Investigating Chinese Vegetable Processing Firms' Economic Incentives to Enhance Quality and Safety Controls

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China's vegetable quality and safety controls are being challenged as previously seen in other food industries. This study surveyed 170 vegetable processing firms in Zhejiang, China. We systematically investigated Chinese vegetable processing firms' current status of quality and safety controls and factors affecting firms' propensity to invest in food safety controls in the future. This study shows that a processing firm's incentive for food safety and quality control comes directly from its target market but is greatly influenced by governmental financial and technological support; firms' small scale and low education level of decision makers are obstacles to improving food safety levels.

China's food safety issues have become a global concern. Frequent outbreaks of food safety incidents have greatly decreased consumers' confidence in Chinese products. According to China's Health Ministry, there were almost 34,000 domestic food-related illnesses in 2005, with spoiled food accounting for the largest percentage, followed by poisonous products or animals and the use of agricultural chemicals. For example, in 2008, melamine-contaminated infant milk powder affected more than 300,000 Chinese infants, killing six (SciDev.Net 2010). In 2010, excessive isocarbophos pesticide residues were detected in cowpeas produced in Hainan province (People's Daily Online 2010). A long list of Chinese food exports have been rejected by the United States, the European Union, Japan, Korea, and other countries, including pesticide-laden pea pods, fermented cabbage with parasites, frozen spinach with excessive pesticide residues, drug-laced catfish, filthy plums, and crawfish contaminated with salmonella. Because of these frequently rejected exports, Chinese vegetable export value has greatly decreased. For example, in 2004, vegetable exports to Japan from Ningbo, Zhejiang Province decreased by 3.9 percent compared with exports in 2003 (Zhejiang Online 2010). In 2005 approximately six percent of Chinese agricultural products were considered pollution-free, while safer, better quality, and "green" labeled food accounts for just one percent of the total (USDA 2006).

The Chinese government treated the food safety problems seriously and attempted to overhaul its food system and implement measures to improve and ensure food safety and the general reliability of Chinese products in both the export and domestic sectors (Liu, Hobbs, and Kerr 2008). The process began as early as 2001, when the Chinese Department of Agriculture put forward the Plan of Pollution-Free Food Implementation. In 2003 the Chinese government promulgated the Pollution Free Agriculture Product State Certification in order to enhance the safety and quality level of agricultural products from farm gates to consumers' tables. In order to restore consumers' confidence in "Made-in-China" products, the Chinese government launched a nationwide product quality and food safety certification plan in August 2007, in which vegetable quality and safety control are an important part. Due to the government's huge investment and effective supervision, China's vegetable quality and safety level have substantially increased. For example, in 2008 pollution-free, "green" labeled, and certified organic products accounted for 20 percent of the total agricultural food products (China Economic Information Network 2009).

However, vegetable pesticide levels are still impermissibly high in many situations due to the mismatch between the complicated inspection process required for vegetable production and China's small-scale and fragmented vegetable farms, and farms' non-standardized vegetable production techniques. Farmers' knowledge of proper fertilizer, pesticide, and fungicide application and use is very important for improving vegetable quality and safety levels. However, most Chinese farmers are

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under-educated on issues related to vegetable safety, which makes farmers' self-regulation infeasible and the implementation of governmental safety regulations more difficult (Zhou and Jin 2009). As a result, it is necessary to explore new ways to implement governmental food safety regulations, such as using intermediary organizations to drive farmers to provide safe vegetables. During the last decade the Chinese government has started fostering the growth of small to medium farm enterprises by providing financial and policy support. But due to budget constraints, the Chinese government gives priority to those enterprises whose sales are at least ¥5,000,000 (about US$715,000), which are considered to be more likely to survive market competition. These enterprises are called "flagship enterprises."[1] Given the trend that fresh produce will be partially or completely processed before entering markets and the intermediary nature of processing firms[2] in the supply chain that connects farmers and consumers, it is possible for the processing firms, especially those "flagship firms," to take a lead in implementing governmental regulations to improve vegetable quality and safety.

Because of the increasing concerns about food safety and quality around the world, many countries have adopted national or international food safety standards and certifications, including organic certification, ISO 9000, GAP, HACCP, GMP, and QS. Some of those standards are internationally recognized for controlling food safety/quality. HACCP, for example, is a detailed protocol of requirements for producing and processing food products. HACCP adoption can be used as an indicator of a firm's relatively high food safety control level. These standards are not widely adopted in China. For example, in 2005 only about 20 percent of Chinese food producing and processing firms had adopted HACCP (Chinese Certification and Accreditation Year Book 2005).

In recent years many researchers have studied food processing firms' managerial behaviors of quality and safety control. Caswell (1998) and Buzby and Frenzen (1999) found that firms' motivations for quality and safety control come from buyers' pre-sale quality requirements and post-sale penalty policies. Starbird (2000) and Hudson and Jones (2001) showed that firms' motivations come from penalties and liabilities for violating quality regulations as well as from benefits of firms' better reputations among consumers generated by enhanced quality control. Udith and Hanson (2006) modeled firms' motivations in adopting quality and safety management systems and found that transaction costs, contracts, responsible management, a firm's scale, domestic and international organizational regulations, and consumer requirements all affect firms' attitudes toward the adoption of quality and safety management systems. Martinez and Poole (2004), Farina et al. (2005), Spers, Zylbersztajn, and Lazzarini (2003), and Denise and Christopher (2005) found that firms' adoptions of quality control standards and measures depended on considerations of the potential costs and risks of new technologies, benefits of customer brand loyalty, firms' own characteristics and strategic objectives, the regulatory environment, product characteristics, and market characteristics. Due to a unique market structure, the agricultural industry structure, and farmers' backgrounds in China, existing food safety research results might not be applicable, and therefore research on exploring possible ways to improve China's agricultural product quality and safety management is greatly needed.

To our knowledge, only a few studies have ever focused on investigating how to improve Chinese food safety systems. For instance, Sang (2003) and Hu, Fred, and Thomas (2006) explored possible effective agricultural product-quality and safety-management systems by considering consumer demand for safe products and the relationship between firms' vertical integration in the supply chains and their provision of safe agricultural products. There are even fewer studies on quality and safety manage-

[1] Small-scale and medium-scale firms account for 99 percent of the firms in China; 60 percent of them are scattered in villages and small towns, and they are called "township enterprises." The township enterprises had the closest connection with farmers, and were once very vibrant in the agricultural processing industry. But as China reforms its market structure and opens its market more to the world, the small-scale township enterprises are not as competitive, especially in the international market. For example, in 2006 the average number of employees in township enterprises was only 6.3 and the fixed capital was only ¥299,000. The Chinese government has put forward a policy to foster the growth of relatively larger-scale township enterprises by providing financial and policy support.

[2] "Vegetable processing firms" in this paper refers not only to firms conducting in-depth vegetable processing but also to firms that specialize in simple vegetable grading, cleaning, and cutting.

ment decision-making methods of stakeholders, such as farmers and processing firms. Zhou (2006), Yang (2006), and Zhang (2004) conducted empirical studies about farmers' quality and safety management behaviors. Wei (2004) found that agricultural cooperatives play an important role in Chinese agricultural product quality control and improvement. Zhou (2007) conducted a study of food processing firms' implementation of HACCP systems and found that implementation was affected mainly by firms' scale, market structure, safety management effectiveness, and firms' decision makers' knowledge of food safety issues. Most of the aforementioned food safety studies related to China are qualitative and focus on aggregate agricultural products. However, different agricultural products have different attributes and, hence, very different quality and safety control requirements. Therefore the conclusions drawn from aggregate agricultural product studies may not be applicable to specific agricultural product categories such as vegetables. By surveying the vegetable processing firms in Zhejiang province, this study attempts to fill this gap by investigating China's current status of vegetable quality and safety control and Chinese vegetable processing firms' propensity to invest in quality and safety controls in the future.

Zhejiang province is located on the southeast coast of China; the north of the province is just south of the Yangtze Delta. Zhejiang province is one of the most economically vibrant and developed provinces—its gross domestic product (GDP) in 2008 accounted for more than six percent of China's national GDP and its per capita GDP is the highest of all the provinces in China (Zhejiang Statistics 2009). Zhejiang is also one of the leading provinces that have been very successful in economic reform and is considered a "model" by many local governments and firms in other provinces (Feng 2008). Many of the aforementioned "flagship enterprises" are located in Zhejiang province. The vegetable production and processing industry is one of the most important agricultural sectors in Zhejiang province. In recent years the vegetable processing industry in China has increased in geographic specialization. Most vegetable processing firms are located in the provinces of Shangdong, Fujian, Zhejiang, Xinjiang, and Guangdong. Zhejiang province ranked third in the export value of vegetables. Compared with vegetable processing firms in other provinces, the firms in Zhejiang province are more export-oriented; therefore the vegetable processing firms in Zhejiang have a relatively higher food safety level compared with those in most other provinces in China. For example, in 2006 and 2007 the number of firms in Zhejiang that had "green" certification ranked second of all provinces in China (Green Food 2010). The vegetable processing firms in Zhejiang province are more export-oriented, more connected to the international market, and thus more affected by the Chinese food quality and safety issues in the international context compared with firms from other regions in China. Therefore a study of the vegetable processing industry in the Zhejiang province may provide great insights into the current opportunities and challenges of China's vegetable quality and safety controls in order to catch up with the high international food safety standards and into the major factors that affect China's vegetable quality and safety control level. What is learned from the vegetable processing firms in Zhejiang may provide guidance on how to improve vegetable quality and safety levels for firms in other areas of China.

The objectives of our research are to understand the current status of Chinese vegetable firms' food safety and quality control, and to unveil the key factors that affect the decision makers' propensity to improve vegetable safety and quality control in the future based on understanding of their current status. Specifically, this study provides insights into Chinese vegetable processing firm decision makers' incentives to improve product quality, the bottlenecks of implementing product quality and safety controls, the vegetable firms' existing product recall systems, firms' collaboration with customers in the supply chain, firms' collaboration with the raw material suppliers, and the major factors that can affect Chinese vegetable firm decision makers' propensity to make investment in food safety and quality control measures in the future. This research provides important policy implications for the Chinese government and other developing countries.

The rest of the paper is organized as follows: Section 2 describes materials and methods including data collection and empirical models; Section 3 presents the results and discussion, including the current status of Chinese vegetable firms' food safety and quality controls and a logistic model estimation that identifies the major factors that affect Chinese vegetable firm decision makers'

future investment in food safety control; and the last section concludes the study and makes policy recommendations.

Materials and Methods

Data Collection

During October, 2006 and March, 2007 we surveyed vegetable processing firms in Zhejiang province, China, about their quality and safety control behaviors. The decision makers of these firms were asked to answer a series of questions via in-person interviews or mail-in surveys. A hotline was opened to help participants better understand the questions. Two pilot studies were conducted at selected sites located in the Jinhua and Ningbo areas in July and August, 2006 to validate the design of the questionnaire.[3] The questionnaire was revised based on the pilot studies results. There are around 800 vegetable processing firms in Zhejiang province. The Zhejiang Department of Agriculture maintains a list of vegetable processing "flagship enterprises" that covers most (more than 90 percent of vegetable sales) of the vegetable processing firms in Zhejiang. We obtained our sample from this list. The sample was stratified across the different regions in Zhejiang. The vegetable processing firms on the list were randomly selected to participate in the final survey. One hundred and seventy questionnaires were sent to survey respondents and 129 valid responses were received by the time of this analysis. Decision makers of the surveyed firms were asked about their adoption of safety standards, their motivations to adopt the standards, firm characteristics, target markets, and resources allocated to product safety and quality control.

Empirical Analysis and Models

For the analysis of the current status of Chinese firms' food safety control (FSC) levels, we used ANOVA analysis, descriptive summary statistics (means, percentages, etc.), and qualitative analysis to analyze the survey data. For the analysis of the factors that affect firms' decision markers' propensity to improve FSC in the future, we used an FSC utility model to conduct the analysis.

Based on Caswell (1998) and Segerson's (1999) studies, Nakamura, Takahashi, and Vertinsky (2001) proposed a utility model to study Japanese food firms' product certification and quality-management-system certification. The authors suggested that food firms' incentives to adopt mandatory and non-mandatory measures to improve food safety level can be expressed by a decision maker's utility function. Udith and Henson (2006) used the utility model to analyze Canadian pork-processing firms' quality-control behavior and found that the perceived utility brought by food safety control greatly affects the entrepreneurs' decisions about product quality and safety controls.

We used a similar FSC utility model to investigate the major factors that affect Chinese vegetable processing decision makers' incentives to improve FSC.

A decision maker *i*'s utility brought by improving product quality and safety control is

$$(1)\quad U_i = U(X_i\beta) + \varepsilon_i ,$$

where U_i is the decision maker's utility brought by FSC, which is a function of X_i, the vector of the independent variables that affect the decision maker's utility brought by FSC. X_i can include the decision makers' own opinion and characteristics, firm's characteristics, product characteristics, target market, etc. ε_i is a random disturbance, which is assumed to follow extreme value distribution.

In the empirical analysis we did not observe utility U_i. Instead, what we observed was decision makers' opinions about whether improving their current FSC levels could bring greater benefits, which is a binary variable, y_i. Therefore our observations are

$$(2)\quad \begin{aligned} y_i &= 1 \text{ if } U_i > 0 , \\ y_i &= 0 \text{ if } U_i \leq 0 . \end{aligned}$$

Equation 2 means that if the decision maker's utility brought by FSC improvement is positive ($U_i > 0$), the decision maker would agree that improving their current FSC level can bring net benefits ($y_i = 1$). If a decision maker's utility brought by FSC improvement is zero or negative ($U_i \leq 0$), the

[3] According to Zhejiang Statistical Yearbook, Ningbo's vegetable production is the second highest in northwestern Zhejiang and Jinhua's production is the second highest in southwestern Zhejiang. We chose these two areas because the vegetable processing firms in these two areas are representative of those in Zhejiang province in terms of technological development level, firm sizes, and other characteristics.

decision maker would disagree that improving their current FSC level can bring net benefits ($y_i = 0$). Assuming U_i is linear—that is, $U_i = X_i\beta + \varepsilon_i$—Equation 2 leads to

$$Prob(y_i = 1|X_i) = \frac{e^{X\beta}}{1+e^{X\beta}} \quad , \tag{3}$$

$$Prob(y_i = 0|X_i) = \frac{1}{1+e^{X\beta}} \quad ,$$

where *Prob* represents probability, β represents regression coefficients, and X_i represents the factors that determine a decision maker's utility level. We conducted some qualitative and quantitative analysis of the firms' current status of quality and food safety controls based on the survey results, which can help decide what variables should be included in vector X_i.

Results and Discussion

Vegetable Processing Firms' Current Status of Quality and Safety Controls

Incentives to Improve Product Quality

In the questionnaire we asked participants about the incentives for firms to improve product quality. About 76.5 percent of them chose "to improve the product's reputation and popularity," 68.1 percent chose "to make the product more profitable," 62 percent chose "to meet governmental and market requirements for product quality," and 58 percent chose "to be socially responsible." The results show that the sampled firms' strongest motivation to improve product quality was to improve product credibility and popularity in order to accumulate intangible brand assets. At the same time, these firms started to compete with each other on product quality and tried to differentiate their products from others' through quality improvement.

Bottlenecks to Implementing Product Quality and Safety Controls

The decision makers were asked to rate the obstacles they were facing that prevented them from providing safe products, using a one-to-five Likert scale. The obstacles include untimely delivery, inconsistent raw-material supply quality, lack of funds, and low technological level.

The Status of Quality Certification

Survey results showed that 29 percent of firms had HACCP certification, which is implemented by China National Regulatory Commission for Certification and Accreditation. Further analysis showed that the major obstacles that prevented firms from applying for a higher level of product certification and management system certification, such as organic certification, were firms' out-of-date quality and safety control technologies and lack of economies of scale.

Expectation of the Government's Role

Survey results showed that 53 percent of the decision makers thought the government should play a very important role in the improvement of FSC. The rest of the decision makers believed the local government's role to be somehow important. Further analysis showed that most decision makers expected their local government to provide financial support. Other governmental supports they wanted included informational support and consistent and fair governmental polices.

Collaboration Customers in the Supply Chain

Table 1 shows that export markets had stricter requirements about quality and safety control, while traditional wholesale markets' and wet markets' requirements were not as strict. However, urban markets (supermarkets and specialty stores), and traditional wholesale[4] and wet markets had a higher percentage requesting pre-purchase tests than did importers. This may be due to the Chinese government not requiring inspections and less strict certification standards for vegetables selling to domestic markets whereas it does have mandatory inspections and stricter certification standards for exported vegetables.

Table 2 shows that export markets provided stronger support for vegetable processing quality and safety controls than for other customers. The percentage of export markets that provided raw-material control support and technical support were far greater than that of other customers.

[4] The customers of the traditional wholesale markets are mostly small-scale retailers in wet markets, restaurants, and other small-scale traditional Chinese stores.

Table 1. Vegetable Quality and Safety Requirements from Customers in the Supply Chain (%).

	Pre-purchase test	Production and processing records	Production environment inspection	Origin and product certification
Export markets	56.5	71.4	68.3	77.8
Urban markets (supermarkets, specialty stores)	86.1	51.5	29.7	74.3
Traditional wholesale and wet markets	55.8	16.2	16.9	23.7

Table 2. Vegetable Quality and Safety Support from Customers in the Supply Chain (%).

	Raw material support	Technical support	Financial support	Training support	Certification support
Export markets	41.9	56.5	19.4	43.5	41.9
Urban markets (supermarkets, specialty stores)	16.8	21.8	18.8	38.6	32.7
Traditional wholesale and wet markets	18.2	16.9	14.9	12.3	12.3

Product-Recall System

The survey results showed that only 27.8 percent of surveyed firms had established product-recall systems, 43.1 percent did not have a recall system but had staff specializing in handling product traceability, and 29.2 percent had not set up a recall system as no product recall had ever been needed. Previous research showed that the main reason for setting up a recall system is market pressure, so we used one-way ANOVA to further analyze the difference in these firms' target markets. The results showed that those firms with export or urban markets as target markets were more likely to set up recall systems, while firms with traditional wholesale and wet markets as target markets were not as enthusiastic about setting up recall systems.

Collaboration with Suppliers In the Supply Chain

The survey showed that 38.9 percent of firms had contracts with a group of farmers in the same region (for instance, a village) who grew raw materials exclusively for them (hereafter referred to as "firm base"[5]), 41.7 percent of them had contracts with specialized raw material suppliers (cooperatives and brokers), and only 19.5 percent of them purchased raw materials directly from markets. Further analysis showed those firms with a larger scale were more likely to purchase from a firm base or have contracts with cooperatives or brokers rather than directly from markets. Furthermore, those firms targeting

[5] Firms may lease land from the government and sign contracts with a village with the result that all of the farmers in the village grow vegetables exclusively for the firms.

export markets were less likely to purchase raw materials directly from markets.

The decision makers were also asked to score their raw-material contractors on a scale of one to five. The average score of firm bases was 4.15, the average score of cooperatives was 3.77, and the average score of individual farmers was 3.55, which means that the firm base was the best at contract performance, followed by cooperatives and individual farmers. For raw-materials traceability, 62.5 percent of firms indicated that they can always trace raw materials if they had a firm base as suppliers. Around 59.4 percent of them stated that they can trace raw materials if they had contracts with cooperatives. However, for purchases from individual farmers and raw-material markets, only 27.0 percent and 6.9 percent, respectively, of firms indicated that raw materials were traceable. The supplier food safety control was more than just source verification; it also included requirements to maintain records of how the products were produced. With collaboration, the firms would require suppliers to keep the production records, make sure the production environment was safe enough to produce vegetables, and monitor if the products had certain certifications such as "pollution free" or "green" certification.

Factors Affecting Decision Makers' Propensity to Invest in FSC in the Future—Logit Model Estimation Results

The definition and summary statistics of independent variables in the logit model are shown in Table 3. FSC is the dependent variable in the logit model. Even though a significant number of firms indicated that the cost of investment in FSC was still greater than returns, 68.3 percent of decision makers believed that stricter product quality and safety control in the future can generate greater potential benefits. Further analysis of the survey data showed that these decision makers believed quality and safety controls can help build up brand loyalty and a better long-term relationship with customers. The number of employees was used to measure a firm's scale. On average, the firms in our sample had 154 employees. The vegetable processing industry in China is labor intensive. From the average number of employees we can see that the scale of the vegetable processing firms were relatively small. Thirteen percent of firms are owned by the Chinese federal government or a local government or are co-owned by government and foreign investors, and 87 percent of them are privately owned. As for the education level, only 15 percent of the decision makers had a college degree, 44 percent had some college or professional degree, and the rest had a high school diploma or lower education level. The average decision markers' education level was between high school diploma or lower and some college or professional degree. Thirty-eight percent of firms produced more than ten types of products. As for major product categories, 24 percent of firms focused on pickled vegetables. Fifty-eight percent of firms had some of their products exported to areas or countries outside the mainland of China. The high export rate was because the firms in our sample were mostly "flagship enterprises." The majority of the exporting countries or areas included Japan, Hong Kong, Macau, South Korea, Singapore, the United States, Germany, and Italy. Only 63 percent of the decision makers believed that good quality could bring a good price, while the rest did not believe so. Around 28 percent of the firms had a relatively higher current FSC level.

The logit model estimation results are shown in Table 4. The log-likelihood is −35.49 and the chi-square test statistic is 93.24 (p-value < 0.001). The predication accuracy is 89.92 percent, which indicates a good fit of the model.

The estimation results demonstrated that the number of employees, a measure of a firm's scale, had a significantly positive effect on a decision maker's propensity to improve FSC. The larger the firm size, the more likely the decision maker is to agree that improving their current FSC level can bring net benefits. This is because larger-scale firms have stronger abilities to implement FSC more successfully; therefore the decision makers are more likely to believe the investment in FSC can bring benefits in the future. Because of the small scale, the vegetable processing firms did not have enough capital to invest in FSC. As shown in the previous section, the vegetable processing firms' primary bottlenecks to implementing FSC were lack of funds and low technological level. Almost all decision makers considered government's role to be very important or somewhat important and most of them need governmental financial support. Governmental supports are critical for these small firms to improve FSC.

Table 3. Variable Definitions and Summary Statistics (n = 129).

Variable	Variable definition	Mean	Standard deviation
FSC	If the decision maker believes that the future investment in FSC can bring greater net benefits, 1 = yes, 0 = no	0.68	0.47
Employee	Number of employees in a firm	153.93	153.78
Stateown	The firm is owned by Chinese federal or local government, 1 = yes, 0 = no	0.13	0.34
Education	The highest education level of the firm's decision marker 1 = High school diploma or lower (31 percent) 2 = Some college or professional degree (44 percent) 3 = College degree and higher (15 percent)	1.74	0.71
Diversity	Number of types of products produced by the firm, 1 if number of types of products is greater than ten, 0 otherwise.	0.38	0.49
Product	Major product category produced by the firm, 1 if the major product category is pickled vegetables; 0 if the major product categories are fresh, dried or other vegetables.	0.24	0.43
TargetMarket	The firms' major target market, 1 if the any of the products produced by the firm are exported to other countries, 0 otherwise	0.58	0.50
Goodprice	If the manager believes good quality can bring good price, 1 = yes, 0 otherwise	0.63	0.49
FSCstock [a]	A measure of the firm's current FSC level, 1 = high level, 0 = low level. The level is measured using the predicted value of whether the firm has HACCP certification or not	0.28	0.45

[a] The *FSCstock* is a measure of a firm's current FSC level. To avoid endogeneity problem, we used the predicted HACCP level of a firm to measure its current FSC level. Specifically, we used a logit model to predict HACCP level. The dependent variable was a dummy variable—whether a firm had a HACCP certification—and the independent variables were the firm's characteristics, the manager's characteristics, and the perceived problems with raw materials. After we ran the logit model, we predicted the HACCP using the estimation results. The goodness of fit of the model was good, which was reflected by the fact that the model prediction accuracy was about 80 percent. The predicted dummy variable HACCP was used as the variable *FSCstock*. The estimation results are available to readers upon request.

The coefficient of *Stateown* is positive and significant. The decision makers of firms that were owned by the Chinese government were more likely to agree that improving their current FSC level could bring net benefits. This is because government-owned firms can get stronger support from the Chinese government in terms of financial capital, human capital, and technological investments. Therefore they have a stronger ability to successfully improve the FSC level; privately owned firms must bear all the investment costs and risks by themselves, so the decision makers of these firms were less likely to agree that investments in FSC can bring net benefits. The Chinese vegetable processing industry consists of a significant proportion of privately owned firms (87 percent in Zhejiang province), reinforcing the importance of governmental supports in FSC improvements, which is especially true for privately owned firms.

Table 4. FSC Utility Logit Model Estimation Results (n = 129).

Variable	Mean	Standard deviation
Intercept	6.72***[a]	2.16
Employee	0.009***	0.003
Stateown	1.86**	0.77
Education	4.07***	0.93
Diversity	2.34***	0.86
Product	-2.00**	0.91
TargetMarket	1.53**	0.72
Goodprice	2.90***	0.74
FSCstock	-4.07**	1.71

* significant at the 0.10 level.
** significant at the 0.05 level.
*** significant at the 0.01 level.

The firm's decision maker's educational level had a statistically significant influence on the firm's perceived benefits brought by a FSC investment. The higher the education level of the firm's decision maker, the more likely the decision maker was to believe that the investment in FSC can bring greater benefits. This indicates that improving a firm's decision maker's education level could eventually improve a firm's possibility of investing in FSC, which in turn improves the firm's FSC level.

The firm's product diversity and product categories affected the decision maker's perception of benefits brought by FSC. The larger the diversity of a firm's products, the more likely the decision maker was to believe that improvement in FSC can bring larger benefits. The coefficient of *Product* was negative and significant, meaning that if a firm's major product category was pickled vegetables, the decision maker was less likely to believe investment in FSC could bring net benefits compared with those firms whose major product categories were fresh, dried, or other vegetables. Since pickled vegetables didn't have as many food safety and quality issues compared with fresh and dried vegetables, the marginal benefits from further investment in FSC would be relatively lower.

Target market type had a significant impact on a decision maker's perception of benefits brought by FSC. Compared to the decision maker of the firms that targeted export markets, the decision makers of the firms whose target market was domestic supermarket and Chinese traditional wholesale and wet markets had lower perceived benefits brought by FSC and were less likely to agree that improvement in FSC could bring net benefits. This is because the Chinese domestic market is less sensitive to vegetable quality and safety issues, and thus has less strict requirements for FSC compared with export markets, as shown in Table 1. Therefore the decision makers might believe that returns from product quality and safety investments cannot cover the costs if they targeted these traditional domestic supermarkets or wholesale and wet markets. The results indicate educating the Chinese domestic market and consumers about food safety issues can increase the Chinese domestic market's sensitivity to vegetable quality and safety problems, which can potentially drive Chinese vegetable processing firms to improve their FSC levels. On the other hand, domestic-market customers, such as urban supermarkets and traditional wet markets, provided less FSC support compared with export-market customers. Strong support from export customers makes decision makers believe that investments in FSC are more likely to be successful and thus can bring net benefits.

The coefficient of *Goodprice* is positive and significant, which is straightforward and indicates that those decision makers who believed the improvement of product quality can lead to a higher price were more likely to invest in FSC. The investment in FSC is costly and the ways to recover the costs is to increase the products' price or increase the market share in order to bring higher profits. This has some implications for education of consumers as well. If the market or consumers are more aware of food safety issues they may be willing to pay a higher price for products that are considered to be of higher quality or safer. The larger market demand for safer or higher quality products would make the firms believe that "good quality" can bring "good price," therefore they would be more willing to make investment in FSC.

A firm's current FSC level significantly affects the decision makers' belief about whether the investment in FSC could bring net benefits: the higher the firms' current FSC level, the less likely a decision maker is to believe that further investment in FSC would bring net benefits. This result is intuitive because if a firm already has a relatively higher FSC level, the marginal benefits from further investment in FSC would be smaller.

Conclusions and Policy Recommendations

The Chinese food safety level is relatively lower than that of developed countries, which is reflected by many domestic food-borne illnesses and rejected food exports to developed countries. Future Chinese food safety levels are largely dependent on whether the decision makers of food-producing firms are willing to make investment in FSC. Based on the survey of vegetable processing firms in Zhejiang province, we analyzed the current status of the FSC level by vegetable processing firms and investigated the major factors that affect Chinese vegetable firm decision makers' propensity to make investments in FSC in the future. We found that many of the Chinese vegetable processing firms' decision makers in Zhejiang province have realized that higher product quality can facilitate marketing access, enhance a firm's reputation, and contribute to a firm's long-term success. However, a substantial number of the vegetable processing firms' decision makers still regard meeting governmental regulations as the only incentive to improve FSC. To improve quality and safety levels, both market and governmental regulations are indispensable for these firms. The survey results showed that the bottlenecks to implementing product quality and safety controls were untimely delivery and inconsistent quality of supplied raw materials, lack of funds, and obsolete technologies. Most of the decision makers of these firms expected the government to provide financial support for them to improve their FSC levels.

From the logit model estimation results, we found that the decision makers in larger-scale firms focused on export markets and who had higher education levels were more willing to invest in FSC in the future. We also found the decision makers of state-owned firms and those who believe good quality can bring good prices were more likely to believe the investment in quality and safety controls could bring net benefits in the future.

Based on the findings of our study, we make several policy recommendations to improve China's vegetable industry's product quality and safety level through the leadership of vegetable processing firms.

- Governmental Support in Vegetable Quality and Safety Control—Most of China's vegetable processing firms are small scale, do not have sufficient funds to invest in food quality and safety controls, and are lagging behind technologically. However, the cost of quality and safety control is high, and the investment cannot gain sufficient returns to cover the cost in the short term. The Chinese government should provide financial support or subsidy for investments in vegetable quality and safety inspection equipment and product quality and safety research and development.

- Educate Domestic Market about Food Safety Issues—Firms' target markets determine the quality and safety control level. Compared with export markets, Chinese domestic markets are less strict with food safety control requirements and provide less food quality and safety control support. Thus the Chinese government and the vegetable firms themselves should educate the domestic public about food quality and safety issues. Improving the domestic public's knowledge of food safety issues will generate the demand for safer products and guarantee that

"good quality" can bring "good price," which in turn will drive food firms to enhance product quality and safety control levels.

- Improve the Education Level of the Vegetable Safety and Quality Related Personnel, Especially That of the Decision Makers in a Firm—The education level of vegetable processing firms' food safety and quality related personnel are not high. Our sample showed that around 31 percent of the decision makers in vegetable processing firms only have a high school diploma or lower and only 15 percent of them have a college degree. The firms should improve the firms' personnel's awareness of food safety issues through training, workshop, experts' lecture, etc. Vegetable processing firms themselves or the government should provide incentives to attract people with higher education levels to manage food safety related issues. Foster the Development of Firm Bases to Control Raw-Material Quality through Vertical Collaboration—Vegetable quality, safety, and traceability can be improved through vertical collaboration with raw-material suppliers, such as by setting up firm bases. The Chinese government should strengthen its financial support for firms to set up firm bases. Much of the land in China is state-owned; the Chinese government should reform the land market and provide private incentives for vegetable processing firms to rent the government land to set up firm bases. Previous studies found that Chinese farmers' awareness of food safety issues is very low and they also have high contract default rates (Zhou and Jin 2009). Therefore another support the government can provide is the education of farmers at firm bases about food safety and quality issues and how to decrease contract default rates.

- Combining Non-Regulatory Private Incentive and Regulatory Penalty Mechanisms—The results showing that the choice of quality and safety control is directly affected by the target markets indicates that effective quality control is realized through proper non-regulatory private incentive and regulatory penalty mechanisms. Therefore the Chinese government should set up systematic food quality and safety laws and regulations, be stricter with rules that only safe products can enter into markets, and increase penalties on fake and low-quality products. Furthermore, the government should support and encourage the development and growth of retailers, such as supermarkets and specialty fresh produce stores, that have higher food safety and quality requirements.

As mentioned in the introduction, the sample of the vegetable processing firms was from Zhejiang province. The flagship firms in Zhejiang province were more export-oriented and had relatively higher levels of food safety and quality control, so our sample is not representative of all the vegetable processing firms in China, but our analysis does provide insights into the current challenges the Chinese vegetable processing firms are facing in vegetable quality and safety control. Using the sample of firms in Zhejiang province we also identified the bottlenecks to improving vegetable safety and quality levels and the major factors that might affect it. Since many local governments and firms in other provinces in China consider the flagship firms in Zhejiang province as a "model," our analysis provides important guidance on how to improve the vegetable processing firms' quality and safety control level in other areas of China.

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