about the competitive institutions, or the transaction cost function that can drive them $f_c(\bullet)$. Through ordinal measure of transaction costs (e.g., Umbeck), only get vague impressions can be obtained as to the role of transaction costs in production. The second is the identification of cardinal transaction costs in economic theory and its statistical measurement. The consistence between economic significance and statistical significance render $f_c(\bullet)$ as a useful guide to see irrational behavior in social planning countries [24–30].

3. Methods

The study area covers three agricultural communities in Jianli, which is located in the middle of the southern region of Hubei Province, China. These are denoted as Village "Wangyuan", Village "Daijiamen", and Village "Fenhong", as shown in Figure 1. In 2016, data were collected from 45 farmers involving n = 191 instances of land use cost–benefit data in great detail (The empirical study on transaction costs is considerably concrete and oriented toward a real-world scenario such that large samples are almost excluded. Frequently, there are approximately 100 samples. The reciprocal exchange contracts in Cheung are limited to 9 copies, and the corresponding number in Laffont and Matoussi is 170). Using these data, we imputed 191 contracts through indirect measurement using micro-level data that are directly relevant to transaction costs hypothesis. These n = 191

crop contracts reflect agricultural production typical of South China, including not only typical commodities such as rice, potatoes, and pumpkin, but also economic crops such as varieties of vegetables, rape, and cotton, and even crayfish, crab, and soft-shelled turtle. Although the investigation covers three villages, they are representative of the areas diverse crop production.

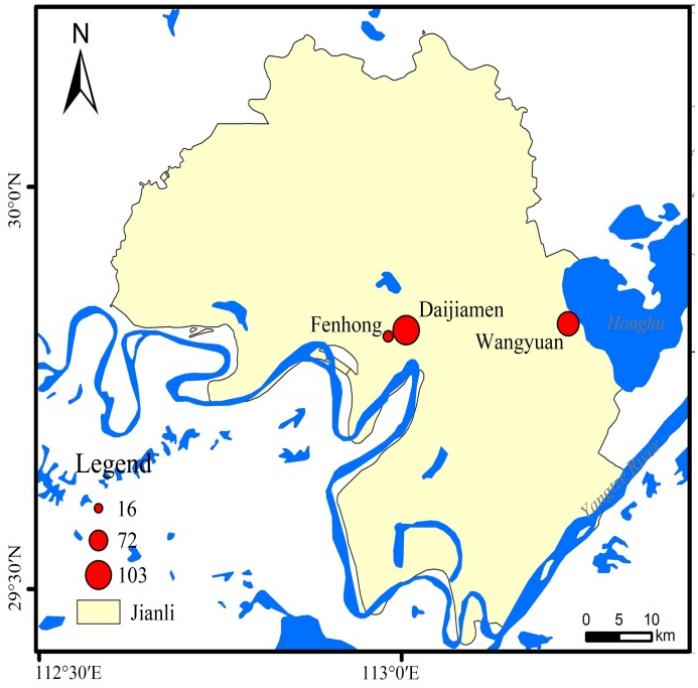


Figure 1. The Distribution of Study Area.

3.1. Research Hypothesis

According to the economic rent criterion, contract holders will maximize economic rent given a specific constraint. However, then the question arises as to what are observed in three typical villages of Southern China. In Village "Wangyuan" or "Daijiamen", the prevailing rent rate of cultivated land is US$462.70 per hectare. Land transfer expense aside, farmers have other transaction costs to deduct by law. After the Spring Festival, village cadre will collect a fee according to the "Burden Card". This sum is rather stable, fluctuating at approximately US$15.50 per head. If the area they actually cultivate is beyond 1 hectare, an extra of US$461.19 per hectare is charged by customs, regardless of whether the land is transferred from strangers or inherited from their relatives. However, the later expense is included in the "Other expense" rather than the land rent, because the village secretary does not state clearly whether this revenue is used for land improvement. Considering the magnitude of income and economic significance of Hypothesis, investigators also imputed the former one in "Other expense". In Village "Fenhong", the rent of land depends on its location. Those farming on land near the Yangtze River must take the risk of floods, which discourages the bidding among farmers. On average, they only pay US$398.50 per hectare. Fishers remote from this risk pay US$1136.80 per hectare. However, this relatively high price was reported only once. The average monthly rents are US$38.81/hectare/month, US$28.40/hectare/month, and US$49.25/hectare/month. Needless to say, all these figures are not only negligible compared to land rent in industry but are also far below the level of modernized western farms. An alternative explanation for this apparent abnormality is that farmers may turn to maximize their human capital. That is, their wages become economic rent. However, the investigators fail to find evidence to support such a conjecture. In Village A, labor is paid according to sex. Male labor earns US$31, while female labor earns US$3.10 less. Labor's going rate in Village B is US$31. At a fishing village, the measure of labor is somewhat different. They count a staff as "Gong", and a labor can offer three Gongs per

day on average. It costs US$9.30 to hire a "Gong", so one can reasonably impute US$27.80 as the labor's payment in one day. If a measurement error of 10% was approved, then the competitive wage rate is approximately US$27.80 per day. It may be induced by transaction costs, according to the hypothesis just laid out. Turning to land rent, the conjecture will be confirmed further. It will be shown in the rice crop's real data from a landlord of 10 "mu" in Village A. Expenses on rent, re-adjustment of farm boundaries, base fertilizer, seedlings, pesticide, after manuring, harvest, and other expense are US$103.00, US$154.60, US$224.10, US$243.40, US$278.20, US$46.40, US$154.60, and US$386.40, respectively. This comparatively competitive wage rate excludes the value of human capital as economic rent. According to usual construction, economic rent can be attributed to such factors as land, human capital, and primary products, but this investigation shows that contract holders abandoned the maximization of any of them. Therefore, consider a conjecture such that the information cost makes price signals out of order, leading to ambiguous property rights. Consider the following problem:

$$\underset{H}{Max}\left\{P\bullet f(T)\bullet e^{-r\bullet H} - f_c(\bullet)\bullet\int_0^H e^{-r\bullet t}dt - V - W\bullet L - K\right\} = O \quad (1)$$

V denotes economic value of agent A_1's resource, P is price of final goods, L measures "proxy factor" input of agent A_2 and its rate is W, and r designates the competitive rate of return (i.e., interest rate). The production function $f(T)$ is continuous, with a positive 1st derivative and a negative 2nd derivative. T reflects the investment period.

This differs from Faustmann or Fisher's investment model in two aspects. First, H is used to denote the refined definition of expectation. Second, the transaction costs function $f_c(\bullet)$ is explicit in the model. Intuitively, agent behavior is driven by transaction costs, and under certain conditions that are relevant to the case examined, their behavior is driven more by transaction costs than economic rent. Given a windfall loss of GE = Δ, the analysis is as follows: Geometrically, H_i will shift to the right owing to this shock, as Figure 2 shows. Note point E^* measures intersection of vertical axis and the tangent line to production function $f(T)$ that indicates Fisher solution. To reconcile different horizon notations, † is used in Figure 1 to measure variable time dimension. Given a constant interest rate (with H_1 remaining where it was), the time interval between H_1 and H_i shrinks. Equation (1) can be illustrated as a hypothesis: Given significant information costs, agents can turn from maximization of economic rent to transaction costs, and that contract holders use underpricing to restrain competition. Though seemingly irrational on the surface, this phenomenon is consistent with institutional economics and utility maximization under constraints. For example, evidence of positive profits in American timber-harvesting contracts are well observed, which means that the landlord and timber owner abandon the zero-profit constraint [27].

3.2. A Cardinal Measure of Transaction Costs

Crop plans are relevant to direct measurement of transaction costs. First, the investigators standardized the production process for every crop in contract sample; then computed the windfalls for every contract according to Formula (1). Specifically, they included such non-pecuniary expenses as own labor and own material as prime costs, the interest of which also constitutes part of the costs. Referring to the accounting of the pension association in "Wanyuan", the investigators set the monthly interest rate at 1.2%. Windfalls are identified by estimating transaction costs, where windfalls are defined by income net of prime cost and land rent during the accounting period of the crop contract.

After obtaining cost–benefit data, the investigators reclassified the data farmers reported to make transaction cost statistical estimations and relevant rank tests possible (To save space the statistics of the standardized process with both monetary value and non-pecuniary benefits included are omitted. Relevant statistical table are available on request). The reclassification included investment items such as labor, seeds, fertilizer, machinery, pesticides, and herbicides. For example, when surveying the famous rice–

crayfish rotation plan in Southern China, the investigators learned that most of farmers hold back crop outputs (e.g., from soybeans) as input for another crop and simultaneously buy from the market as well. When considering grain and vegetable crops, comparable treatment generally appears. Based on this, the investigators separated investments into two sub-items: self-owned and outsourced. Pesticide control turns out to be the joint work of the agents' labor and the pesticide, so the cost of the pesticide and the expense of outsourcing the service are discerned. Herbicide treatment is similar.

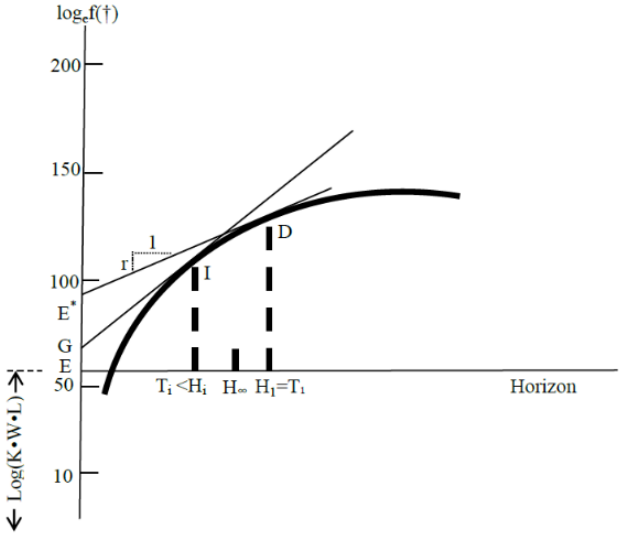


Figure 2. Transitory shock lengthens period of investment.

Note that important production factors omitted from Table 1 were captured (e.g., rotation, inter-planting, and relay planting). This study also captures social factors that are thought to affect contract outcomes, including agents' characteristic related to farming and farm management (Subtraction, Memory, and Knowledge), experience (Farming Experience), social status (Body Mass Index, or BMI), risk preference (Risk Tolerance), and an important farm characteristic (Area).

Table 1. Factors examined in Cheungian research on contracts.

Reference	Topic	Citation Frequency	Key Factors Examined
Cheung	Reciprocal exchange	239	Variance of expected yield of honey and pollination service
Umbeck	Contract selections in "California Gold Rush"	79	Yield variance of gold
Staten, Gilley, and Umbeck	Automobile credit contract	13	Interest rate.
Leffler and Rucker	Timber harvest contracts	119	The ratios of hardwood sawtimber, to measure tract heterogeneity
Laffont and Matoussi	Lease contract in Village "El Oulja" in Tunisia	218	Contract type and length of sharecropping contract.
Allen and Lueck	Farm organization contract	333	Crop cycle, age of farmers and farmer's education
Ackerberg and Botticini	Land lease contract in Tuscany	164	Contract type and tenant's wealth
Fang, Keane, and Silverman	Medigap contract in America	269	Health factors and risk tolerance

3.3. Transaction Costs Function: Nonparametric Approach

By estimating the transaction cost statistic and applying it to other characteristic variables of the sample farmers, this study confirms the critical role of transaction costs in determining the farmer's various investments, and also identifies several critical characters that may influence transaction costs significantly both in economic and statistical senses. Now, it further penetrates into the relationship between these factors and the transaction cost function. Though field investigation offers solid evidence for the transaction cost criterion, investigators are cautious when quantifying the effect of potential variables on transaction costs. Hence, employ nonparametric regression is employed, for which there is no need to specify a parametric function form. The parametric analysis is merited given the statistical results and disagreement in economic theory, as demonstrated by Cheung and further explored by Umbeck, Leffler, and Rucker and other pioneers. Using the Stata command "npregress" estimates a local linear regression solving the minimization problem:

$$\min\gamma \sum_{i=1}^{n} \{y_i - \gamma_0 - \gamma_1{}'(x_i - x)\}^2 K(x_i, x, h) \quad (2)$$

The γ_0 in Equation (2) is the conditional mean at a specific point x, and slope coefficient $\gamma_1{}'$ is the derivative of the mean function with respect to x. Comparable to the optimal process in ordinary parameter estimation, they differ in two key points: owing to the absence of a specific functional equation, researchers cannot indicate how many degrees of freedom are used when the computer labors in estimation [31,32]. It also adds two additional technical features that differ from common parameter estimation. First, there is no F-statistic in the reported results, owing to the special procedure of the bootstrap method, by which the degree of freedom criterion in classical statistics collapses. Second, this method does not rely on the assumption that variables follow a normal distribution, similar to the transaction cost statistic created.

4. Results

Table 2 lists the variables used and its description from imputed contracts. Among them the most interesting variable in this study is transaction costs computed according to Equation (1). To control complications from negative numbers on statistical calculations, investigators separate positive transaction costs from negative and group them as Transaction Costs 1 and Transaction Costs 2, respectively. The description of the rest is shown in Table 2. Their descriptive statistics are presented in Table 3.

Table 2. Descriptions of Variables.

Variable	Description
Subtraction	Farmer's responses to a series of related numerical calculations (e.g., "100 − 7 = ___", "93 − 7 = ___" and so on.)
Memory	Farmer's ability to correctly memorize the order of 10 familiar crops and verbally reiterate them to the researchers.
Knowledge	Farmer's understanding of 10 well-known facts (such as "When was agricultural tax abolished in China?" or "Who is the current president of the People's Republic of China?").
BMI	Indicator of socioeconomic status, broadly related to human capital accumulation.
Farming Experience	Farmer's time in farming.
Area	Area is contract-contingent and designates tilled plot area used to harvest crops.
Risk Tolerance	Farmer's response to a set of questions meant to assess risk preference.
Transaction costs	Relevant to competition.

Table 3. Descriptive statistics of characteristic variables.

	Number of Observations	Minimum	Maximum	Mean	St. Dev.
Subtraction	191	2.00	14.00	9.45	4.57
Memory	191	1.00	8.00	3.87	1.75
Knowledge	191	1.00	10.00	7.19	1.60
BMI	191	15.71	31.27	23.15	4.11
Farming Experience	191	1.00	60.00	38.52	11.27
Area	191	4.00	35.70	14.94	6.69
Risk Tolerance	191	1.00	6.00	2.50	2.06
Transaction Costs 1	172	0.61	41,972.63	2221.65	37,272.55
Transaction Costs 2	19	−41.52	−0.04	−9.72	73.95

4.1. Transaction Costs Investment Criterion: Evidence from Imputed Contracts

The approximation of the transaction costs measure is given in Figure 3. The distribution of cardinal measures has a tendency of skewing to the left, each member of which deviates from zero significantly. By examining real world crop patterns, more thorough understanding about the transaction costs criterion can be gained. All rice growers appear to have positive profits, despite the appearance of perfect competition. The range of profits is large, with a minimum US$164.10 and a maximum of US$4999.50 (see Figures 4 and 5). A reasonable conjecture is that more windfalls will be expected in such crops as crayfish, crab, soft-shelled turtle, carp, and eel, suggesting monopolistic competition. When considering the crayfish crop, all the windfalls are still positive and the lowest amount is US$1854.70, which is almost 12 times that of the lowest profit for rice (Windfalls in such crops as soft-shelled turtle and eel are much higher. However, only one observation in each is reported due to the higher feeding cost. Profits are US$35,756.90 and US$41,853.20). Recall that the accounting period of crayfish is in succession with that of rice, and this rotation pattern increases the efficiency of land use significantly. It is evident from the data that the land rent price is depressed relative to profits.

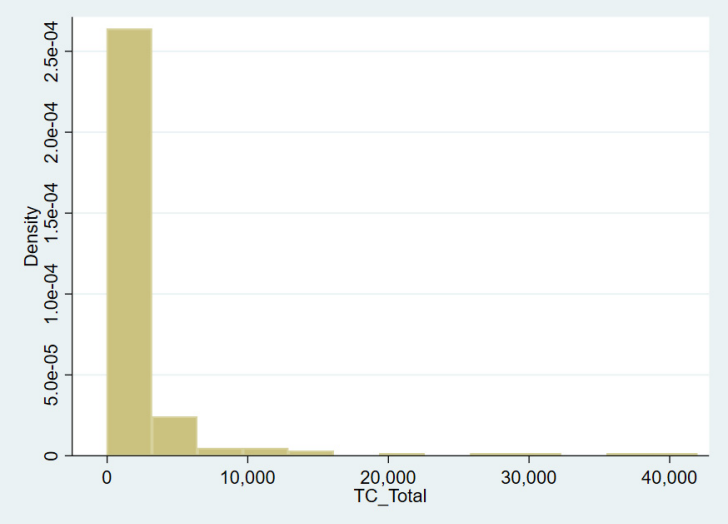


Figure 3. Numerical transaction costs in contracts (N = 191).

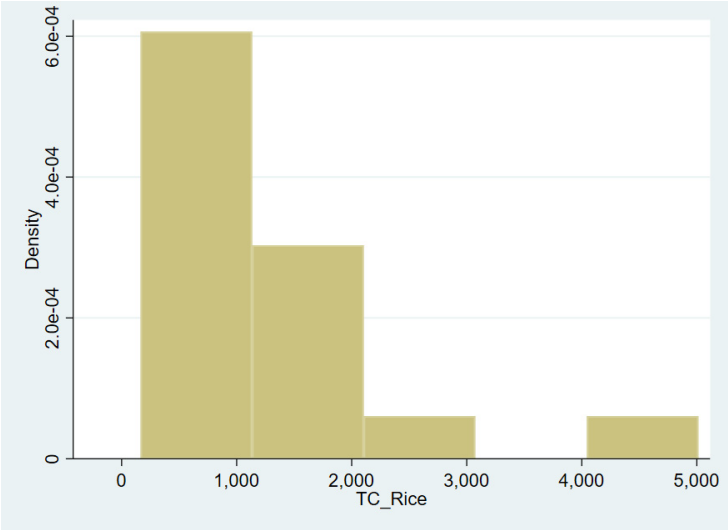


Figure 4. An illustration of profit differentials for rice.

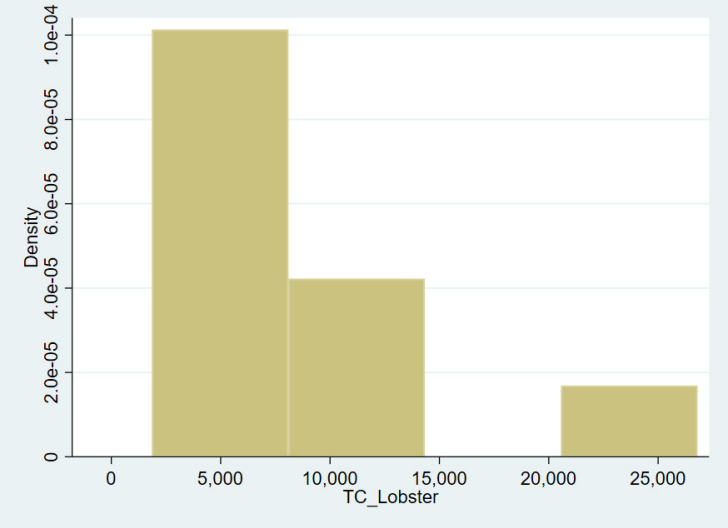


Figure 5. An illustration of profit differentials for lobster.

Some agents encountered windfall losses. However, since agents seldom hold only a contract that has a detrimental effect, the loss can be offset by other crops' profits. In Village A, a loss occurred in three soybean contracts and one rapeseed contract, and losses ranged from −US$1.60 to −US$41.40. When considering Village B, the findings are similar. Losses occurred in one rape contract, one cotton contract, one peanut contract, one pakchoi–cabbage rotation contract of two seasons and two Chinese cabbage rotation contracts of five seasons, in which the detrimental values are US$25.00 to US$0.04. Referring to the corresponding contract holders and computing the ratio of the loss to the agent's total windfalls, the percentages were lower for Village A (−0.41% to 0%) than for Village B (0.09% to 2.17%) (In regard to owners of these crops in Village A, the sums of windfalls are US$7056.00, US$9978.30, US$3850.80, and US$5392.20. In Village B the amounts are US$1155.70, US$498.80, US$3352.70, US$3042.00, US$1809.50, and US$2889.90). If a measurement error of 5% is permitted, the results can be attributed to this kind of statistical inaccuracy, and they are totally irrelevant to permanent adverse shocks. Respondents reported that they will match Chinese cabbage with pakchoi, bok choy, and cabbage, with no exceptions in the samples covered. It is worth noting that these four crops face such common natural enemy as aphids and cabbage caterpillars. The economic reflection behind

this strategy is that crops open to adverse shocks serve as an advantageous externality to other crops. This diversified planting rather than specialization confirms the conjecture that agents will behave as if the maximization criterion (1) is followed, since internalization of the adverse effect is clearly shown by these illiterate persons. The results for Village C are all positive. Collectively, these data suggest that the transaction cost criterion is well-founded.

4.2. Transaction Costs Rank Statistics and Nonparametric Transaction Costs Function

On first inspection, data support the transaction costs hypothesis, though further analysis (e.g., statistical significance) and discussion is merited. Since few studies use this transaction costs approach, This paper emphasizes potential factors that are included in $f_c(\bullet)$, and then assess transaction costs using nonparametric regression. The relevant variables are mostly about agents' characteristics, though transaction costs analyses usually focus on the production decision itself. Here, what characteristics will affect real investment is investigated rigorously. These factors are potential options that will be included in the transaction cost function. According to Figure 2, profits in 191 contracts obviously deviated from a normal distribution. Therefore, according to the typical analytic approach of employing factor analysis or principal components analysis, the statistical significance of the results may have little economic meaning. This paper instead use rank analysis, a form of nonparametric analysis, to inquire into the property of $f_c(\bullet)$. In estimating transaction cost statistics, C_c is defined as the capital C corresponding to Coase and Cheung, both of whom are pioneers of the transaction costs paradigm.

4.2.1. Transaction Costs and Farmer's Investment Decision: Proof from Rank Statistics

From the view of mathematical statistics, as the rank number grows, C_c will follow a chi-square distribution asymptotically. That is, C_c can be approximated as follows:

$$C_C = \frac{p-1}{p\sigma^2}\sum_{j=1}^{p}\left(\overline{r_j}-\rho\right)^2 \tag{3}$$

In this expression, p is the rank number and $\overline{r_j}$ is the average rank of the jth column, while ρ and σ^2 are the mean and variance of the rank table respectively. Statistical significance can be judged by chi-square distribution table (Any further inquiry into the mathematical statistical foundation of nonparametric tests is welcome. Traditionally, the rank method is used to analyze consumption data, as Friedman has shown. In this investigation, statistic "C" is based on investment data to verify the naïve hypothesis, such as the transaction cost criterion. An additional contribution lies in the explanation for negative investment [33]). Notably, most popular software solutions address rank data rather roughly. In regard to the rank statistical test, the adequate method is to appeal to the chi-square distribution table. However, it is apparent that the "rank test" order in Stata 16.0 still depends on ANOVA. As it will be shown, ANOVA misses the mark in the samples covered. Another alternative is to compute the "z-statistic" in the Kruskal–Wallis Test, but a deficiency lies in the fact that the statistic itself changes as the rank groups shifts. Because relevant software is rarely available, investigators manually calculate the corresponding rank statistics for seven potential factors. For the critical transaction cost variables, they are classified into 12 different groups in Table 4.

Table 4. Transaction costs groups.

Group Item	Contract Observations	Sum	Average	Variance
1	5	156,746.27	31,349.25	62,482,206.45
2	7	78,673.12	11,239.02	3,565,218.55
3	10	53,834.72	5383.47	884,332.50
4	6	23,582.92	3930.49	195,093.21
5	15	31,148.22	2076.55	141,301.26
6	15	17,313.04	1154.20	51,759.55
7	13	7717.31	593.64	8829.92
8	17	6432.19	378.36	2006.16
9	15	3098.54	206.57	2797.22
10	19	2122.68	111.72	471.07
11	50	1454.34	29.09	415.55
12	19	−184.71	−9.72	131.37

The group averages decrease monotonically from the top to the bottom, and except for a minor outlier, the variance also decreases in one direction. Recall that a well-established finding in economics is that consumption variation increases with an increase in people's income class, which precisely mirrors the results of grouping transaction costs. It is remarkable that all 19 observations in group 12 are negative. It is novel not only from statistical considerations but also from the available research on contract theory, while consistent with maximum problem (1) proposed in Section 4. According to Table 2, investigators set $p = 12$, so rank statistic (3) can be reduced to:

$$C_C = \frac{12}{13}\sum_{j=1}^{12}\left(\overline{r_j} - 6.5\right)^2 \tag{4}$$

To save space, now the statistical results based on Formula (4) are shown. Before estimation, the cost information in the original table are classified into six items broad categories, and distinguishing between "Own" (e.g., provided by the farmer) and "Outsourcing" (e.g., paying for the good or service) where relevant. Statistical significance in the sub-items can be used to assess the relevance of transaction costs to production decisions.

To emphasize the robustness of rank statistic (4), the F-test based on ANOVA is also provided, though the rank statistic (4) is preferred both for economic and statistical interpretation (see Table 4). While the ANOVA results demonstrate that Transaction Costs are relevant to every item, the rank test narrows its influence to six items. The story about Subtraction is almost the converse. Given the transaction cost criterion (1), six rank statistics of the subtraction variable are significant at the 5% level, which shows that this cognitive ability has a considerable influence on investment. However, when turning to Stata's ANOVA order, this ability can only impact pesticide investment.

Normally, good memory can improve decision making. However, little evidence is found to support this conjecture by the rank method. There are no items that are influenced by this variable, although the corresponding number under ANOVA is 13 items. However, when focusing on Transaction Cost, the numbers of relevant items decrease, as Table 4 shows. The pattern does not appear to be random, but instead calls into question the value of the memory variable. The results from the Knowledge are similar to those of the Subtraction variable, which confirms findings about the influence of cognitive ability on various investments. In regard to results in Table 5 concerning farming Experience, the significant investment items that were affected in the rank test "C_e" column are seven, while the corresponding figure in ANOVA is 2. When observing the "Transaction Costs–BMI" table, the Transaction Costs statistics show the same pattern, but in terms of the health measure, superiority between these two methods cannot be decided. According to the rank statistic, BMI only impacts four investment items, a slightly poorer efficiency than that of ANOVA. Owing to space limitation, results concerning "Memory–Transaction

Costs", "Knowledge–Transaction Costs", and "BMI–Transaction Costs" are in Appendix A (Tables A1 and A2).

Table 5. Transaction Costs versus Subtraction and Farming Experience efficiency comparisons using two-factor rank test and ANOVA.

Investment Item	Rank Test		ANOVA		Rank Test		ANOVA	
	C_c	C_s	F_c	F_s	C_c	C_e	F_c	F_e
Rent	12.56	23.24 **	26.80 ***	1.59	14.39	9.88 *	26.80 ***	3.34 ***
Interest	12.95	21.27 **	7.43 ***	0.35	16.62	11.90 **	7.43 ***	0.92
Labor	19.54 *	12.44	4.68 ***	0.59	18 *	9.74 *	4.68 ***	1.66
Own labor	25.18 ***	10.85	5.44 ***	1.48	18.63 *	8.88	5.44 ***	1.20
Outsourcing labor	6.51	4.32	2.63 ***	0.35	8.55	2.65	2.63 ***	1.07
Seeds	12.32	14.88	13.92 ***	0.30	15.96	8.51	13.92 ***	0.66
Own seeds	4.43	7.62	7.54 ***	0.60	11.33	4.39	7.54 ***	1.71
Outsourcing seeds	15.29	16.54	5.47 ***	0.14	20.76 **	6.52	5.47 ***	0.49
Fertilizer	14.71	23.16 **	8.78 ***	0.64	18.69 *	13.66 **	8.78 ***	0.83
Own fertilizer	3.41	7.99	9.09 ***	1.26	9.05	2.56	9.09 ***	1.28
Outsourcing fertilizer	13.95	23.73 **	8.22 ***	0.65	18.61 *	12.76 **	8.22 ***	0.83
Machine	18.59 *	17.60 **	6.91 ***	0.77	18.10 *	4.70	6.91 ***	0.24
Own machine	6.85	18.29 *	1.07	1.48	9.17	6.40	1.07	2.33 **
Outsourcing machine	13.49	14.21	6.69 ***	0.70	17.25	4.03	6.69 ***	0.37
Disinsection	17.98 *	23.61 **	8.43 ***	0.74	20.42 **	9.86 *	8.43 ***	0.43
Pesticide	16.61	24.28 **	7.92 ***	0.65	20.13 **	10.31 *	7.92 ***	0.58
Outsourcing service	4.87	3.33	3.11 ***	3.97 ***	13.6	1.98	3.11 ***	1.21
Herbicidal	19.04 *	9.43	3.68 ***	0.18	17.26	2.67	3.68 ***	0.21
Herbicide	23.01 **	7.59	1.97 **	0.83	21.56 **	2.91	1.97 **	0.96
Outsourcing service	——	——	3.96 ***	0.11	——	——	3.96 ***	0.30

Notes: The rank statistic of the "Subtraction" and "Experience" variables were computed according to (4). "***", "**" and "*" indicate that Transaction Costs (or Subtraction and Experience) have no impact on varieties of investments can be rejected at the 1%, 5% or 10% confidence interval, respectively.

Generally, there have been two ways to deal with risk. The first is to attribute so-called risk into opportunity sets, based on the "Friedman–Savage" axiom. The drawback of this line of reasoning is that sometimes the opportunity sets are vague, giving positive transaction costs. The role for contract theory is apparent here. Alternatively, transaction costs can be ignored and instead producer risk type can be assessed as an explanatory variable. Having done this, risk is typically incorporated into the agent's utility function, leading to terms such as "Individual Rational" and "Incentive Compatible", which is central to this kind of equilibrium analysis. This approach may lead to the conclusion that "Risk Tolerance" (Data on risk tolerance are extracted from a gamble question basing on the "Expected utility hypothesis" invented by Friedman and Savage [34]). contributes enormously to investment fluctuations. This is a derived implication of the asymmetric information assumption, which is the theoretical foundation of the "Stiglitz–Spence–Akerlof" paradigm. However, there is evidence that challenges this paradigm. Staten, Gilley, and Umbeck rejected the so-called "Credit Ration" hypothesis of Stiglitz and his co-author, and Fang, Keane, and Silverman also verified Stiglitz and Rothchild's "Adverse Selection" hypothesis [35–38]. However, as have been indicated in the literature review, these studies still leave some obscure room for the risk type analysis, so a direct test based on rank statistic may serve to extend the research agenda. As the results show, risk tolerance is unnecessary in interpreting the farmer's investment.

Needless to say, the results in Table 5 reject the second line of inquiry into risk, while it does not contradict the "Friedman–Savage" axiom and transaction costs hypothesis based on contract theory. The rank statistic C_r is significant in only one item, and the statistical significance is 10%, which is rather weak and can be attributed to measurement error. It

also implies that Chinese farmers in the sample covered behave as if they gamble and buy insurance at the same time. In regard to the Transaction Costs, the efficiency is rather robust, as anticipated.

The rank test of Area fails to be significant, which is in direct contrast to many popular views. Setting failure of corporation farming at "Red River Valley" in the 1900s aside [28], the current academic atmosphere in China is inclined to consider the exit of small farmers as a time-consuming job rather than an orientation problem. There is a considerable body of relevant research on economies of scale of agricultural operations, while inquiries into decision margins of farmers are rare. From the lens of economic theory, taking time and interest into consideration makes the so-called scale operation argument futile. That is, the importance of the scale of the operation is one implication of transaction costs criterion. When farmers need to harvest crops urgently, having rented much larger plots than average is advantageous in the short run. However, when demand is stable and permanent, farmers can harvest as expected rather. If officials order small farmers to surrender their lands and then parcel them out according to a scale operation rule, a significant social cost may appear. This is also a feature of agricultural policy in the West (e.g., in France, where the multi-functionality concept has been used to economically support a patchwork of many small farms).

The social importance of farms and farmers is also seen in the United States. For example, Knoeber analyzed bans on corporate farming in 10 states and incentives for small farms [39]. Here, when testing the relation between area and various investment items, interesting results appear (see Table 6). Choosing 10% as the statistical significance level, the number of items influenced is zero. This result is in part explained by recognizing that sown area and area under cultivation can differ, particularly when considering a diversity of land characteristics (e.g., slope and soil condition) and land management (e.g., rotation and inter-planting). This can also explain the insignificant effect of land consolidation on rental price of land in Slovakia [40].

Table 6. Transaction Costs versus Risk tolerance and Area efficiency comparisons using two-factor rank test and ANOVA.

Investment Item	Rank Test		ANOVA		Rank Test		ANOVA	
	C_c	C_r	F_c	F_r	C_c	C_a	F_c	F_a
Rent	17.35 *	5.63	26.80 ***	7.87 ***	18.5 *	0.63	26.80 ***	10.20 ***
Interest	18.19 *	5.53	7.43 ***	1.69	22.77 ***	0.03	7.43 ***	6.77 ***
Labor	9.84	4.12	4.68 ***	2.74 **	11.75	0.97	4.68 ***	6.06 ***
Own labor	11.00	3.41	5.44 ***	1.94	10.45	1.93	5.44 ***	5.80 ***
Outsourcing labor	9.95	3.56	2.63 ***	1.95	47.72 ***	7.38	2.63 ***	4.58 ***
Seeds	17.41 *	4.94	13.92 ***	1.00	21.10 **	0.63	13.92 ***	3.51 **
Own seeds	12.14	5.39	7.54 ***	0.14	18.38 *	2.74	7.54 ***	0.25
Outsourcing seeds	11.42	5.85	5.47 ***	1.21	13.20	0.30	5.47 ***	3.87 **
Fertilizer	18.28 *	7.28	8.78 ***	0.79	22.50 ***	0.5	8.78 ***	10.99 ***
Own fertilizer	7.38	4.64	9.09 ***	2.49 **	27.83 ***	5.03	9.09 ***	0.99
Outsourcing fertilizer	19.18 *	8.42 *	8.22 ***	0.74	21.22 **	0.33	8.22 ***	11.29 ***
Machine	12.25	4.17	6.91 ***	4.43 ***	11.33	1.98	6.91 ***	4.45 ***
Own machine	8.30	6.06	1.07	0.98	23.33 **	4.56	1.07	7.05 ***
Outsourcing machine	11.77	4.23	6.69 ***	4.61 ***	22.68 ***	4.52	6.69 ***	4.56 ***
Disinsection	13.47	6.70	8.43 ***	2.63 **	15.47	0.20	8.43 ***	10.36 ***
Pesticide	12.65	6.44	7.92 ***	2.46 **	15.18	0.20	7.92 ***	10.78 ***
Outsourcing service	5.81	3.50	3.11 ***	1.41	54.38 ***	6.24	3.11 ***	0.50
Herbicidal	15.45	5.53	3.68 ***	0.94	18.38 *	2.30	3.68 ***	2.92 **
Herbicide	18.18 *	4.91	1.97 **	0.43	21.45 **	2.19	1.97 **	5.01 ***
Outsourcing service	——	——	3.96 ***	0.94	——	——	3.96 ***	2.77 **

"***", "**" and "*" indicate that Transaction Costs (or Risk tolerance and Area) have no impact on varieties of investments can be rejected at the 1%, 5% or 10% confidence interval, respectively.

According to the rank statistics results shown in Tables 5 and 6, the number of investment items influenced by factors other than transaction costs is 3.15 on average. To select proper variables in the sense of both statistics and economics, a simple average rule is applied: any characteristic variable whose double-factor rank test is equal or above 4 is a candidate variable in the transaction costs function, $f_c(\bullet)$. As already outlined, the most important factor in $f_c(\bullet)$ is Subtraction ability, with eight significant results. The second most important factor is farming Experience, and the corresponding number is 7. The remaining two central variables are the BMI index and Knowledge successively. It seems that Memory and Area variables are irrelevant in Transaction Costs function: According to rank test results reported in Tables 6 and A1, none of the 20 investment items are significantly influenced.

4.2.2. Transaction Costs Function: Nonparametric Approach

Using the nonparametric order of Stata 16.0, univariate, bivariate regressions on Transaction Costs are estimated, and results are summarized in Table 6. As expected, Transaction Costs in all four models are significant at the 1% level, while there are differences among statistical significance values among the coefficients of the four characteristics noted. The t-value of BMI is 1.34, which is significant at this level, while the corresponding t-value of Knowledge in nonparametric Model 2 is only 0.41, a much poorer result than both the corresponding results of the rank statistic and ANOVA results. Subtraction and Farming Experience have strong results, where the correlation coefficients are 1140 and −682.7, respectively, and both are statistically significant at the 5% level. The robustness *p*-value of the correlation coefficient of farming experience is <0.001. Interestingly, the sign of these two variables are inversely related: in Model 3, the ability of Subtraction co-moves with the Transaction Costs of the contract, while in Model 4, farming Experience can reduce Transaction Costs rather effectively.

To be cautious, investigators also employed bivariate, trivariate, and four-variable regressions on Transaction Costs before focusing on these two characters. It seems that the inclusion of the BMI variable as an independent variable reduces the effective observations considerably, such that the iteration process cannot be completed, and the inclusion of knowledge in Model 3 and 4 result in the same problem. Therefore, in Table 7 not only the regression of Subtraction, Farming Experience, and Knowledge on Transaction Costs are reported, but also the regression of Subtraction and Farming Experience on Transaction Costs, as tabulated in Model 5 and Model 6, respectively.

Table 7. Nonparametric regressions: Y = Transaction Costs (N = 500).

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
BMI	158.8 (118.3)					
Knowledge		83.4 (205.2)			658.2 (801.4)	
Subtraction			175.8 ** (85.1)		234.2 (425.4)	174.1 * (90.8)
Experience				−105.3 *** (32.0)	−136.9 (192.1)	−89.0 ** (44.1)
Number of Observations	191	191	191	191	119	172
R-squared	0.056	0.033	0.021	0.04	0.153	0.185

Notes: All six models are estimated by non-parametric regression technique. "***", "**" and "*" indicate that coefficient estimation of given variable is not significant can be rejected at the 1%, 5%, or 10% confidence interval, respectively.

As expected, the correlation coefficient of Knowledge in Model 5 is not significant even at the 10% level, and it worth noting that it also makes the *p*-values implied in robustness

standard errors of other variables increase above 10%. This statistical finding is rather idiosyncratic. However, in a purely statistical sense, the sample covered does not offer solid evidence of Knowledge's role in Transaction Costs.

Model 6 considers only the regression of Subtraction and farming Experience on Transaction Costs, in which all three variables are statistically significant. The correlation coefficient of Subtraction is 174.1, slightly less than its counterpart in Model 3, while the correlation coefficient of Farming Experience is −89.0, which is approximately three twentieth lower than its counterpart in Model 4. In addition, Model 6′s R-squared (R^2) is higher than the total R^2 of Model 3 and Model 4. These suggest that the addition of Farming Experience improves the usual omitted variable bias. Combining all of these findings in Models 1–6, it is confirmed that among the four factors, transaction costs statistics and other rank statistics are recommended. Moreover, farming Experience and Subtraction are most powerful in explaining the magnitude of and variation in Transaction Costs. The significance of BMI and Knowledge is left unclear given the statistical evidence of the nonparametric regression in the context of the economic implication inherent in these two variables.

Combining the "margin" results and "contrast" results in these two tables, the effect of one unit change in the level of factors can be predicted. According to Table 8, increasing Subtraction ability by one unit will increase transaction costs by US$513.40, ceteris paribus. Moreover, a one-year increase of Farming Experience will save US$116.20 in transaction costs, assuming subtraction ability otherwise remains constant.

Table 8. Prediction according to transaction cost function of model 6 (N = 500).

		1 Unit Increase in the Level of Subtraction	**1 Unit Increase in the Level of Farming Experience**
Predicted Margins of the Transaction Cost Function	Observed Margin	2524.5	1894.7
	Bootstrap Std. Err.	551.6	417.7
	z	4.580	4.54
	$p > \|z\|$	0.000	0.000
	Percentile [95% Conf. Interval]	1561.8 3703.9	1134.9 2744.3
Change of Transaction Costs with an Infinitesimal Change in the Independent Variable	Observed Contrast	513.4	−116.2
	Bootstrap Std. Err.	204.1	71.2
	Percentile [95% Conf. Interval]	163.6 947.7	−304.3 −12.8

5. Discussions

5.1. Contributions to Economic Theory

The most important contribution of this investigation is the transaction costs criterion derived. Economic theory often dictates that every individual pursue his benefit in the sense of rent maximization. Putting emphasis on rent is useful way to do research. It is not difficult to figure out that transaction costs function $f_c(\bullet)$ will disappear in Equation (1) if the force that constrains rent dissipation becomes larger and larger. Then gradually, agents holding given contract will not default to rent dissipation behavior. However, given certain factors that drive in rent dissipation, price signal will be interrupted. Rent maximization will thus be invalid. That is, the hypothesis in Equation (1) is related to both rent dissipation behavior and rent maximization in neo-classical tradition, therefore more general in understanding pricing practice. This generality also distinguishes the transaction costs hypothesis from Outright Purchase Hypothesis. In the spirit of McGee, the benefit of former owner from outright purchase is rent per se. So apparently it misses informal competition institution prevailing in many developing countries.

Besides, traditional writings in neo-institutional emphasizes the role of the property right [41,42]. Relevant quantitative evidence related to competition is rare. The empirical findings laid out also confirm the existence of two different kinds of transaction costs: rent dissipation and costs occurred to reduce rent dissipation. This substitute between transaction costs needs more attention in future academic writings. These findings cast some doubt about Williamson's explanation on the origin of transaction costs [43]. Asset specificity is recognized as major source of transaction costs in Williamson's framework, while the China case examined revealed that rent dissipation is largely driven by certain agent characteristic empirically. Irrational behavior is more closely related to individual than physical asset. Lastly, both quantitative findings from rank test and non-parametric regression technique confirm the qualitative Coase conjecture. Coase argued that although organization of the production is a complex structure, discovering factors that determine relative costs of coordination by management can be helpful [44]. In this paper several potential variables are sorted that matters in production using econometric tools, which not only confirm the power of transaction costs economics, but also extend Cheung's the qualitative underpricing hypothesis.

5.2. Implications and Limitations

One point in non-parametric regression estimation merits discussions: the adjusted R^2 of Model 1–4 reported in Table 6 is low. In usual econometric practice R^2 measures the power of independent variables in explaining the variance of dependent variable. The counterpart results of Models 5–6 explain why it happens: Models 1–4 only consider one variable, so apparently the Models are subject to misspecification. After taking both Farming Experience and Subtraction ability into consideration, the AR rise to 18.5%, which is the best in Table 6. Besides, the prerequisite of using R^2 is that all variables under consideration are assumed to follow normal distributions. According to Figures 2–4, it is not difficult to figure out that distribution of Transaction Costs is skewed to the left rather than normal, which also contributes low R^2 of Models 1–4. Lastly, most important task of econometric modeling is to specify mechanism behind data [45]. According to results reported, the underpricing practice is well founded. So in some sense, this low adjusted R^2 of Models 1–4 is just confirmation of transaction costs function in Model 6 rather than a pitfall.

The opposite signs of Farming Experience and Subtraction are also interesting findings that merit further inquiry. These findings are closely related to two sides of Transaction costs: transaction costs can be viewed as either cost or rent dissipation [46]. "Cost" means there is a choice, while the later implies that free choice among agency contracts is restricted, and this dichotomy in the definition of transaction costs receives support from Cheung's most striking empirical work on share-tenancy. It can be conjectured that Farming Experience is related to the farmer's ability of discovering opportunities in tilled and capitalizing on their increasingly effective human capital. Their ability to process new information is considerably higher than naïve farmers. Therefore, according to Equation (1), the transaction cost criterion may be invalidated if an ever-increasing part of windfalls is discovered and priced, and it is not surprising that transaction costs can thusly decrease significantly. This also provides a workable solution to underpricing phenomenon in rural China. To make for smooth transmission of price signal, developing professional farmers is a promising way. On the other hand, Subtraction computation does not guarantee that a farmer can hold the considerable information needed to make a rational choice both in total and at margin. A higher score of Subtraction only means that the farmer can discern a proper opportunity at the margin, but in general equilibrium (when profits are less obvious), they may miss it. This is rather plausible, because the information everyone owns to make transaction is local and limited, while terms of trade are subject to competition from outsiders rather than this given person [47,48]. Besides, this positive correlation between Subtraction ability and rent dissipation constitute a kind of uncertainty that is alien from risk induced by natural risk [49]. Though irrational prime facie, this confirms

the significance of transaction costs and point out one major source of uncertainty: human behavior matters in economic activity. Lastly, recent research in brain science also provides alternative explanation for positive correlation between Subtraction and Transaction costs: people are more familiar with addition than subtraction [50]. Ill-educated farmers in rural China are more inclined to be over-confident and make errors in the sense of general equilibrium.

The major limitation of this investigation is the focus on transaction costs rather than ambiguous property right involved behind rent dissipation behavior. The Coasean–Cheungian paradigm put transaction costs in the center of economic analysis, from which rich implications are derived. However, to gain deeper understanding about real world, property right paradigm is also helpful. Why is tilled land being underpriced? In the language of Cheung, it is because of high transaction costs in land transferring. Note that many scholars from mainland China eschew this fundamental point. As demonstrated in non-parametric regression, Risk and Area variables recommended by rank test are found to be insignificant in transaction costs function, implying that more emphasis shall be put on searching economic significance rather than statistical significance. When shifting to property right paradigm, the answer lies in absence of certain property right. However, relevant inquiry will involve too much deduction and so should be left to future study.

6. Conclusions

The zero-profit constraint and price-taking behavior implied in the complete competition argument have long been core assumptions of research on market mechanisms. In regard to irrational behavior and superficial market failure, economists following the Pigouvian tradition often give overly complex explanations, which Cheung dismissed (perhaps too harshly) as ad hoc theory. Focusing on the typical fact that land use in rural China does not maximize land rent and the right to exclude is unclear for farmers; it adds support for the use of transaction costs theory in the context of ambiguous property rights. It is demonstrated that a naïve economic agent operating under ambiguous property rights will default to windfall behavior.

This paper also makes a minor methodological contribution, by employing an approximate rank statistic based on transaction costs grouping, which follows an asymptotic chi-square distribution. The results, derived from data on 191 contract samples, show that the efficiency of this statistic is superior to Fisher's ANOVA method in this context. The approach presented here is also beneficial for identifying potential variables in the transaction cost function $f_c(\bullet)$. Using a nonparametric technique, it is found that while BMI, Knowledge, Subtraction ability, and Farming Experience were identified by the rank test as significant, Subtraction and Farming Experience are the most important. On a more fundamental level, their role in $f_c(\bullet)$ are pulled in different directions; ceteris paribus, increasing Subtraction ability by one unit will increase transaction costs by US$513.40, and a one-year increase of Farming Experience will save US$116.20 of transaction costs, holding Subtraction ability constant.

These findings provide evidence of a much larger effect of subtraction ability in driving rent dissipation behavior. To policy makers that intent to improve the role of price signals in agricultural land transactions, it may be important to create incentives for long term accumulation of farming skills and experience (e.g., training and education) to develop professional farmers' expertise. Furthermore, "Risk tolerance" and "Area" have mixed results at the 5% statistical significance level, leaving open the question of whether they should be included in $f_c(\bullet)$ in this context. Social costs implied in this application of transaction costs theory are reducing competition and may be detrimental for agricultural productivity in China. Increasing competition will reduce windfalls that farmers receive, but increase agricultural production, perhaps increasing social welfare more broadly.

This investigation highlights at least two related projects that need to be explored further in future. Firstly, the anatomy of ambiguous property behind the transaction costs hypothesis is still an important theoretical task that lacks solid answers. Secondly,

transaction costs' functions need to be evaluated by data beyond what is used to derive this paper's hypothesis. These comparable data from different countries and different periods will reinforce understanding about the relative magnitude of transaction costs and its driving factors, from which much solid evidence can be learnt. Both are exciting and illuminating intellectual adventures.

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Appendix A

Table A1. Transaction Costs versus Memory and Body Mass Index Comparisons Using Two-factor Rank Test and ANOVA.

Investment Item	Rank Test		ANOVA		Rank Test		ANOVA	
	C_c	C_m	F_c	F_m	C_c	C_h	F_c	F_h
Rent	13.64	2.97	26.80 ***	7.20 ***	14.71	17.81	26.80 ***	4.09 ***
Interest	12.68	4.48	7.43 ***	4.91 ***	14.26	19.98 *	7.43 ***	1.75 *
Labor	22.49 **	3.51	4.68 ***	4.35 ***	21.66 **	10.93	4.68 ***	1.93 **
Own labor	22.83 **	5.29	5.44 ***	2.65 **	20.07 **	12.72	5.44 ***	1.7 *
Outsourcing labor	13.70	1.74	2.63 ***	5.01 ***	6.57	2.44	2.63 ***	2.79 ***
Seeds	14.38	5.60	13.92 ***	3.11 ***	14.19	17.30	13.92 ***	1.88 **
Own seeds	11.08	5.55	7.54 ***	0.64	9.59	9.82	7.54 ***	1.28
Outsourcing seeds	14.91	3.69	5.47 ***	3.84 ***	14.83	19.56 *	5.47 ***	1.06
Fertilizer	17.79 *	5.78	8.78 ***	10.98 ***	17.27	17.26	8.78 ***	5.39 ***
Own fertilizer	6.25	3.63	9.09 ***	0.88	10.55	11.48	9.09 ***	1.38
Outsourcing fertilizer	17.23	7.19	8.22 ***	11.11 ***	17.58 *	17.87	8.22 ***	5.38 ***
Machine	20.13 **	7.00	6.91 ***	1.53	21.36 **	24.94 **	6.91 ***	1.21
Own machine	11.97	6.01	1.07	1.95 *	10.33	30.50 ***	1.07	2.22 **
Outsourcing machine	16.92	4.70	6.69 ***	1.51	17.54 *	11.97	6.69 ***	1.25
Disinsection	22.61 **	2.44	8.43 ***	2.90 ***	18.94 *	13.09	8.43 ***	1.47
Pesticide	21.99 **	2.58	7.92 ***	3.24	18 *	13.12	7.92 ***	1.49
Outsourcing service	7.93	2.02	3.11 ***	0.39	4.58	2.68	3.11 ***	1.46
Herbicidal	23.15 **	4.27	3.68 ***	3.32 ***	26.08 ***	17.95	3.68 ***	0.97
Herbicide	24.88 ***	4.53	1.97 **	1.19	29.08 ***	16.97	1.97 **	1.11
Outsourcing service	——	——	3.96 ***	3.58 ***	——	——	3.96 ***	0.91

"***", "**" and "*" indicate that Transaction Costs (or Memory and Body Mass Index) have no impact on varieties of investments can be rejected at the 1%, 5% or 10% confidence interval, respectively.

Table A2. Transaction Costs versus Knowledge Comparisons Using Two-factor Rank Test and ANOVA.

Investment Item	Rank Test		ANOVA	
	C_c	C_k	F_c	F_k
Rent	19.06 *	12.83 **	26.80 ***	1.38
Interest	20.20 **	12.64 **	7.43 ***	0.81
Labor	13.63	6.24	4.68 ***	0.25
Own labor	15.16	6.00	5.44 ***	0.25
Outsourcing labor	10.33	1.90	2.63 ***	0.29
Seeds	20.63 **	11.38 *	13.92 ***	0.94
Own seeds	12.55	5.23	7.54 ***	1.79
Outsourcing seeds	9.88	9.85	5.47 ***	0.49
Fertilizer	22.93 **	17.54 ***	8.78 ***	2.08 *
Own fertilizer	7.53	5.09	9.09 ***	2.19 **
Outsourcing fertilizer	24.46 **	19.21 ***	8.22 ***	2.11 *
Machine	23.85 **	9.07	6.91 ***	1.41
Own machine	14.61	7.05	1.07	1.88 *
Outsourcing machine	15.35	6.61	6.69 ***	1.59
Disinsection	14.14	10.55	8.43 ***	0.56
Pesticide	13.84	10.54	7.92 ***	0.55
Outsourcing service	13.06	2.02	3.11 ***	0.26
Herbicidal	22.21 **	4.82	3.68 ***	0.30
Herbicide	25.75 ***	4.70	1.97 **	0.27
Outsourcing service	——	——	3.96 ***	0.39

"***", "**" and "*" indicate that Transaction Costs or Knowledge have no impact on varieties of investments can be rejected at the 1%, 5% or 10% confidence interval, respectively.

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