

ORIGINAL ARTICLE

An empirical examination of the effects of local agro-food quality and safety supervision in China

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agro-food; China; effects; empirical examination; quality and safety; supervision.

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Received 21 July 2011; Revised 4 February 2012; Accepted 21 February 2012.

doi: 10.1111/j.1757-837X.2012.00178.x

Abstract

Introduction As the development of China's economy, as well as people's living conditions grows, more concerns have arisen around food safety issues. However, due to uneven resource distribution, the food safety situations between urban and rural areas differ. Compared to the ongoing research on urban food safety, rare attention is given to the study of this problem in rural areas. **Objectives** Based on the survey result of 892 counties of China, this study is designed to analyze factors that exert influence on the supervision of agro-food quality and safety. **Methods** In view of the actual conditions in China, 12 variables were selected as the original evaluation indexes in the process of this supervision. Factor analysis was used to figure out the regional difference and major factors influencing the agro-food quality and safety supervision in these counties. In order to analyze the main influencing factors, the counties were divided into four groups according to their composite scores. And the different major factors of these four clusters were given by comparative analysis. **Results** Through the analysis, this thesis found out that sufficient budget is the most important factor that affects the local agro-food quality and safety supervision, and the overwhelming majority of China's counties enjoy mediocre supervision. **Conclusion** Furthermore, this thesis also found out that the difference between regions is significant and counties in the east coastal areas have established the most effective supervision institution on the agro-food quality and safety.

GUO X, WANG F, YU X, LIU X, QIAN Y, CHEN S (2012). An empirical examination of the effects of local agro-food quality and safety supervision in China. *Quality Assurance and Safety of Crops & Foods*, 4, 185–192.

Introduction

Food safety is still a crucial public health issue both in developed and developing countries until now. According to a recent survey, food safety has become the very social problem in China that people are most concerned about (Li & Li, 2008). Since the beginning of the new millennium, food contamination scandals took place in China almost every year. Thus, both the government and the industry have put the food safety issues into perspective, and the supervision work is developing at a fast pace accordingly.

As the main food-consuming type, agro-food accounts for more than 70% of total food consumption in China. Therefore, the food safety level in China is highly reflected by the safety of agro-food. According to *Food Safety Law of the PRC*,

the management of the quality and safety of agro-food is regulated under the provisions of *the Law on the Quality and Safety of Agricultural Products*. As the enforcement of this regulation, the supervision, especially the local supervision which is close to the producers, is the most effective measure to secure the safety and improve the quality of agro-food in China.

In recent years, there has been a growing literature focusing on agro-food quality and safety supervision. These studies mainly attached great importance on the current conditions and the existing problems of agro-food quality and safety supervision (Martinez *et al.*, 2007; Nguz, 2007; Lio & Liu, 2008; Bagumire *et al.*, 2009; Farrell *et al.*, 2009; Dreyer *et al.*, 2010). They also analyzed the reasons for the government to supervise the agro-food. The root cause of (the reasons for)

the government supervision is the agro-food market failure (Li & Ying, 2004; Yan & Yan, 2004; Wang & Xu, 2005; Li & Liu, 2010). It objectively requests government intervention in market for agro-food quality and safety. Chen (2008) pointed out that the foundation of government supervision is its compulsory force and its advantages of information, organization and finance. Based on the present condition and characteristics of government supervision, some scholars found out that the main influencing factors of government supervision are legislation, inspection and laboratory services, supervision authority, and information system (Wang & Xu, 2005; Lai & Kang, 2006; Nguz, 2007; Bagumire *et al.*, 2009; Li & Xu, 2010). As for the existing problems, many scholars proposed some related measures and new ideas with the purpose of improving government supervision. For instance, Martinez *et al.* (2007) suggested co-regulation as a possible model for food safety governance.

These studies analyzed all aspects of the supervision which include legislation, inspection, budget, supervision authority and information. However, due to lack of empirical supports, most of the studies tend to analyze the agro-food quality and safety supervision theoretically. Therefore, on the basis of the previous research achievements, this study aims at making an empirical analysis on the government supervision.

The data and variables

The data

The data of this research were collected via a questionnaire survey which was carried out by Ministry of Agriculture of China in September 2009. Questionnaires were distributed over the country to each local agricultural department. The questionnaire consists of 36 questions involving the aspects of region's basic situation, supervision authority, supervision measures and the suggestions. By January 2010, 1419 questionnaires from 20 provinces¹ (64.5% of all 31 provinces of China) were recovered, and then 892 valid questionnaires without missing values and errors were selected to generate the data of this study. These counties from 20 provinces, which occupy 1/3 of all 2858 counties of China, are quite representative.

¹The 20 provinces come from the eastern, central and western China. They are provinces of Fujian, Guangdong, Zhejiang, Jiangsu, Hebei, Shandong, Liaoning, Jilin in eastern China, Anhui, Hunan, Henan, Jiangxi, Shanxi in central China, and Guangxi, Guizhou, Shanxi, Sichuan, Yunnan, Sinkiang and Inner Mongolia in western China.

Variables

Table 1 lists the variables used in the empirical analysis. All of the variables were from the questions about the regulators and supervision measures which can affect agro-food quality and safety supervision directly. And they were selected based on the actual conditions of agro-food quality and safety supervision in China. The mean value of each variable (Table 2) is also their ratio because they are all nominal level variables. As shown in the result, the ratio of some variables such as Agro-food Safety Public Services in Township (X2, $P = 0.2189$), Budget for Agro-food Supervision (X7, $P = 0.3816$) and Preferential Policies or Subsidies for the Certification of Agro-production (X9, $P = 0.1291$) is still lower than the others. This suggested that these three supervision measures have not been well implemented.

Analysis methods

In order to figure out the regional difference and major factors influencing the agro-food quality and safety supervision of these counties, this thesis selects factor analysis as the most important analysis method.

Factor analysis is a collection of methods used to identify underlying variables that explain the pattern of correlations within a set of observed variables. The purpose is to reduce multiple variables to a lesser number of underlying factors that are measured by the variables or to explore the latent structure of the variables in your data file. It mainly has four stages: preliminary analysis; factor extraction; factor rotation; and interpretation.

In order to test the applicability of factor analysis, several indices were selected and inspected, such as the communalities, Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity (BTS). In the language of factor analysis, the communality is the proportion of variance of a particular variable that is due to common factors shared with other variables. If the data are adequate for factor analysis, the mean communality should be quite high. The KMO value should be greater than 0.5 for a satisfactory factor analysis. BTS should show that the correlation matrix is not an identity matrix by giving a significance value smaller than 0.001.

Another aspect of factor analysis is to make sure of the number of factors included in the model, which is related to how much of the variance in the data set has to be occupied. An appropriate number of factors were extracted from the correlation matrix based on the initial solution.

Table 1 The explanations of variables

Variable	Connotation
Specialized Supervision Department	A department attached to agriculture administration, which is mainly responsible for the management of agro-food safety and quality
Agro-food Safety Public Services in Township	An executive department under the agricultural authority and is responsible for agro-food safety training for farmers, food control technology extension, routine inspections of agro-food production processes and the implementation of agro-food control measures
Department of Agricultural Law Enforcement	The regulatory authority is responsible for the implementation of laws relevant to agriculture, the high quality and the right applications of seeds, agricultural chemicals, veterinary drugs, the component of the feed, and the food additives, etc.
Government Performance Evaluation System	A set of performance assessment indexes which are created to evaluate government officials' performance. Whether the index of officials' performance on agro-food safety is covered in the evaluation system or not, can be regarded as a reflection of the local government's endeavor on agro-food control.
Responsibility Contracts	Official contracts signed between the upper governments and the lower governments, who are usually a specific policy's executors, to make sure that the lower governments will do their best to ensure the agro-food safety
Agro-food Safety Commitment	Official contracts signed between local agricultural administration and agro-food production enterprises or specialized farmer cooperatives to make sure the agro-food producers will do their best to ensure the agro-food safety during the course of productions, for example, not to abuse agricultural chemicals and veterinary drugs.
Budget for Agro-food Supervision	According to Article 4 of the law of the PRC on Agricultural Product Quality Safety: The people's government at the county level or above shall include agricultural product quality safety administration into the national economic and social development planning at the present level and offer funds of agricultural product quality safety for carrying out the work of agricultural product quality safety. So, the thesis chooses the ratio of the budget for agro-food supervision to the total budget as a variable to evaluate the local governments' endeavor.
Preferential Policies or Subsidies for the Establishment of Agricultural Wholesale Markets' Own Testing Departments	According to Article 37 of the law of the PRC on Agricultural Product Quality Safety: An agricultural product wholesale market shall establish or entrust an agricultural product quality safety test institution to test the quality safety of the agricultural products sold in the market by random inspection; when finding any inconformity with the agricultural product quality safety criteria, it shall require the seller to immediately stop the sale and report to the administrative department of agriculture. So, whether the local agricultural administration offers preferential policies or subsidies to wholesale markets to establish their own testing departments or not is chosen as a variable to show the local governments' endeavor.
Preferential Policies or Subsidies for the Certification of Agro-production Routine Monitoring	The Chinese agriculture authority establishes an agro-production certification system which, ranged according to the rigidity and numbers of certification requirements, contains Safe Food, Green Food, Organic Food. The thesis chooses preferential policies or subsidies for applying certifications offered by the local governments as a variable to show the local governments' endeavor. According to Article 34 of the law of the PRC on Agricultural Product Quality Safety: The state sets up an agricultural product quality safety monitoring system. The administrative department of agriculture of the people's government at the county level or above shall, in accordance with the requirements for guaranteeing the agricultural product quality safety, make a plan of monitoring the agricultural product quality safety, organize the implementation thereof, and supervise and make a random inspection on the agricultural products under production or on sale in the market. So, the thesis chooses whether the routine monitoring institution established or not as a variable to show the supervision strength of the local governments.
Market Access	In order to ensure the agro-food safety, under the market access institution, only the qualified agro-food producers are allowed to sell their products in the markets. The market access institution implemented differently on degrees in scales by different local agricultural administrations, so the thesis chooses whether this institution be established or not as a variable to weight the local governments' supervision strength.
Traceability	The establishment of a traceability system is a voluntary measure for local government in food control. If the local government attaches high importance on agro-food safety, a traceability system will be constructed.

Table 2 Descriptive statistics of variables

Variable code	Variable	Variable declaration	Mean	Standard deviation
X1	Specialized Supervision Department	= 1 if there exists local specialized supervision department = 0 otherwise	0.6689	0.47087
X2	Agro-food Safety Public Services in Township	= 1 if there exists agro-food safety public services in township = 0 otherwise	0.2189	0.41370
X3	Department of Agricultural Law Enforcement	= 1 if there exists a Department of Agricultural law enforcement = 0 otherwise	0.6330	0.48266
X4	Government Performance Evaluation System	= 1 if the agro-food quality and safety is brought into the Government Performance Evaluation System = 0 otherwise	0.8238	0.38121
X5	Responsibility Contracts	= 1 if the contracts are signed = 0 otherwise	0.8272	0.37832
X6	Agro-food Safety Commitment	= 1 if the agro-food producers make a commitment to the supervision authority = 0 otherwise	0.6476	0.47799
X7	Budget for Agro-food Supervision	= 1 if there exists specific budget = 0 otherwise	0.3816	0.48605
X8	Preferential Policies or Subsidies for Markets' Own Inspection Departments	= 1 if there exists subsidies and preferential policies = 0 otherwise	0.1291	0.33546
X9	Preferential Policies or Subsidies for Certification of Agro-production	= 1 if there exists subsidies and preferential policies = 0 otherwise	0.4837	0.50002
X10	Routine Monitoring	= 1 if there exists agro-food routine monitoring institution = 0 otherwise	0.8429	0.36412
X11	Market Access	= 1 if there exists agro-food market access system = 0 otherwise	0.3232	0.46797
X12	Traceability	= 1 if there exists agro-food traceability system = 0 otherwise	0.4905	0.50019

Kaiser (1974) recommended retaining all factors with eigenvalues greater than 1. In practice, another important aspect is the extent to which a solution is interpretable. Therefore, one usually examines several solutions with more or fewer factors, and chooses the one that makes the best sense.

Factor values had to be rotated in order to interpret the solution set more easily. Factor rotation can simplify and clarify the data structure, so it is used to improve the meaningfulness, reliability and reproducibility of factors. Rotation maximizes the loading on each variable on one of the extracted factors while minimizing the loading on all other factors. This process can clarify the relationship between the variables and the factors.

The ultimate goal of factor analysis is usually to identify the underlying constructs summarizing a set of variables. So, the next step is to look at the content of variables that load onto the same factor to try to identify the common themes. According to the results of factor rotation, we can name and interpret the factors by their common variables.

Results and discussion

Factor analysis

Factor analysis with orthogonal varimax rotation was employed in the study by using SPSS Version 18.0 (SPSS Inc., Chicago, IL, USA). The mean communality of the variables was 0.65, indicating that each variable accounted for a moderate proportion of common variance while other variables accounted for extracted factors. Table 2 shows the KMO and BTS results of the data set. The KMO measure of sampling adequacy was 0.76, which was within the acceptable range. The BTS was significant at better than the 0.001 level ($X^2 = 1436.455, P < 0.001$), indicating that the variables were interdependent. The mean communality, KMO measure and BTS all proved the data highly suitable for factor analysis.

In terms of principal component analysis, this thesis accepted eigenvectors with the corresponding eigenvalues higher than 0.8. This criterion slightly increased the number of extracted components, which made it possible to get a final ranking and selection of the number of basic waveforms

Table 3 KMO and Bartlett's test of sphericity

KMO	0.76
Approximate chi-square	1436.455
Degree of freedom	66
Significance	0.000

KMO, Kaiser–Meyer–Olkin.

after the procedure of varimax rotation. The cumulative percentage of variance explained by these factors was 68%, meaning that a considerable amount of the common variance shares by the 12 variables could be accounted for by the six factors. Table 3 shows the total variance explained.

Although various methods can be applied to factor rotation, the varimax method is the most commonly used one. The loadings of each metric on each of the first six factors after orthogonal rotation are shown through the factor pattern in Table 4, which also shows the rotated factor pattern loadings for each group.

Factor interpretation

Factor 1 consisted of Responsibility Contracts (X5), Government Performance Evaluation System (X4) and Agro-food Safety Commitment (X6) for these items had the highest loading as shown in Table 5. Respective loadings of these items were 0.865, 0.818 and 0.588. According to these items, the first factor accounting for most of the explained variance (15.9%) was a dimension of the importance that the government attached on agro-food quality and safety, so we named this factor as 'The attention of the government'.

Items with high loadings on Factor 2 were Market Access (X11) and Traceability (X12), with the respective loadings of 0.797 and 0.711. Factor 2 accounted for 12.5% of the explained variance, closely following Factor 1 (15.9%). It was a factor representing the market supervision measures that the government has adopted for agro-food quality and safety. These measures were related to the supervisory system which was established by the government to regulate the market. Therefore, we could interpret this factor as 'Market access and traceability'.

Specialized Supervision Department (X1) and Agro-food Safety Public Services in Township (X2) constituted the third factor because of their high loadings. Their loadings were 0.744 and 0.701, respectively. Factor 3, which could be interpreted as a dimension of the development of supervision system, occupied 12.1% of the explained variance. This factor depicted the establishment of local government organizations for agro-food quality and safety. We termed this factor as 'Local government organizations'.

The variables of Preferential Policies or Subsidies for the Certification of Agro-production (X9), Preferential Policies or Subsidies for the Establishment of Agricultural Wholesale Markets' Own Testing Departments (X8), and Budget for Agro-food Supervision (X7) comprised the fourth factor. Respective loadings were 0.739, 0.636 and 0.539. Factor 4's ratio in the explained variance was 10.7%. Its purpose was to show the financial support that the government has provided to wholesale markets on establishing their own testing departments, certification system of agro-production and taking other measures so as to ensure agro-food quality and safety. Therefore, we could title this factor as 'Financial support'.

Factor 5, Routine Monitoring (X10), was the only variable with a loading more than 0.5, which accounted for 8.6% of the explained variance and indicated whether the routine monitoring institution was established or not. So, we tagged this factor as 'Routine monitoring'.

The item with high loading on Factor 6 was Department of Agricultural Law Enforcement (X3) (Table 6). Its variance (8.4%) was the least among all the factors. This factor described the enforcement efforts of the supervision authority. So, we labeled it as 'Department of agricultural law enforcement'.

Discussion

With a suitable solution and accordingly rotation, this thesis went into the factor scores. In the process of original analysis, the scores were calculated based on the regression method. The factor score matrix gave a score for each case on these patterns. To compute the factor score in a given case for a given factor, the case's standardized score on each variable was multiplied by the corresponding factor loading of the variable for the given factor, and these products were summed. And the factor scores can be calculated directly by SPSS. On that basis, this essay can derive the total scores of each case through multiplying factor scores by the contribution of variance of each factor.

The total scores were used as the criterion to evaluate the effects of local agro-food quality and safety. In light of this criterion, this thesis grouped the counties into four clusters for a further study according to the range of total scores and the number of the counties.

The first cluster included 105 counties with a total score higher than 0.5. These were the counties which did best on the agro-food quality and safety supervision in this study. About 60% of them are in Jiangsu, Shandong and Zhejiang province, and 73.3% in eastern China which is the most

Table 4 Total variance explained

Component	Initial eigenvalues			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	2.946	24.552	24.552	1.914	15.951	15.951
2	1.308	10.903	35.455	1.502	12.514	28.464
3	1.180	9.836	45.291	1.456	12.129	40.594
4	0.955	7.957	53.247	1.287	10.723	51.317
5	0.931	7.755	61.003	1.037	8.641	59.958
6	0.878	7.313	68.316	1.003	8.358	68.316
7	0.771	6.423	74.739			
8	0.702	5.849	80.588			
9	0.694	5.782	86.370			
10	0.663	5.523	91.893			
11	0.600	5.004	96.897			
12	0.372	3.103	100.00			

Table 5 Rotated component matrix

	Component					
	1	2	3	4	5	6
X5	0.865					
X4	0.818					
X6	0.588					
X11		0.797				
X12		0.711				
X1			0.744			
X2			0.701			
X9				0.739		
X8				0.636		
X7				0.539		
X10					0.933	
X3						0.857

Table 6 Factors composition

Factors	Variables
Factor 1	X4: Government Performance Evaluation System X5: Responsibility Contracts X6: Agro-food Safety Commitment
Factor 2	X11: Market Access X12: Traceability
Factor 3	X1: Specialized Supervision Department X2: Agro-food Safety Public Services in Township X7: Budget for Agro-food Supervision
Factor 4	X8: Preferential Policies or Subsidies for the Establishment of Agricultural Wholesale Markets' Own Testing Departments X9: Preferential Policies or Subsidies for the Certification of Agro-production
Factor 5	X10: Routine Monitoring
Factor 6	X3: Department of Agricultural Law Enforcement

developed areas of the country. They scored well on Factor 2, Factor 3 and Factor 4, but performed mediocre on Factor 5. The reasons for the widespread distribution of these well-supervised counties in eastern China are as follows: owing to their developed economies, local supervision administrations in these areas enjoy abundant funds; with this advantage, the supervision departments are often reasonably structured and adopted diversified and effective supervision measures. For example, in these regions, the market access and traceability institutions have already been established.

The second cluster was comprised of 355 counties with a total score between 0 and 0.5. The performance of these counties on agro-food quality and safety supervision was mediocre. Among them, about 50% are located in eastern China, 30% in western China and the rest in central China. They scored well on Factor 1 and Factor 5, but were pulled down by Factor 4. In other words, comparing with the previously mentioned counties, these counties do not attach

great importance on the agro-food safety problem. Due to their limited budget, many relevant agro-food control measures, such as market access and traceability institutions, failed to be established; therefore, supervisions in these counties are not fully up to expectations.

The third cluster of counties consisted of 318 counties with a total score between 0 and -0.5. The supervision on the agro-food quality and safety in these counties was shown less effective in the study. About 38% of the counties are in eastern China, 38% are in western China and the rest are in central China. These counties scored well on Factor 1, but were pulled down by Factor 2 and Factor 4. Sixty-two percent of these counties were located in China's central and west regions, a comparatively less developed area. In these counties, though the local supervision administrations have recognized the importance of agro-food safety, but owing to the scarcity of funds, the work of agro-food quality and

safety supervisions starts late and the suitable supervision measures are not yet to be taken. As a result of all these reasons, supervisions in these regions did not function properly.

The fourth cluster had 114 counties whose total scores were less than -0.5 . Their supervision on the agro-food quality and safety was ranked the least effective. About half of these counties are located in western China and they are mainly distributed in Sichuan province, Sinkiang and Inner Mongolia. Most of them scored poorly on all the six factors. The reasons for this were their underdeveloped economics situations, original tradition agriculture production mode, less attention from upper governments, unsatisfactory local supervision administration, insufficient funds and ineffective supervision measures. There is still a huge room for the improvement of the supervision in these areas.

Conclusions

It can be found through the above analysis that the scores of the last three clusters are all pulled down by Factor 4, though their other major factors are different. In a sense, it means that most of the counties of China have not provided sufficient funds for agro-food quality and safety supervision.

Therefore, 'Financial support' (Factor 4) is the most important factor on agro-food supervision and it exerts a tremendous influence on the second, third and fourth clusters of counties. 'The attention of the government' (Factor 1), 'Market access and traceability' (Factor 2) and 'Routine monitoring' (Factor 5) are the less important factors on agro-food supervision. 'The attention of the government' (Factor 1) wield much power on the second, third and fourth clusters of counties. 'Market access and traceability' (Factor 2) and 'Routine monitoring' (Factor 5) exert great influence on the first, second and fourth cluster of counties. 'Local government organizations' (Factor 3) and 'Department of agricultural law enforcement' (Factor 6) are the least important factors on agro-food control. Factor 3 have some effect on the first cluster of counties and Factor 6 affects the performance of the fourth clusters of counties supervision.

Through the above analysis, this thesis comes to a conclusion that the supervision performs best in the counties of eastern China, and then followed by the counties in central China and the counties in western China did this job worst. Because of diversified supervision measures, reasonable constructed supervision departments and abundant funds, counties in eastern China possessed the most effective agro-food supervisions. In contrast, counties in central China also

place great emphasis on agro-food control, but owing to the limitation of funds and supervision measures, the supervision situations in these regions are not as effective as in the eastern counties. Last but not the least, in western China, counties have to be confronted with the most disadvantageous situations, such as the lack of specific administrations, attentions, funds, supervision measures, etc., all of these shortages made them become the ones which should make the biggest improvements on agro-food supervisions.

According to different county numbers, this thesis found out that the first and fourth clusters of counties occupied 24.6% of the total counties and the second and third clusters of counties accounted for 75.4%. The two percentage numbers suggested that most counties in China are under mediocre agro-food supervision. Generally speaking, though the supervision measures and strengths among different counties are diverse from each other, there is still a tremendous space for the development of China's local agro-food supervision.

Acknowledgements

The authors gratefully acknowledge the funding support from National Social Science Foundation of China (NSSFC-09BJY069).

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