China Economic Review 45 (2017) 232–243

Contents lists available at ScienceDirect

China Economic Review

journal homepage: www.elsevier.com/locate/chieco

# Product quality asymmetry and food safety: Investigating the "one farm household, two production systems" of fruit and vegetable farmers in China

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ARTICLE INFO

*Keywords:*
Food safety
"One household, two production systems"
Non-separable model
Inspection
Certification
Informant asymmetry

ABSTRACT

The Chinese government faces a great challenge to safeguard the safety of the food supply chain due to the significant fragmentation of producers and weak institutional resources to monitor and enforce safety standards. Food safety in China has received escalating attention since the 2008 milk scandal. Mainly due to safety concerns, Chinese farmers adopt two separate production systems for the market and self-consumption, and thus, the so-called "One Farm Household, Two Production Systems" (OFH-TPS) has gained popularity in the recent years.

This study provides a theoretical framework to examine how product inspections and certifications affect the OFH-TPS adoption by mitigating information asymmetry of product quality. It also shows that both food safety concerns and cost savings are important factors for famers' decision on the adoption. The empirical analysis finds that product inspections conducted by firms, agricultural cooperatives, and farmers curb the OFH-TPS adoption, whereas government inspections have no statistically significant effect. Farmers who grow "Green Food" are less likely but organic farmers are more likely to adopt the OFH-TPS. We also find that pesticide use training curbs the OFH-TPS adoption, and the perceived adverse effects of pesticide use to the environment and human health have no statistical effect. Farmers who use highly toxic or banned pesticides and/or who perceive food safety at the local markets is poor are more likely to adopt the OFH-TPS. This study provides rich policy implications. To safeguard food safety, it is critical to engage the private sector for co-regulation, improve the efficacy of government inspections, and promote education on pesticide use to both farmers as well as retailers of pesticides.

## 1. Introduction

Food supply chain and food safety becomes an important public health issue in China along with the unprecedented fast economic growth (Lam, Remais, Fung, Xu, & Sun, 2013). Concerns about food safety reached a climax during the 2008 milk scandal.[1] In 2011, food safety was ranked first among the top five safety concerns in China, followed by public safety, traffic, health, and the environment (Lam et al., 2013). The extensive use of chemicals in production imposes a challenge to food safety. The annual fertilizer

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[1] The 2008 milk scandal in China involved an intentional contamination of dairy products by melamine to artificially boost the protein reading. Tainted milk products have significant adverse health impacts, especially for infants and children. By November 2008, The Chinese Ministry of Health reported an estimated 300,000 ill children, with six infants dying from kidney diseases. It was referred by the World Health Organization as "one of the largest [food safety events] in recent years."

http://dx.doi.org/10.1016/j.chieco.2017.07.009
Received 12 February 2017; Received in revised form 15 June 2017; Accepted 22 July 2017
Available online 29 July 2017
1043-951X/ 

applied per hectare of land amounted to 300 kg per crop in Northern China, 50% more than what is perceived as high usage in Europe (Ju, Kou, Christie, Dou, & Zhang, 2007). China is the world's leading producer and consumer of pesticides. In 2011, > 2.6 million tons were produced and 1.8 million tons were used (Li, Zeng, & You, 2014). The amount of pesticides applied annually was 15 kg per hectare, higher than Japan (12 kg/ha), the Republic of Korea (6.6 kg/ha), and India (0.5 kg/ha) (Jin, Wang, Shao, & Jin, 2010). It is common for Chinese farmers to apply highly toxic or even banned pesticides (Yang et al., 2014). A significantly high level of pesticide residue is often found in fruits and vegetables (Qin et al., 2016). Given the food safety crisis, Chinese consumers are willing to pay price premium for safe food (Ortega, Wang, Wu, & Hong, 2015; Wu, Wang, Zhu, Hu, & Wang, 2015).

In the recent years, a new phenomenon in food production has emerged – farmers engage in the dual production systems in separate land parcels or in distant locations within the same land parcel, one for self-consumption and the other for the market. Farmers, in general, likely apply less pesticides and fertilizer as well as other chemical inputs for self-consumption to ensure food safety. We name this dual production practice as “One Farm Household, Two Production Systems” (OFH-TPS). About 66% out of the 654 farmer households sampled adopted the OFH-TPS (Ni, Zheng, & Yu, 2014). However, this study classifies the respondents into the OFH-TPS farm households or not based on their answer whether they eat vegetables they produce for the market. It is likely that the OFH-TPS ratio is overestimated. Xu, Zhou, and Pan (2013) find that the main driving force for adopting OFH-TPS is to ensure the food quality for self-consumption. They find that 56.67% of the 60 households surveyed apply less pesticides and chemicals or use non-synthetic pesticides and fertilizers to produce foods for their own consumption, but apply more chemicals and pesticides, including banned ones, for market-oriented production.

Previous OFH-TPS studies either used indirect survey questions to classify the OFH-TPS farm households or limit to a small sample size. Research using direct measures and large sample size is needed to have a better estimation of the OFH-TPS adoption. Furthermore, except for descriptive analyses (Ni, Yu, & Zheng, 2014; Ni et al., 2014; Xu & Zhou, 2014; Xu et al., 2013), the literature is sparse in understanding the economic and policy aspects of the OFH-TPS adoption. As OFH-TPS farmers were reported to use pesticides intensively for commercial agri-foods, the studies on farmers' pesticide application are also related to the OFH-TPS analysis (Wang, Wang, Huo, & Zhu, 2015; Zilberman & Millock, 1997). Monitoring chemical inputs in agriculture is quite challenging in China. One reason is that Chinese agriculture is highly fragmented because the Household Responsibility System (HRS) launched in 1978 transformed a highly controlled collective system into an individual household farming system (Jia, Huang, & Xu, 2012; Lin, 1992). Furthermore, the enforcement of food safety in rural China's agricultural production system is weak, largely because of a limited fiscal budget and a lack of well-trained personnel (Holtkamp, Liu, & McGuire, 2014).

Like many food safety concerns, the OFH-TPS arose due to the credence attributes of food quality (e.g., chemical and pesticide residue). In the US, contract farming, either through agri-enterprises or cooperatives, is suggested as a way to help farmers avoid price risk and control product quality (Goodhue, 2000; Hueth & Ligon, 1999). However, a national investigation shows that farmer cooperatives in China seldom specify food safety standards (Jia et al., 2012). Diverting from the literature on food quality that focuses on product differentiation, price premium, and market competitiveness, one of the main reasons Chinese farmers adopt the dual production system is to ensure food quality for their own consumption. On the other hand, food certifications such as Green Foods and Organic Foods impose quality requirements and signal different quality perspectives. The question that naturally arises is how the OFH-TPS adoption varies between farmers with different food certifications and farmers without any food certification.

This study aims to explore the factors affecting the OFH-TPS adoption among Chinese farmers in the aspects of asymmetric information and quality signals. It offers the following contribution to the literature. First, it extends non-separable household production modeling to address food quality concerns. Becker (1965) incorporated food consumption and time use in the household utility function that provides a fundamental modeling framework. Based on Becker's work, Singh, Squire, and Strauss (1986) introduced a non-separable model where the economic agent is both a producer and a consumer. The non-separable models are also commonly employed to study the market participation of rural households (De Janvry & Sadoulet, 2006; Key, Sadoulet, & De Janvry, 2000). We use the non-separable model for the agri-food safety crisis. Second, this study is the first to provide empirical evidences of the OFH-TPS adoption based on the theoretical modeling focusing on information asymmetry and quality signals. Specifically, we formally model and empirical test how the quality signaling mechanisms such as product inspection and certification can be used to reduce information asymmetry and, therefore affecting the OFH-TPS adoption. For product certification, both qualify signaling and cost components are considered when deciding on the OFH-TPS adoption.

This rest of this paper proceeds as follows. Section 2 presents a conceptual framework to explain how information asymmetry, product inspections, and product certifications affect the OFH-TPS adoption. Section 3 discusses the household survey and provides data summary statistics. Section 4 presents the empirical results based on the instrumental variables approach. Section 5 concludes the paper and offers policy implications.

## 2. Conceptual framework

A non-separable model is commonly employed to study market participation of economic agents who are both producer and consumer of their own products (De Janvry & Sadoulet, 2006; Key et al., 2000; Singh et al., 1986). We denote product quantity by $q_k$ and product quality by $s_k$ for the market ($k = 1$) or self-consumption ($k = 2$). Product quality is expected to differ if the OFH-TPS is adopted. Production costs can be affected by both quantity and quality: $C(s_k,q_k)$. A quality improvement requires an extra cost such that $\frac{\partial C(s_k,q_k)}{\partial s_k} > 0$. We further assume that better quality results in a price premium such that $\frac{\partial P(s_k)}{\partial s_k} > 0$ if quality information is publicly available and/or searchable; otherwise quality has no effect on product price.

Following Auriol and Schilizzi (2015)'s framework, we assume that an individual utility consists of two components. The first