*Forest Chemicals Review*
*www.forestchemicalsreview.com*
*ISSN: 1520-0191*
*July-August 2022 Page No. 1408-1426*
*Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022*

# The Influence of Industrial Organization Modes on Quality and Safety Control Tendency of Tea Planters: Examples from China

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***Abstract:***

Based on 1,069 tea planters' data from four tea-producing provinces in China, the paper uses binary logit regression model to empirically analyze different models of tea organization how to impact quality and safety control behavioral tendency of tea planters. The paper finds out that different organizational model of tea planters has a mixed effect on quality and safety. Compared to planter, large-scale family farms do better in quality control, but the advantages in safety control are not obvious. The inter-subject organization has a significant role in promoting the quality and safety control of producers. The paper also finds individual characteristics, production characteristics, environmental characteristics, cognitive level, and expected benefits also affects tea producers' quality and safety control behavioral tendency. The paper suggests that developing tea farmers' cooperative, improving the industrialization of planting, strengthening training and guidance on tea farmers' safety product can improving psychological contract, then affecting quality and safety control behaviors of tea producers.

***Keywords****: Quality safety control, Industrial organization model, Excitation mechanism, Safety product intention.*

## I. INTRODUCTION

The problem of food quality and safety has seriously endangered people's health and life, which also causes a series of social and economic problems. First, Chinese society has a crisis of trust in food quality and safety; Second, problems about quality and safety of Chinese agricultural products, such as excessive pesticide residues and heavy metals, has become the main factor affecting Chinese export volume on agricultural products. However, the reasons for the quality and safety problems in the process of food supply are complex. The development of science and technology, the immoral behavior of the main body on the value chain, environmental accumulation and cognitive defects of actors will all have impacts on food quality and safety. At present, the multi-governance food safety governance system has been gradually established. But food safety governance is facing the dilemma in failure of market and failure of government due to existence of information asymmetry and moral hazard of producers. Therefore, how to coordinate the vertical organization relationship in agricultural industrial chain and realize the effective

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governance of food quality and safety by constructing different industrial organization modes is a problem, which is worthy of theoretical and practical research.

## II. CONCEPT DEFINITION AND LITERATURE REVIEW

### 2.1 Concept Definition

#### 2.1.1 Agricultural industrial organization model

Marshall (2007) regarded organization as the fourth production factor that can strengthen the role of knowledge, and believed that it includes three aspects, which are internal organization, organizations among various enterprises in the same industry and organizational forms and government organizations among different industry [1]. At present, the industrial organization in the research mostly refers to the second content. That means the organization or market relationship among enterprises in the same industry. Considering there are many business entities in agricultural production, such as small farmers, large producers, family farms, cooperatives and agri-enterprises, and there are significant differences in the production, operation and quality control behavior of each entity, this paper defines the agricultural industrial organization model as the main organization of each stage on the agricultural industrial chain and the relationship between different subjects. The industrial organization characteristics of producers include not only organization form of their own stage, but also the cooperative relationship with upstream producers and downstream producers.

#### 2.1.2 Quality and safety

Academic literatures have not given an authoritative definition of quality and safety. In the existing research, scholars tend to regard quality and safety as a holistic abstract concept, and they focus on quality attributes or safety attributes according to the needs of specific research. Some scholars think quality and safety are juxtaposed.

Some scholars believe the concept of quality covers the concept of safety. DAS (2008) said safety was the attributes in food that may damage human health and life, which was only an integral part of food quality [2]. Caswell (1998) divided food quality into safety attributes, nutritional attributes, value attributes, packaging attributes and process attributes [3]. Obviously, the nutritional attribute focuses on the use value of food, and the safety attribute focuses on the impact on health after consumption. Antel (2000) divided food quality and safety into safety attributes and unsafety attributes, and further subdivided quality and safety into quality and safety [4]. Therefore, quality safety has multi-dimensional attributes. Of course, different attributes have different economic and social significance. In order to further study the quality and safety attributes of food, referring to the classification method of Caswell(1998), this paper defines safety attributes of food with health and life damage risk as “food safety”, and the unsafety attributes of food without health and life damage risk and can constitute use value as “food quality”. Therefore, food quality and safety includes quality and safety, in which safety is the premise of quality.

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2.2 Literature Review

The research on industrial organization and food quality and safety can be traced back to Coase's social cost problem. The close vertical cooperation of production and marketing environment in the industrial chain can save the transaction cost of safe food, such as information search cost, negotiation cost and supervision cost. Food enterprises can reduce information cost and monitoring cost by carrying out chain operation mode, signing long-term contract and implementing vertical integration. Cooperative alliance and vertical integration can significantly improve efficiency. The higher the level of vertical integration in the downstream of the supply chain, the higher the efficiency of cooperatives. The adoption of food safety supervision and unified quality by cooperative organizations to farmers can significantly affect the problem of excessive pesticide residues. Enterprise management theory puts forward process quality control and a series of specific behavior methods in order to meet consumers' requirements for product quality. The high incidence of food quality and safety risks indicates that the management mode of complete market has defects, and the mixed mode or integrated mode is feasible, because integrated operation can avoid the moral hazard and adverse selection problems caused by information asymmetry [5]. Vertical integration in the industry is an effective way to ensure food traceability and ensure that the final products meet the expected standards [6].

Due to the risk of market failure in food safety supply, Chinese scholars and governments also begin to pay attention to the problems of transportation cost, principal-agent and incomplete information in the field of organizational economics. Since the 1980s, relevant government departments have actively encouraged and promoted the development of various cooperative organizations to ensure food quality and safety [7]. The government also adopts administrative means to encourage the cooperation of planting, breeding and processing, in order to realize the national food safety strategy and industrial economies of scale [8]. In practice, social capital enters the agricultural field, establishes various bases and provides safe food by leasing contiguous land and employing local agricultural workers to implement vertical integration. Of course, the loose cooperation modes, such as company plus farmer or company plus cooperative organization, is also very common. However, the literature and the practice of food quality and safety show that the integration of food industry chain, especially vertical integration, is the most effective way to solve the problem of food safety in mature and emerging markets. However, most of the existing studies focus on whether to join the supply chain organization, the impact of the organization mode on the production intention of the main body of the value chain, and the systematic relationship between the practice preference of food quality and safety and the characteristics of the main body of production and operation. The research methods are mainly game theory and theoretical derivation.

Although the current research has achieved rich results, there is still a distance between the existing research and reality. First, most of the research in this field is based on traditional economic theories and methods, and the theoretical depth needs to be further deepened, and many variables affecting the subject's behavior need to be further empirically investigated. Second, the actors involved in food safety have great heterogeneity. The research conclusions of a certain region and a certain time may not be extended to other regions or future time points. Third, with the development of technology and the emergence of new

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business forms in the food industry, food safety problems present new challenges, and new regulatory policies will appear accordingly, which requires dynamic evaluation and research. Therefore, while fully absorbing and learning from the research results of others, based on Chinese industrial environment, consumer culture, economic level and governance model, it is still necessary to analyze the great impact of industrial organization on farmers' food quality and safety production behavior in China. Therefore, taking tea as an example, on the basis of field investigation, this paper selects typical tea industry organization modes to investigate the relationship between different organization modes and farmers' food quality and safety production behavior, so as to promote the development of tea industry and the innovation of tea organization mode, solve the quality and safety problems of agricultural products Provide theoretical basis and decision-making basis for improving people's quality of life and health level.

## III. THEORETICAL LOGIC AND RESEARCH HYPOTHESIS

### 3.1 Theoretical Logic

The logical starting point of this paper comes from the discussion of the causes of "market failure". The theory of "market failure" has been valued by researchers since Ronald Coase published the nature of enterprises in 1937. Arrow (1974) once proposed that market failure can be studied from the perspective of transaction cost and believed that high market transaction cost will lead to market failure [9]. However, it should also be noted that for agricultural products, in addition to transaction costs, taste, appearance, color, quality and safety will also affect the success or failure of the market. If consumers buy cheap agricultural products from the market, but the safety cannot be guaranteed, resulting in damage to consumers' health and excessive pesticide residues detected by the customs of the importing country at the time of export, market failure will still occur. In this case, producers will adopt other trading modes to avoid risks.

There are many upstream and downstream relationships and mutual value exchange in industrial supply chain, and tea supply chain is no exception. Farmers are downstream organizations, such as brokers, farmers' cooperatives and agriculture leading enterprises, which transport agricultural products. Downstream organizations feedback market demand, production and processing requirements and other information to farmers. Once scattered farmers join supply chain organization, the efficiency of various information feedback will be improved, the existing production environment and resource endowment of farmers will be improved, and the reform of farmers' production technology and behavior will become a possibility.

Studies have shown that with the development of social economy and culture, Chinese urban consumers have greatly improved their attention and awareness of safe food, have a higher willingness to pay for safe food, and are willing to pay additional fees for food safety [10]. Moreover, consumers also changed their actual purchase behavior and began to buy safer food or even organic food. Consumers' purchasing of safe food not only affects their own health, but also directly affects economic interests of food producers and operators. Such information is fed back to farmers through the information transmission between the main bodies of the supply chain, which will undoubtedly have an impact on

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farmers' production behavior and production technology.

However, for farmers, joining the supply chain means that their production behavior will be constrained, which give up their autonomy in production to a certain extent and need to produce according to the standards required by the downstream entities of the supply chain. How many farmers are willing to give up their freedom and bind their hands and feet? If farmers choose to join a certain mode of supply chain, based on the assumption of rational management, there is only one reason that they have seen or expected that economic benefits obtained after joining the supply chain are higher than the losses caused by loss of autonomy. If joining a supply chain organization can obtain higher remuneration, higher market price or more stable demand than joining other types of supply chain organizations, farmers are willing to take safer production behavior.

What are the reasons for the frequent occurrence of food quality and safety incidents? From the perspective of economics, it is nothing more than market failure and government management failure. The causes of market failure involve information asymmetry, externality and public goods, among which information asymmetry is the essential reason. Therefore, there will also be such a situation, that is, even if farmers join a certain industrial organization, due to asymmetry of information and existence of moral hazard, farmers' production behavior may not be fully implemented according to the standards required by the downstream subjects of supply chain. Driven by interests, farmers will use low-quality chemical fertilizers and high toxic and high residue pesticides [11]. This paper attempts to study whether and to what extent farmers' production behavior will change when they participate in industrial organizations. It is further analyzed that if farmers join different industrial organizations, the internal characteristics of industrial organizations will also be different, and whether it will have a different impact on farmers' food quality and safety production behavior.

### 3.2 Research Hypothesis

#### 3.2.1 Food quality and safety and producer control

Producer quality and safety control is a process in which producers standardize and restrict factor input and production management in order to make their products meet certain quality and safety standards.

Food quality and safety ($Q$) is the combination of tea quality attributes ($q$) and safety attributes ($s$), that is, $Q \subseteq (q,s)$ . Food quality attribute is the result of a series of quality control ($q_i$) , that is, $q_i = F(q_1, q_1, \cdots q_i \cdots)$ , and tea safety attribute is the result of a series of safety control $s_i$ ,that is, $s_i = F(s_1, s_1, \cdots s_i \cdots)$ . It is assumed $\frac{\partial q}{\partial q_i} > 0$ , and $\frac{\partial s}{\partial s_i} > 0$ , that quality and safety control behavior is conducive to improving product quality and ensuring product safety. In other words, stricter control behavior urges producers to improve the probability of producing high-quality food. Therefore, we can indirectly explore the impact of industrial organization on tea quality and safety by studying the quality

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and safety control behavior of producers.

It is found threat to food quality and safety mainly comes from two types of risks. The first is the risk caused by backward technology, that is, the quality and safety problem that cannot be detected by the existing technical level. At this time, although the actor has fully fulfilled his legal and moral obligations, the risk is still unavoidable. The second is the analysis of the immoral behavior of the actor, that is, in the links of food production, processing, transportation and sales, the rational actor, driven by economic interests, violates the integrity and morality, selects and uses the input products. The second risk includes whether the inputs of pesticides, veterinary drugs and food additives are safe, whether they are overused, whether environmental sanitation meets the requirements, etc., which is the focus of safety control by producers. Food quality control includes the whole process of the whole industrial chain "from field to table". Therefore, producer quality control includes both facility conditions and management specifications, including raw material control and process control [12].

3.2.2 Action mechanism of industrial organization on food quality and safety

Industrial organization affects food quality by affecting producer quality control. Food quality includes two aspects that are safety attribute and quality attribute. The security attribute is mainly characterized by trust goods. There is often information asymmetry between upstream and downstream subjects, which is easy to lead to market failure and more government intervention. The quality attribute is more reflected in the characteristics of search products and experience products, which is mainly constrained by market mechanism, reputation mechanism and vertical control mechanism, with less government intervention. Although the food safety problem is hidden, once a food safety incident occurs, the reputation of the enterprises involved will be seriously damaged, and even bring a devastating blow to them. Therefore, enterprises also strengthen the safety control of raw materials and production process to ensure product safety.

The main organizational forms of producers are diverse and have their own advantages. Compared with part-time or ordinary tea planting small farmers, large farmers and family farms (here in after referred to as "family farms") are usually operated by leasing land, with larger scale, more sufficient capital, better production equipment, more standardized production and management and stronger ability to implement good quality control. However, the demand for pesticide and chemical fertilizer is more, so the risk of its safety attribute is greater. The choice of producer behavior is the result of the trade-off between cost and benefit. Controlling food safety with serious information asymmetry is difficult to achieve a reasonable return in the transaction, and the product quality is easier to achieve high quality and good price. Based on that, this paper puts forward the following hypotheses:

Hypothesis 1: The organizational form of producers has an impact on their quality control behavior. Family farm has a positive effect on producer's quality control and a negative effect on producer's safety control.

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The food market is close to a perfectly competitive market, and each transaction is a non-repeated game. The close vertical organization can change non-repeated game into repeated game, coupled with the informal relations such as trust formed in long-term cooperation, which can enhance the binding force of the reputation mechanism [13]. With the deepening of vertical control, enterprises can not only control product price, quantity and transaction time, but also restrict factor input and production process. It is a common way for upstream and downstream enterprises to enter into contracts with producers in order to obtain a stable customer market or qualified raw materials. Cooperatives plus farmers is also an important organizational form among subjects. In practice, there are great differences in cooperatives, or unified procurement of raw materials and sales of products, or focusing on production management and technical services, which will help farmers break through the constraints of their own cognitive level and resource conditions, so as to implement better quality control of their production. However, when the expected income of cooperative organizations is lower than that obtained by deception and concealment, farmers will still take opportunistic behavior. When opportunistic behavior of a farmer is discovered by other members, punishment of the cooperative organization includes not only expelling the defaulting members from the cooperative organization to reduce their future benefits, but also excluding them from village social networking to reduce their social benefits [14]. Based on the above analysis, this paper puts forward the following hypotheses:

Hypothesis 2: Inter subject organizational characteristics have an impact on producer quality control. Signing contracts with enterprises and joining cooperatives have a positive effect on producers to implement better quality control and safety control.

To sum up, producer quality control can be expressed in the following functional form:

$$q_i = F(M_1, M_2, Z) \qquad (1)$$

$$s_i = F(M_1, M_2, Y) \qquad (2)$$

In formula (1) and (2), $M_1$ represents the organizational characteristics of the main body, $M_2$ represents the organizational characteristics between the main bodies, $Z$ and $Y$ represents other factors affecting quality control and safety control respectively.

3.2.3 Other factors affecting the quality and safety control of producers

Previous studies have found that the quality control behavior of producers is affected by many factors such as individual characteristics, production characteristics, environmental characteristics, cognitive level, expected income and risk attitude [15]. Individual characteristics include age, education, production years, etc. production characteristics include production scale, production specialization, technical level, etc. Older producers are less able to learn and adopt new technologies. A good educational background helps producers improve their knowledge learning and information analysis ability. On the one hand, a longer production life helps to reduce the bad quality control behavior of producer due to insufficient cognition or

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unskilled technical operation, but on the other hand, it is easy to make producers rely on their long-term production habits, which is unfavorable to the popularization and application of good quality control technology. The expansion of production scale can reduce the average cost, realize economies of scale, and increase the income brought by the slightly high product price. The higher the degree of production specialization of producers, the greater the impact of production on their income, and producers will pay more attention to risk reduction and income improvement in production and operation. The higher the level of production technology mastered by producers, the more capable they are to implement better quality control. Based on that, this paper puts forward the following hypotheses:

Hypothesis 3: Individual characteristics and production characteristics affect producer quality control. Among them, age has a negative impact, the impact direction of production years is uncertain, and education, production scale, production specialization and technical level have a positive impact on producers to implement better quality control.

Environment includes market environment, technology environment and policy environment. The acquirer's inspection of food quality to eliminate unqualified products can urge producers to strengthen quality control [16]. Producers' technology choice space depends on the technological environment they face. Producers who master more technologies may choose better quality control technology [17]. The government can influence the quality control behavior of producers through supervision. Based on that, this paper puts forward the following hypotheses:

Hypothesis 4: External environment affects producer quality control. Specifically, the purchaser's sampling inspection, technical environment and policy supervision have a positive impact on better quality control of producers.

Producers' quality control behavior is restricted by their cognitive level of relevant knowledge. The knowledge of banned pesticides and pesticide safety interval is highly professional, which is difficult for agricultural producers to master. Therefore, producers with low cognitive level are prone to unintentional bad quality control behavior [18]. The cost for producers to implement good quality control is current, while the income is future. When cost is certain, the higher the expected income of producers for providing high-quality food, the more inclined they are to implement better quality control behavior. In addition, risk attitude will also affect producers' production and management decisions. Compared with risk averse, risk preference will be more willing to take better quality control behavior in order to obtain higher returns in the future [19]. Based on that, this paper puts forward the following hypotheses:

Hypothesis 5: Producers' cognitive level, expected return and risk attitude affect producers' quality control. The higher the cognitive level of producers, the greater the expected return and the more risk preference, the better the quality control of producers.

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## IV DATA SOURCE AND ANALYSIS

### 4.1 Data Source

In recent years, governments all over the country have issued measures to vigorously develop the tea industry. The scale of the tea industry has expanded rapidly, the industrial organization model has been enriched, and the family farms, cooperatives and agricultural enterprises of tea have increased rapidly. The research of this paper provides rich ingredients. The duration of the survey is from June, 2018 to August, 2020. The locations include tea planting and processing agglomeration areas in 12 counties which locate four major green tea producing provinces of Zhejiang, Fujian, Anhui and Guizhou in China. The selection of survey sites here is to consider the representativeness of the survey objects. First, it is hoped that the survey objects will involve three different Chinese main production areas of green tea, that is Jiangnan tea area (Zhejiang and North Central Fujian), southwest tea area (Guizhou) and South China tea area (South Central Fujian). Second, it is based on the needs of comparison between traditional main tea producing areas (such as Hangzhou and Anxi County) and emerging main tea producing areas (Meitan County, Anji City, Songyang county and Suichang county). The contents of the survey include the family characteristics of tea growers, tea planting factor investment, production management, industrial organization, growers' awareness of quality and safety and government regulation policies. Most of the survey was completed by the survey team in the form of questionnaires, and a small part was completed by one-to-one semi-structured interviews with tea growers. In this survey, 100 questionnaires were distributed in 12 counties and cities, a total of 1200 questionnaires were distributed, and 1069 valid questionnaires were recovered. The effective rate of the questionnaire was 89.08%.

### 4.2 Sample Descriptive Statistics

#### 4.2.1 Tea industry organization

Small scale planting is the organizational form of farmers' traditional tea planting, while large-scale planting such as professional households and family farms is an important organizational form of professional and intensive tea planting, and it is also a new agricultural management organization supported by government departments. Therefore, the paper divides the main organizational form into two types which are small-scale planting and large-scale planting. Inter subject organizations are mainly divided into growers joining tea professional cooperatives and signing contracts with upstream agricultural socialized service organizations or downstream tea processing enterprises. In our survey sample, 62.9% are small-scale farmers and 37.1% are large-scale farmers; Among them, 32.9% of the farmers joined the professional tea cooperatives, 18.7% of the farmers signed contracts with tea processing enterprises to sell fresh tea leaves, and 10.5% of the farmers joined the cooperatives signed contracts with tea processing enterprises. The services provided by the cooperative to its members are mainly three unified points, that is, unified planting technology, unified processing products, unified product sales and separate planting management, technical training, loan guarantee and information sharing. After the growers sign the contract with the enterprise, the services provided by the enterprise to the growers mainly include loan

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guarantee, preferential purchase of inputs, technical guidance and training, purchase of protective price, etc. at the same time, the enterprise also puts forward normative requirements for the growers in terms of tea quality, planting archives, tea seedling varieties, pesticide and fertilizer use, etc.

4.2.2 Quality control of tea growers

Quality and safety control are two important dimensions of tea growers' quality control. In terms of tea quality control, according to the requirements of the construction of tea standardized planting base, this paper believes that the key points of tea quality control include three aspects, that is, tea seedling variety control, production process management and soil fertility maintenance. The paper selects “whether to plant clonal tea seedlings”, “whether to have production files” and “whether to apply organic fertilizer” as the indicators of quality control. In terms of safety control, this paper selects “whether to mix pesticides according to the dosage in the instructions”, “whether to apply low toxic pesticides” and “whether to implement the pesticide safety interval” as the variables to control the safety of tea. These indicators define “yes” as 1 and “no” as 0. The sample planting farmers choose “yes”, which means their quality control is better.

4.2.3 Tea industry organization and quality and safety control of growers

Before econometric analysis of the impact of industrial organization on the quality and safety control of tea producers, this paper first makes descriptive statistical analysis on the quality control behavior of tea producers under different forms of industrial organization, and carries out mean difference t-test. The results are shown in TABLE I. The analysis found that under different organizational forms, tea growers performed well in terms of tea seedling varieties and low toxic pesticides, accounting for 89% or more of the standard growers, while they performed poorly in terms of production archives, with less than 11% of the standard growers. First, main organizational form and quality control of growers. In terms of safety control, large-scale planting is significantly better than small-scale planting in tea seedling quality, soil fertility maintenance and production file management. In terms of safety control, large-scale planting is significantly better than small-scale planting in mixing pesticides according to the dosage specified in the instructions and implementing the safety interval of pesticides, and there is no significant difference in the application of low toxic pesticides. Second, inter subject organization and quality control of growers. In terms of quality control, the tea growers who joined the cooperative were significantly better than the farmers who did not join the cooperative in tea seedling variety control, production process management and soil fertility maintenance indicators. In terms of safety control, farmers who join the cooperative are significantly better than tea growers who do not join the cooperative in blending pesticides according to the dosage specified in the manual and applying low toxic pesticides, but there is no significant difference in the implementation of pesticide safety interval. The tea growers who signed the contract were significantly better than the tea growers who did not sign the contract in all indicators of quality and safety control.

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**TABLE I. Differences in quality control of tea growers under different forms of industrial organization**

| INDEX | | SUBJECT ORGANIZATION | | | INTER SUBJECT ORGANIZATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | SCALE | | | JOINED COOPERATIVE | | | DIGNED CONTRACT | | |
| | | small (737) mean value (A) | big (332) mean value (B) | Mean difference H0:A-B=0 T-value | No(561H) mean value (C) | Yes (508H) mean value (D) | Mean differenceH0:C-D=0 T-value | No (816H) mean value (E) | Yes (253H) mean value (F) | Mean differenceH0:E-F=0 T-value |
| QC | BV | 0.79 | 0.89 | -1.651** | 0.82 | 0.86 | -1.303** | 0.78 | 0.96 | -0.934* |
| | PA | 0.27 | 0.46 | -2.335*** | 0.09 | 0.54 | -5.327 | 0.12 | 0.61 | -2.668** |
| | OF | 0.76 | 0.87 | 1.259* | 0.79 | 0.92 | 1.512* | 0.69 | 0.89 | -2.329 |
| SC | BI | 0.75 | 0.89 | -0.938 | 0.65 | 0.94 | -0.791*** | 0.76 | 0.93 | 1.331* |
| | LT | 0.91 | 0.92 | -0.443** | 0.89 | 0.95 | -0.513** | 0.87 | 1.00 | -0.585** |
| | SI | 0.83 | 0.89 | 0.344 | 0.75 | 0.97 | 0.492 | 0.83 | 0.95 | -1.347*** |

Notes: ***** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Abbreviations are as following, H stands for household, QC stands for quality control, SC stands for safety control, NJ stands for not joined the cooperative, BV stands for breed variety, PA stands for planting archives, OF stands for organic fertilizer, BI stands for blend according to instructions, LT stands for low toxic pesticide, SI stands for safety interval.

## V. MODEL SELECTION AND RESULT ANALYSIS

### 5.1 Model Setting and Variable Meaning

Statistical analysis shows that there are significant differences in many aspects of quality control and safety control of tea growers under different organizational forms. Next, the paper will further analyze the specific impact of industrial organization on the quality control behavior of tea producers through econometric model. The selection of dependent variables mainly considers two aspects: one is to select the indicators with significant differences between different organizational forms in the previous statistical analysis, and the other is to select the indicators that can be analyzed by econometric regression. Therefore, the paper selects six indexes of tea seedling varieties, production files, application of organic fertilizer, blending according to the specified dosage, low toxic pesticides and safety interval as the dependent

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variables of econometric analysis. In terms of independent variable selection, in addition to the industrial organization model variables, other factors affecting the quality control of farmers are also included in the model as control variables. The specific variable setting and descriptive statistics are shown in TABLE II. Considering that these quality control indexes are binary variables, binary logit model is used for fitting. The basic form of binary logit regression model is:

$$p_i = F\left(\alpha + \sum_{j=1}^{n} \beta_j x_j\right) = \frac{1}{1+e^{-(\alpha+\sum_{j=1}^{n}\beta_j x_j)}} \tag{3}$$

In the formula(3), $p_i$ is the probability of number $i$ tea grower's quality control meeting relevant requirements, $\alpha$ is a constant term, $\beta_j$ is the regression coefficient of number $j$ independent variable, and $n$ is the number of independent variables. $x_j$ is the number $j$ independent variable, involving the industrial organization variables mentioned in the previous hypothesis and other factors affecting the quality control of farmers. The linear expression of binary logit regression model is obtained by logarithmic transformation of equation (3):

$$Ln\left(\frac{p_i}{1-p_i}\right) = \alpha + \sum_{j=1}^{n} \beta_j x_j \tag{4}$$

**TABLE II. Variable setting and descriptive statistics of influencing factors of tea growers' quality and safety control**

| VARIABLE NAME | VARIABLE DOMAIN ASSIGNMENT | MEAN VALUE | STANDARD DEVIATION |
|---|---|---|---|
| Large-scale planting | Yes=1； No=0 | 0.37 | 0.49 |
| Joined cooperative | Yes=1； No=0 | 0.39 | 0.45 |
| Signed contract | Yes=1； No=0 | 0.15 | 0.23 |
| Age | Respondent's age | 48.82 | 12.45 |
| Education | 6 years=1； 9 years =2； 12 years =3； more than12 years =4 | 2.06 | 0.71 |
| Planting years | Years of tea planting by growers | 8.94 | 10.72 |
| Degree of specializatio n | According to the proportion of tea sales net income in household net income | 0.68 | 0.23 |

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| | | | |
|---|---|---|---|
| Technical training | Participate in technical training provided by the government, cooperatives and related enterprises, Yes=1； No=0 | 0.73 | 0.44 |
| Government supervision | Influence of government supervision on quality control of growers, very little =1, Not large = 2, General = 3, Larger = 4,Very large = 5 | 2.01 | 1.17 |
| Sampling inspection | No sampling = 1, Occasional sampling = 2, Spot check every time = 3 | 1.69 | 0.78 |
| Awareness of pesticide prohibition | Very little understanding = 1, Not familiar = 2, General = 3, Comparative understanding = 4, Very well understood = 5 | 3.87 | 1.23 |
| Cognition of pesticide safety interval | Very little understanding = 1, Not familiar = 2, General = 3, Comparative understanding = 4, Very well understood = 5 | 3.75 | 1.29 |
| Pesticide residue cognition | Impact of pesticide residues on human health: very small = 1; Not large = 2; General = 3; Larger = 4; Very large = 5 | 3.97 | 1.06 |
| Income impact expectation | The impact of producing higher quality and safer tea on their own income, very small = 1, Not large = 2, General = 3, Larger = 4,Very large = 5 | 2.53 | 1.41 |
| Risk attitude | Dislike taking risks = 1; Intermediate risk = 2; Enjoy taking risks = 3 | 1.45 | 0.56 |

5.2 Result Analysis

Because there is a possibility of mutual influence between the quality and safety control of tea growers and the choice decision of industrial organization. Tea growers may choose to join the agricultural industrial organization because their production behavior is safe enough, and joining the agricultural industrial organization will make the production of tea growers safer. The synchronous trend between the two will bring endogenous problems. At the same time, whether tea growers join cooperatives and sign agreements with tea processing enterprises must be affected by variables such as tea growers' personal characteristics, family characteristics and resource endowment characteristics. Therefore, theoretically, there is a strong endogenous relationship between the quality and safety of tea production and whether tea farmers join the industrial organization.

Steps to eliminate endogeneity: firstly, we use Hausman-test method to measure whether endogeneity exists and the influence degree of endogeneity; secondly, we find instrumental variables to eliminate the endogeneity of the model; thirdly, sargan test is performed on the model considering endogeneity to detect whether there is excessive restriction of constraints, that is, to test the legitimacy of instrumental variables. If the directions of all variables in the model considering endogeneity are consistent with the results of ordinary least squares estimation, it shows that the instrumental variables are effective. According to the

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specific requirements of effective instrumental variables (related to endogenous variables, but not related to error terms), this paper intends to select the distance between farmers and tea green professional trading market and the planting scale of tea farmers as instrumental variables.

Before the regression of the model, the paper tested the multicollinearity of the independent variables, and found that the absolute values of the correlation coefficients between small-scale planting and large-scale planting, between junior middle school and senior high school, between the cognition of banned pesticides and the cognition of pesticide safety interval are greater than 0.5,and there may be a variety of collinearity problems; By further calculating the variance expansion factor (VIF),it is found that the average VIF value of all independent variables is 1.61 and the maximum is 1.79,which are between 1-5 and close to 1. Therefore, the problem of judging multicollinearity is not serious and the model is still acceptable. This paper adopts stata20.0 software to fit the model, and the results are shown in TABLE III.

**TABLE III. Effect of industrial organization on quality control of tea producers**

| VARIABLE NAME | BV | PA | OF | BI | LT | SI |
|---|---|---|---|---|---|---|
| LARGE-SCALE PLANTING | 0.59* | 0.87 | 0.93* | 0.39** | 0.65 | -0.22 |
| | (0.98) | (1.65) | (1.35) | (0.81) | (1.30) | (-1.21) |
| JOINED COOPERATIVE | 0.77** | 0.95 | 0.54* | 0.79* | 0.41 | 0.47*** |
| | (2.62) | (1.79) | (1.16) | (1.11) | (1.65) | (1.73) |
| SIGNED CONTRACT | 0.76* | 1.33** | 1.06* | 1.23** | 0.61 | 0.78*** |
| | (1.08) | (1.57) | (1.92) | (1.48) | (0.93) | (1.03) |
| AGE | -0.001 | -0.08** | 0.004 | -0.06* | 0.03 | -0.02 |
| | (-0.04) | (-2.09) | (0.016) | (-1.81) | (1.05) | (-0.77) |
| EDUCATION (reference group: 6 years) | | | | | | |
| 9 YEARS | 0.13 | -0.04 | -0.32 | 1.03* | 0.07 | 1.09** |
| | (0.52) | (-0.30) | (-0.79) | (1.45) | (0.14) | (1.27) |
| 12 YEARS | 0.22 | 0.79* | -0.34 | 0.96** | 0.06 | 1.34* |
| | (0.34) | (1.46) | (-0.41) | (1.87) | (-0.71) | (-0.69) |
| MORE THAN 12 YEARS | 0.37 | -1.02 | -1.13 | 0.25* | 0.45 | 0.22 |
| | (0.29) | (-1.20) | (-0.90) | (0.63) | -0.39 | -0.56 |
| PLANTING YEARS | -0.21*** | -0.04 | 0.09 | 0.07 | -0.004 | -0.001 |
| | (-2.63) | (-1.14) | (1.36) | (1.54) | (-0.13) | (-0.28) |
| DEGREE OF SPECIALIZATION | 0.94 | 0.06 | -1.57** | -0.2* | 0.42 | 0.65 |
| | (1.24) | (1.35) | (-2.80) | (-0.39) | (0.57) | (-0.76) |
| TECHNICA | 0.99** | 0.2 | 0.65* | 0.74 | 0.63 | 0.85** |

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| | | | | | | |
|---|---|---|---|---|---|---|
| L TRAINING | (1.05) | (0.48) | (0.79) | (1.21) | (1.16) | (0.76) |
| GOVERNMENT SUPERVISION | -0.03 | 0.08 | 0.13 | 0.25 | 0.19 | 0.13 |
| | (-0.18) | (0.45) | (0.57) | (1.44) | (0.72) | (0.52) |
| SAMPLING INSPECTION | -0.006 | 0.01 | 0.36 | 0.84* | 0.43 | 0.35** |
| | (-0.02) | (0.03) | (0.92) | (2.18) | (1.02) | (0.99) |
| AWARENESS OF PESTICIDE PROHIBITION | - | -0.37 | -0.13 | 0.79 | 2.16** | 0.56 |
| | - | (-1.35) | (-0.90) | (1.24) | (3.09) | (1.37) |
| COGNITION OF PESTICIDE SAFETY INTERVAL | _ | 1.23 | - | 0.41 | 0.35 | 1.66*** |
| | - | (3.22) | - | (0.77) | (1.42) | (4.14) |
| PESTICID RESIDUE COGNITION | - | 0.37 | 0.18 | 1.49** | 1.13* | 1.67*** |
| | - | (1.49) | (0.43) | (2.52) | (1.68) | (0.62) |
| INCOME IMPACT EXPECTATION | 0.26 | -0.10 | 0.06 | -0.09 | -0.01 | 0.32** |
| | -0.38 | (-0.52) | -0.47 | (-0.76) | (-0.32) | (1.41) |
| RISK ATTITUDE | 0.26 | 0.57 | 0.46 | -0.24 | -0.15 | -0.22 |
| | -0.71 | -1.35 | -1.29 | (-0.70) | -0.46 | (-0.61) |
| SAMPLE SIZE | 1069 | 1069 | 1069 | 1069 | 1069 | 1069 |
| LOG LIKELIHOOD | -1002.69 | -2019.22 | -769.81 | -817.03 | -1542.14 | -960.13 |
| QUASI $R^2$ | 0.166 | 0.274 | 0.068 | 0.162 | 0.093 | 0.205 |

Note: the numbers in brackets are the corresponding Z values; ***,** and * represent statistical significance at the 1%,5% and 10% levels, respectively; abbreviations are as following, BV stands for breed variety, PA stands for planting archives, OF stands for organic fertilizer, BI stands for blend according to instructions, LT stands for low toxic pesticide, SI stands for safety interval.

5.2.1 The influence of the main organization on the quality control of tea producers

After controlling the influence of other factors, the influence of large-scale planting on, tea seedling varieties and medium organic fertilizer application is significant at the level of 10% and the direction is

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positive; The effect on blending according to the specified dosage is significant at the level of 5% and the direction is positive, but the effect on the safety interval is significant at the level of 5% and the direction is negative. This is consistent with the expectation of the first half of hypothesis 1, that is, the impact of large-scale planting on product quality is positive, but the impact on product safety is not clear. Compared with small-scale planting farmers, professional large households and family farms have better cultural level, stronger ability to obtain information and market concept, so they have higher consciousness of controlling tea quality. Possible reasons for failing to implement the requirements of pesticide safety interval: on the one hand, producers do not have enough understanding of the impact of safety interval on tea safety; On the other hand, because of the trust property of tea safety, in the case of imperfect traceability system, the security property is difficult to reflect high quality and good price.

5.2.2 The influence of inter subject organization on the quality control of tea Producers

After controlling the influence of other factors, in terms of quality control, whether to join the cooperative has a significant impact on the use of organic fertilizer by tea producers at the level of 10% and on tea seedling varieties at the level of 5%, and the direction is positive. In terms of safety control, whether to join the cooperative or not has a significant and positive impact on tea producers mixing pesticides according to the specified dosage and implementing the safety interval at the level of 10% and 1% respectively. This is consistent with the expectation of hypothesis 2, indicating that joining the cooperative has a positive effect on tea producers to improve quality control and safety control in many aspects. This is inseparable from the cooperative providing various services to members. The survey found that the services provided by the cooperative to members include three unified points (unified procurement, unified processing, unified sales and separate planting management), loan guarantee, technical guidance and training, information sharing, etc. these services help farmers overcome the limitations of their own conditions, so as to implement better quality control and safety control in production.

The influence of inter subject organization on the quality control of tea producers. After controlling the influence of other factors, in terms of quality control, whether to join the cooperative has a significant impact on the use of organic fertilizer by tea producers at the level of 10% and on tea seedling varieties at the level of 5%, and the direction is positive. In terms of safety control, whether to join the cooperative or not has a significant and positive impact on tea producers mixing pesticides according to the specified dosage and implementing the safety interval at the level of 10% and 1% respectively. This is consistent with the expectation of hypothesis 2, indicating that joining the cooperative has a positive effect on tea producers to improve quality control and safety control in many aspects. This is inseparable from the cooperative providing various services to members. The survey found that the services provided by the cooperative to members include three unified points (unified procurement, unified processing, unified sales and separate planting management), loan guarantee, technical guidance and training, information sharing, etc. these services help farmers overcome the limitations of their own conditions, so as to implement better quality control and safety control in production.

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5.2.3 The influence of control variables on the quality control of tea producers

In terms of individual characteristics, the older the respondents are, the lower the probability of establishing production files and the lower the probability of blending pesticides according to the specified dosage; Compared with the respondents with primary school education and below, the respondents with middle school education and high school education performed better in pesticide safety interval and pesticide blending according to the specified dosage, and the respondents with high school education performed better in production file records than those with primary school education and below; The growth of planting years has an adverse impact on the selection of tea seedling varieties, and has no significant effect on other aspects of quality and safety control. In terms of production characteristics, the influence of specialization on the selection of tea seedling varieties is positive, while the influence on the application of organic fertilizer and the blending of pesticides according to the instructions is significant at the level of 5% and 10%, and the influence on the application of organic fertilizer, the blending of pesticides according to the instructions and the implementation of safety interval is negative. The effects of technical training on tea seedling variety selection, pesticide safety interval and application of organic fertilizer were significant at the levels of 10% and 5%, respectively. The acquirer draws lots to mix pesticides according to the specified dosage, and the safety interval of pesticides is significant at the level of 10% and 5% respectively, and the direction is positive. In terms of cognition, tea producers' cognition of banned pesticides helps tea farmers choose to use low toxic pesticides, and the cognition of pesticide safety interval is conducive to tea farmers to implement the safety interval as required. The influence of pesticide residue cognition on blending pesticides according to the instructions, choosing to use low toxic pesticides and implementing the safety interval is significant and positive at the levels of 5%, 10% and 1% respectively. In terms of income expectation and risk attitude, the impact of income expectation on the implementation of safety interval is positive. In addition to the application of organic fertilizer by the degree of specialization and blending according to the instructions, the above econometric analysis results are consistent with the expectations of hypothesis 3, Hypothesis 4 and Hypothesis 5. The degree of specialization has a negative impact on the use of organic fertilizer and the blending of pesticides according to the instructions. The possible reason is that farmers with small-scale planting are more sensitive to the cost-benefit of production and prefer to increase the yield of fresh tea leaves at a lower cost, so as to apply more chemical fertilizers and pesticides.

## VI. CONCLUSIONS AND POLICY IMPLICATIONS

Based on the survey data of 1069 samples from Zhejiang, Fujian, Anhui and Guizhou provinces in China, this paper empirically analyzes the impact of agricultural industrial organization on producer quality control, and draws the following main conclusions.

First, the impact of main organization on producer quality control is mixed. Compared with small-scale planting, large-scale family farms do better in quality control. However, the advantages in safety control are not obvious. The reason is that quality is a comprehensive index, and tea quality belongs to dominant index, that is, people can roughly judge the quality of tea through observation and

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taste. The quality and safety of tea is a hidden index. In general, people can't judge whether tea is safe through senses. It is easier for producers to obtain market returns for the improvement of tea quality, while the information transparency in the improvement of quality and safety is poor, which makes it difficult for consumers to believe and be willing to pay higher prices. Therefore, the producer's control of tea quality is better than that of safety.

Second, close inter subject organization can significantly promote producer quality control. Joining the cooperative can significantly promote the quality control and safety control of tea producers. Signing contracts with enterprises can significantly promote the production records of tea producers and blending agriculture according to the specified dosage. Whether tea producers join cooperatives or sign contracts with enterprises, in addition to the benefits of economies of scale and price concessions, they must also abide by a series of quality and safety requirements put forward by cooperatives and enterprises. Therefore, improving the organization level of tea industry is conducive to the quality and safety control of tea.

Third, the individual characteristics, production characteristics, environmental characteristics, cognitive level and expected income of tea producers will also affect their quality and safety control behavior. Scattered family small-scale planting is the basis of tea industrial organization and the most basic production unit, so tea quality and safety control needs to start from small-scale tea producers. Only by improving the cognitive level and quality of tea producers can tea quality and safety control be guaranteed.

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*July-August 2022 Page No. 1408-1426*
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