

## Marketing Raw Milk from Dairy Farmers before and after the 2008 Milk Scandal in China: Evidence from Greater Beijing

**Xiangping Jia, Hao Luan, and Jikun Huang**

*Center for Chinese Agricultural Policy Institute for Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences Beijing 100101, P.R., China. E-mail: jiexp.ccap@igsrr.ac.cn*

**Shengli Li**

*College of Animal Science and Technology, China Agricultural University Beijing 100193, P.R., China. E-mail: lishengli@cau.edu.cn*

**Scott Rozelle**

*Center for Food Security and the Environment Freeman Spogli Institute, Stanford University. Stanford University Stanford, CA 94305. E-mail: rozelle@stanford.edu*

### ABSTRACT

China's 2008 milk scandal severely impacted its dairy industry. Afterwards, the government took prompt efforts to regulate and enhance food safety standards. For example, a dairy marketing management policy was implemented, and concentrated dairy complexes were recommended as options for smallholder dairy farmers. The results of this study show that the policies affected marketing channels at the farm gate. Since then, new dairy complexes have emerged and are becoming the primary marketing channel for milk. The marketing transformation has profound implications for food safety, and has strengthened vertical coordination in the Chinese dairy chain. [EconLit citations: H12, Q02, Q18]. © 2014 Wiley Periodicals, Inc.

### 1. INTRODUCTION

Both demand and supply in the Chinese dairy sector have grown rapidly in the past two decades. In the 1990s, for example, dairy was the only major commodity that China's consumers were under-consuming. However, dairy demand increased substantially since the mid-1990s (Zhou, Tian, & Zhou, 2002). As dairy demand rose, dairy production also increased sharply. In the mid-1990s China's dairy industry yielded only six to seven million tons of product (Liu, 2003-2009). From the mid-1990s to the mid-2000s the growth of dairy production accelerated to nearly 20% annually. Total production reached 35 million tons in 2007, a level that ranked China third in the world in terms of dairy industry output, after the US and India.

China's dairy production was largely dependent on a large number of small-scale farmers. In the mid-1990s the average dairy household owned and milked only three cows (Zhou et al., 2002). During the following years, although the overall herd size rose steadily, more than 80% of the dairy cows were owned by small-scale households in China (Lu & Tao, 2009).

Ensuring food safety in a dairy industry based on a milk production system dominated by small-scale farmers is challenging. Huang, Wu, Yang, Rozelle, Fabiosa, and Dong (2013) found that in the mid-2000s small-scale milk producers often sold most of their milk—without written contracts—to mobile brokers and local village milk stations. Vertical coordination in the upstream dairy chain was mainly governed through personal ties and mutual trust between farmers and buyers. In such a marketing system, there was rising concern about dairy food safety.

Shortly after the Beijing Olympic Games, China was hit by the biggest food safety crisis in recent decades. In the fall of 2008, it was discovered that milk suppliers had been adding melamine, a colorless crystalline compound used to manufacture plastic resins, to artificially

boost the protein readings of their milk (BBC, 2008).<sup>1</sup> This scandal resulted in 300,000 children becoming sick and developing kidney problems, with infants being especially vulnerable (Barboza, 2008). After the crisis, consumer confidence in the quality of all domestically produced dairy products plummeted and dairy imports rose rapidly (China Dairy Statistical Report, 2010). On the production side, dairy farmers were hit heavily because they could find no one else to procure their milk at reasonable prices, even if their milk was not contaminated. The crisis led directly to decreases in dairy production and farmers' participation in dairy farming (Jia, Huang, Luan, Rozelle, & Swinnen, 2012).

Policy responses by the Chinese government to restore and reconstruct a new production and marketing chain were rapid and immense. On October 10, 2008, the State Council of China issued the "Regulation on the Supervision and Administration of Dairy Product Quality and Safety" (henceforth known as the Quality Regulation) to regulate dairy production, processing and marketing. Regarding marketing, the Quality Regulation focused primarily on inspecting all milk buyers and collection stations. It was reported that 150,000 officials were sent to inspect the marketing chain and a large number of small milk stations were shut down (China Daily, 2009; Xinhua News, 2008). Meanwhile, rescue programs were launched to subsidize the newly established milk stations and to upgrade the existing qualified ones.

After the scandal, a plan to transform Chinese dairy farms was initiated by the government to strengthen food safety. At the start of the milk scandal, small backyard dairy farming was believed to be a partial source of the crisis, and policy guidelines were issued that advised small backyard farmers to move their cows into concentrated production complexes (called *yang-zhi-xiao-qu* in Chinese policy documents). This emerging production system was characterized as a series of "Dairy Complexes" by Mo et al. (2012). In these dairy complexes, dairy farmers were expected to gain access to better service and training in farm management, and to be better monitored regarding production, marketing and quality supervision.

Given the scope and magnitude of the milk scandal and the consequent policy regulations and guidelines, it is surprising that several fundamental questions about marketing arrangements in the upstream dairy chain have not been answered or even debated.<sup>2</sup> Although dairy complexes were assumed to be a solution in a number of public media and policy documents (as if they had already become the dominant type of institutions for milk procurement) there is no study examining their presence in farm-gate marketing. In fact, dairy complexes may not be enforced in every dairy village. Even when a dairy complex was founded in a village, farmers in the village could still decide whether or not to join it. Given the heterogeneous response of farmers, it is unknown who sold through dairy complexes and who did not (and why). Further questions include how the crisis and the consequent policies affected marketing arrangements at the farm gate. Were farmers' marketing channels really changed because of the new policies? How have the changes affected dairy food safety? And what is the role of the emerging dairy complexes in enhancing food safety in the upstream dairy marketing chains in China?

The overall goal of this paper is to address these gaps in the literature. Specifically, we focus on two objectives: (1) to investigate the dynamics in marketing channels at the farm-gate before and after the milk crisis; and (2) to empirically analyze the effects of the government policies on marketing arrangements and their implications for food safety. Due to limited resources, the investigation of marketing arrangements at the farm-level was only carried out in the Greater Beijing Region, which included Beijing suburbs and adjacent counties in Hebei Province.

The rest of the paper is organized as follows. Section 2 describes the background of the standards and regulatory framework of raw milk safety prior to and after the milk scandal in China. Section 3 introduces our data set, as well as the sampling methods of the survey. The next two sections present descriptive and multivariate analyses on the changes of marketing channel at the farm gate and the role of the milk crisis and subsequent policies during the process. The final two sections discuss the findings and conclusions.

<sup>1</sup>In this study milk suppliers are defined as traders and milk collection stations, not small dairy farmers.

<sup>2</sup>There have been efforts to assess the impacts of the crisis on dairy production. The results showed that small-scale dairy farms were seriously hit by the crisis and that dairy complexes emerged (Jia et al., 2011; Mo et al., 2012).

## 2. POLICY DIRECTIVES AFTER THE MILK SCANDAL

### 2.1 Standards and Regulation

Prior to the milk scandal, the regulatory framework of food safety in China was characterized by institutional fragmentation, insufficient coordination, and lax process controls. While the Ministry of Agriculture (MoA) and the Ministry of Health (MoH) in China were in charge of setting standards on raw milk, supervision of the entire dairy chain was spread out across several ministries. For example, under the previous regime, large dairy enterprises were “granted inspection-free status on the basis of their safety record” and magnitude of production (Pei et al., 2011, p. 415). Inspection of raw milk was thus shifted to the enterprises that were short of both incentives and capabilities (viz. laboratories and personnel) to perform the inspections. The assumption was that large dairy enterprises would install high-quality checking and assurance systems for inspection. Nevertheless, this assumption emphasized products rather than processes and ignored the multi-factoral characteristic of risk in the food chain. Additionally, there was no tracing mechanism in place that could differentiate, trace, or determine which farmers were in violation of norms and those who were in compliance.

After the milk scandal broke out in 2008, China’s government made a systematic response to strengthen its regulatory framework and quality control in the food and dairy sectors. In February 2009, China’s government issued the new Food Law, which introduced a significant increase in monitoring capability, ranging from certified laboratories to coordination between national and provincial authorities. Meanwhile, a national food safety commission was established to oversee the supervision and coordination of the food system. Specifically, the MoH is in charge of elaborating national standards for quality, safety and inspections. Within the dairy sector, the MoA and Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) are responsible for quality control, whereby the MoA oversees farm management and the AQSIQ monitors food operators. In the dairy sector, to further strengthen official control, the MoA issued the “Bill for Production and Marketing of Raw Milk” in November 2008 (henceforth known as “the Bill”), and the State Council issued a “Guideline to Further Strengthen Quality and Safety in the Dairy Sector” in September 2010 (henceforth known as “the Guideline”). Both the Bill and the Guideline highlight official control at the local level, and the Department of Animal and Veterinary in MoA has jurisdiction over the inspection of milk stations and transporters.

The standards of raw milk safety were also revised after the milk scandal. Prior to the scandal, the safety standards for raw milk were set by the “Standards for the Qualification of Raw and Fresh Milk Received from Farm” (GB/T 6914-86), which was issued in 1986 (henceforth known as the “Old Standards”). In the Old Standards, quality control for raw milk in China referred to the standards in the European Union and required analysis for specified chemical contaminants (Pei et al., 2011).<sup>3</sup> In addition, this indicates an awareness of the potential harm that raw milk could cause in the previous system. On March 26, 2010, China’s Ministry of Health calibrated the standards and issued the “National Food Safety Standard of Raw Milk (GB 19301-2010)” (henceforth known as the “New Standards”) by reducing the required protein content from 2.95% to 2.8% (Appendix A, row 2), and by decreasing the tolerance of mesophilic bacteria from 4 million to 2 million CFU/g (mL) of raw milk (Appendix A, row 6). The New Standards modified the overstated requirement of protein content in the Old Standards, which partially led to the inclusion of melamine for fraudulent protein readings in raw milk. The New Standards also highlight the importance of rigorously implementing safety and quality standards in China (Ministry of Health, 2011).

<sup>3</sup>The Old Standards are introduced in Appendix A.

## 2.2 Marketing Management Policies and Dairy Complexes

To strengthen dairy safety standards, the government initiated various marketing management policies. These policies were at the heart of the government's most immediate and longer-term restructuring response. The first part of the policy response focused on containing the problem and bringing the crisis to an end on the supply side. Then, Quality Regulation focused mainly on inspecting all milk buyers and collection stations. To implement this regulation, the MoA dispatched approximately 150,000 officials to inspect the buying and preprocessing segments of the marketing chain (Xinhua News, 2008). Milk stations that failed inspection were closed down (either permanently or temporarily) and many other milk buyers and transporters were shut down. For example, in Hebei Province between September and early October 2008, more than 100 milk stations in the villages were shut down permanently and the operating licenses of many others were suspended (ChinaNews, 2008). During the following weeks, the inspection program was expanded rapidly. According to ChinaNews (2009), by early 2009, more than 1,000 milk stations were shut down in Hebei Province alone. This occurred all across China and no doubt contributed in no small part to the immediate plunge in demand for milk from producers (and deliveries).

The second part of the marketing management policies, however, was directed at getting the supply chain running again. The government recognized milk collection stations, buyers and transportation firms that passed inspection with a seal of approval. The government also instituted a nationwide set of testing standards and offered training to collection station managers so that milk procurement could be re-started and revitalized. Government agencies also offered subsidized loans and gave grants to collection stations to bring their facilities up to standard and enhance milk quality and safety through the marketing chain.

In alignment with marketing management policies, the government attempted to restructure the production system by encouraging the conversion from backyard smallholder farming to concentrated dairy complexes. By definition, "Dairy Complexes" are centralized locations that house both cows and dairy farmers for milk production and milk collection. Cows in the dairy complexes are brought in by several individual farmers who often have to live inside the complexes (in a small dormitory room or stand-alone hut) (Mo et al., 2012). Regarding management, a dairy complex is typically managed by a single manager who is responsible for all phases of breeding, milking, and marketing. The dairy farmers take care of their own cows and are asked to follow uniform procedures to carry out production. Another feature is that dairy complexes are more mechanized with milking parlors and milking machines, which is expected to facilitate the supervision of food safety and quality (Zhao & Chen, 2011). More importantly, dairy complexes usually provide dairy farmers with better access to the output market given the contractual arrangements with dairy manufactures.

## 3. SAMPLING PROCEDURES AND DATA PROCESSING

To empirically test the actual transformation of upstream dairy marketing and how the policies have affected food safety, we use a unique dataset that we collected ourselves. This dataset is based on two rounds of a panel survey that were conducted in 2005 and 2009 in the Greater Beijing Region, because this region was the most severely impacted by the milk scandal. In 2005, the data at the village- (or community-) and household-level were collected as part of a larger survey effort (the Greater Beijing Horticulture and Livestock Survey), which investigated the production and marketing of high value agricultural commodities in Greater Beijing.<sup>4</sup>

The first round of the survey in 2005 relied on a spatially-based GIS sampling strategy to choose the 50 townships and 200 villages from which we would collect information on dairy production at the community level (Huang et al., 2010). We also interviewed village leaders about the local dairy economy to identify dairy-producing villages. The detailed questions

<sup>4</sup>Details of the Greater Beijing Horticulture and Marketing Survey can be found in Huang et al. (2010).

included percentage of dairy farmers, average herd size, the distribution of households with different herd sizes, the distance to the nearest collection station/dairy processing firm, and the number of milk stations in local and neighboring villages. We eventually identified 25 dairy villages and 175 nondairy villages from the 200 sampled villages.

After concluding the community survey (and identifying the dairy villages), the first round of our household dairy survey in 2005 was conducted in the 25 dairy villages. The survey was implemented in steps. First, in each village the households were divided into two groups based on whether or not they owned cows. In other words, all households were labeled as a dairy farmer (or dairy household) or a nondairy farmer (or nondairy household). Second, we devised a sampling scheme that was used to draw a sample of dairy and nondairy farmers. In villages where the number of dairy farmers was more than 50, 20 farmers were randomly selected to include 14 dairy households and 6 nondairy households. In the cases of villages in which the number of dairy farmers was higher than seven but lower than 50, we randomly sampled 10 farmers—seven dairy farmers and three nondairy farmers. When the total number of dairy farmers in a village was lower than seven, all the dairy farmers were surveyed. In total, the 2005 household survey included 243 farmers, 63% of whom were dairy farmers.

During the 2005 household survey, the surveyed farmers were asked about their individual household and dairy characteristics. Enumerators collected information on the age, education level and employment history of each household member. The value of the household's assets was collected in an attempt to assess each family's wealth. Respondents also provided information about their dairy activities, including their participation history, their herd size and their marketing channels.

In October 2009 (approximately one year after the milk crisis), we organized a second round tracking survey for the same villages and households. The idea was to track the evolution of the dairy producer, their activities and the policies that they faced in the same villages and the same households that had been interviewed in 2005 as a means of assessing the impact of the milk crisis on marketing activities. For example, we queried the farmers about the buyers of their milk at the farm gate and their production for the year before the crisis in 2008 (precrisis dairy activities) and at the time of the survey in 2009 (postcrisis dairy activities). In addition to repeating the village and household surveys, we also conducted a survey of the officials at the township level.

Based on the two rounds of the survey, we were able to create a longitudinal database of townships, villages and households covering 2004, 2008, and 2009 in Greater Beijing. The total sample used in the analysis includes dairy farms who had cows in 2004 (150 households), 2008 (121 households) and 2009 (104 households), which amounted to 375 observations in three years. The data from 2004 were acquired at the end of year (December 2004), whereas data from 2008 and 2009 were gathered in September of these two years, representing immediately before and one year after the milk crisis, respectively.

#### **4. CHANGES OF MARKETING CHANNELS AT FARM GATE BEFORE AND AFTER THE MILK SCANDAL**

The changes in marketing channels are summarized in Table 1, which shows that mobile brokers and milk stations were the primary buyers at the farm-gate prior to the milk crisis in Greater Beijing. In 2004, the share of dairy farmers who sold milk through these two channels was 82% (16 + 66; column 1, Table 1), and 85% (45 + 40) before the milk crisis in 2008 (column 2). Within these two channels, the share of dairy farmers that marketed through mobile brokers almost tripled, from 16% in 2004 to 45% in 2008, whereas those who marketed through milk stations dropped from 66% in 2004 to 40% in 2008. A similar trend can be observed when we examine the volume of milk sold through different channels. For example, although dairy farmers sold 76% of their milk to milk stations in 2004, the figure fell to 45% in 2008. On the other hand, mobile brokers gained significant market shares, increasing from 19% in 2004 to 50% in 2008. One year after the milk crisis in September 2008, the marketing channel at

TABLE 1. Dairy Farmers Selling Milk by Marketing Channels in Greater Beijing, 2004, 2008 and 2009

	2004	2008	2009
Total sample	150	121	104
Share by marketing participation (%)			
Direct consumers	4	3	2
Mobile brokers	16	45	1
Milk stations	66	40	13
Dairy complexes	0	2	37
Did not sell	14	10	48
Share by marketing volume (%)			
Direct consumers	5	4	4
Mobile brokers	19	50	2
Milk stations	76	45	24
Dairy complexes	0	2	70

Source: Authors' survey.

TABLE 2. Number of Villages that Established Dairy Complexes and Townships that Received Marketing Management Policies in Greater Beijing Between September 2008 and September 2009

	2008				2009		
	Sept.	Oct.	Nov.	Dec.	March	June	Sept.
Number of townships receiving marketing management policies	0	8	10	10	12	12	12
Number of villages with dairy complexes	1	4	4	5	5	5	5

Note. In the Greater Beijing dairy study, we surveyed 25 dairy villages in 15 townships.

Source: Authors' survey.

the farm gate changed radically. Both percentage of dairy farmers and volume of milk sold to mobile brokers decreased to only 1–2% in 2009 (column 3, Table 1). Milk stations also became less dependable for dairy farmers; only 13% of dairy farmers sold their milk to milk stations. Milk stations' marketing volume share also fell from 45% in 2008 to 24% in 2009. Thus, dairy complexes had become the major channel for dairy farmers to sell their milk; the volume sold through dairy complexes accounted for 70% in 2009.

The milk scandal indeed resulted in marketing difficulties for smallholder dairy farmers in Greater Beijing. As shown in Table 1, only 10% of dairy farmers reported not selling milk in 2008.<sup>5</sup> One year after the milk crisis, nearly half (48%) of dairy farmers were unable to sell their milk through any channel (column 3). It thus seemed that the decreasing consumer demand for domestic dairy products in the upstream market negatively affected the dairy processing industry to procure raw milk. This coincided with problems upstream, as some milk stations and mobile brokers were shut down. As a result, dairy farmers had difficulties to sell their milk.

## 5. MARKETING MANAGEMENT POLICIES AND DAIRY COMPLEXES IN GREATER BEIJING

Our data illustrates the prompt response of government reaction after the milk scandal. For the 14 surveyed townships, no township received policy directives in September 2008, when the milk scandal was disclosed. This is not surprising, as it took the central government time to understand the nature and the likely impacts of the crisis. By October, however, one month after the outset of the milk scandal, 8 townships had received marketing management policy directives (row 1, Table 2). By the end of 2008, the policy directives had arrived at 10 townships, and the outreach leveled off in 12 townships after March 2009.

<sup>5</sup>This was largely because of the fact that cows in some small-scale dairy farms had not reached the milk production stage (or age) when the survey was conducted.

TABLE 3. Dairy Complexes, Marketing Management Policy and Dairy Farmers' Marketing Channels in Greater Beijing in 2009

Variables	Sample	Households that sold milk to:				Did not sell
		Direct consumer	Mobile broker	Milk station	Dairy complex	
Marketing management policies						
Yes	98	2	1	12	37	46
No	6	0	0	1	1	4
Dairy complexes in village						
Yes	39	0	0	5	20	14
No	65	2	1	8	18	36

Source: Authors' survey.

Dairy complexes also emerged rapidly after the crisis. For example, only one village hosted dairy complexes before the milk scandal. There was no increase in the occurring month (September 2008). However, one month later, dairy complexes emerged in four villages, and an additional complex was established in December 2008. The emergence of dairy complexes seemed to be a prompt response to the crisis in the early months.

The transformation of marketing channels seems to be correlated with marketing management policies. In Table 3, we examined the relationship between farmers' choice of marketing channels in 2009 and the rollout of the policies by using household data. Of the 104 dairy farmers surveyed in 2009, 98 of them farmed in villages where marketing management policies were delivered. Interestingly, the share of nonselling farmers is relatively lower in villages that received the marketing management policies (46/98) than in villages outside the realm of the government policies (4/6).

A further interesting finding is the correlation between the transformation of marketing channels and the emergence of dairy complexes. Where a dairy complex was established, it became the major marketing channel in the village for the dairy farmers. For example, when residing in villages with dairy complexes, more than 51% of the dairy farmers (20/39, Table 3) marketed their milk through these complexes in 2009. In villages without dairy complexes, the share was just 27% (18/65, Table 3). It is interesting that dairy farmers could also sell milk to dairy complexes when there were no dairy complexes in the village. In fact, farmers could bring their cows into dairy complexes from other villages even though the dairy complex was somewhat distant. Lastly, dairy complexes seem to have played an important role in mitigating marketing difficulties after the milk scandal. In villages with dairy complexes, 35% of dairy farmers (14/39) experienced marketing difficulties, whereas the figure was 55% (36/65) in villages without dairy complexes. The results indicate that the percentage of farmers unable to sell their milk could be reduced by 20% if dairy complexes were established in a village.

## 6. MULTIVARIATE ANALYSIS AND DISCUSSION

Because many factors might simultaneously affect the observed association between policy directives and dairy farmers' choice of marketing channel, a multivariate analysis is needed. In this section, we first specify a multivariate model that seeks to isolate the impact of policy directives on dairy farmers' marketing, and then present the results.

### 6.1 The Model

The basic model used to estimate the impact of the milk scandal and subsequent policy directives on dairy farmers' marketing channels is specified as follows:

$$Y_{ijkmt} = a_1 + a_2^* Shock_{jkt} + a_3^* Trend + a_4 Z_{ijkt} (t = 2004) + e_{ijkt} \quad (1)$$

where the dependent variable,  $Y_{ijkmt}$ , represents four variables that measure a dichotomous choice (Yes = 1; No = 0) of marketing through channel  $m$  or the percentage of marketing volume through channel  $m$  for household  $i$  in village  $j$  and township  $k$  in year  $t$  ( $t = 2004, 2008$ , and 2009). Marketing channel  $m$  includes *Mobile brokers*, *Milk stations*, *Dairy complexes*, and *Not-sell*. We do not include the marketing channel of directly selling to the consumer because it was negligible in our samples.

In the basic model, three of our key independent variables of interest are included in  $Shock_{jkl_t}$ : (1)  $Shock_{jkl_t}$  ( $l = 1, Policy_{kt}$ ) denotes the accumulated number of months between the first month that the marketing management policies were received and the previous month of the study period in township  $k$  in year  $t$ ; (2)  $Shock_{jkl_t}$  ( $l = 2, Complex_{jt}$ ) measures whether there was any dairy complex in village  $j$  in year  $t$  (yes = 1 no = 0); (3)  $Shock_{jkl_t}$  ( $l = 3, Scandal$ ) is a dummy variable that reflects the milk scandal, which equals 0 for months before September 2008, and 1 thereafter.

We also include several control variables: *Trend* represents the general time trend in 2004–2009, and equals one in 2004 and six in 2009. The matrix,  $Z_{ijk_t(t=2004)}$ , is a set of control variables at the household level (*age*, *education*, *asset value per capita*, and *herd size*) and a variable at the community level (*distance to the nearest dairy processor*) for household  $i$  in village  $j$  and township  $k$ . The variable *age* is measured as the age of the household head, whereas *education* measures the number of years of educational attainment for the household head. To create the variable *asset value per capita*, we first aggregate the value of durable consumption assets of the household (housing, furniture, electric appliances and others) by the end of 2004. The value is then divided by the number of household members. The variable *herd size* measures the number of dairy cows that the household owned in 2004. These household-level control variables are constructed as lagged variables (i.e., year 2004) to avoid any endogeneity problems. At the community level, *distance to the nearest dairy processor* in the current year is used to measure farmers' access to the midstream processors and the markets. The symbol  $e_{ijk_t}$  is the error term, which includes all unobserved variables and random noise.

Different estimators are used to determine the effect of the policy efforts on dairy farmers' choice of marketing channel. When the dependent variable is the choice of marketing through a different channel, we use a Probit model (because the dependent variable is discrete and equals either 1 or 0). When the dependent variable is percentage of marketing volume through different channels, we use a Tobit model (because the dependent variable is continuous but censored at 0).

## 6.2. Multivariate Analysis Results

The results of the multivariate analysis for the impact of milk scandal and policy directives on dairy marketing at the farm-gate level are consistent with our expectations. The signs and the significant levels are in line with our prior analysis (Tables 4 and 6). The significance of the three shock variables (i.e.  $Policy_{kt}$ ,  $Complex_{jt}$ , and  $Scandal$ ) shows that the milk scandal broke out in 2008 and the concurrent policy directives affected the marketing channel at the farm gate in the dairy industry.

Specifically, we observe a correlation between the milk scandal and the marketing management policies. To test this, we implemented "Collinearity Diagnostics" and found that the Variance Inflation Factor (VIF) of marketing management policies and the milk scandal are 9.85 and 10.46, respectively. In addition, the condition number is 16.32. All these demonstrate that the multicollinearity between the marketing management policies ( $Policy_{kt}$ ) and the milk scandal ( $Scandal$ ) variables should be a concern. Therefore, we modify specifications of the three *Shock* variables by including the marketing management policies and dairy complex (Table 4), and by including the milk scandal and dairy complex (Table 5). When comparing the results of estimating all three shock variables (i.e.  $Policy_{kt}$ ,  $Complex_{jt}$ , and  $Scandal$ ), we find



TABLE 4. Estimating the Effects of Policy Directives on Farm-gate Marketing Channels Using Probit Models in Greater Beijing, 2004, 2008 and 2009

	Mobile broker (1)	Milk station (2)	Dairy complexes (3)	Did not sell (4)
1. Marketing management policies	-0.05*** (4.87) <sup>a</sup>	-0.02*** (2.94)	0.01** (2.29)	0.02*** (4.81)
2. Dairy complex in village	-0.13 (1.26)	0.005 (0.05)	0.08*** (3.31)	-0.11* (1.72)
3. Trend	0.04*** (5.03)	-0.05*** (4.89)	0.08* (1.66)	0.01 (0.73)
4. Age	0.004** (2.02)	-0.003 (1.43)	-0.002 (1.36)	0.001 (0.50)
5. Education	0.01 (1.52)	-0.01 (1.02)	0.005 (0.82)	-0.01 (0.79)
6. Asset value per capita	0.003 (1.60)	0.001 (0.47)	-0.002 (1.41)	0.001 (0.12)
7. Herd size	-0.004** (2.00)	0.01 (1.63)	0.003*** (3.36)	-0.02** (2.21)
8. Distance to the nearest dairy processor	-0.001 (0.13)	-0.003*** (3.29)	0.001 (0.83)	0.002*** (2.65)

Notes. <sup>a</sup>Absolute values of t-ratio in parentheses; \*, \*\*, and \*\*\* indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. The sample includes dairy households that had cows in 2004 (150 households), in 2008 (121 households) and in 2009 (104 households). Total sample size is 375. Source: Authors' survey.

TABLE 5. Estimating the Effects of the Dairy Scandal and Policy Directives on Farm-gate Marketing Channels Using Probit Models in Greater Beijing, 2004, 2008 and 2009<sup>a</sup>

	Mobile broker (1)	Milk station (2)	Dairy complexes (3)	Did not sell (4)
1. Scandal	-0.54*** (6.35)	-0.23*** (3.16)	0.05 (1.08)	0.36*** (6.88)
2. Dairy complex in village	-0.12 (1.12)	0.01 (0.15)	0.09*** (3.56)	-0.13** (2.06)
3. Trend	0.05*** (5.66)	-0.05*** (4.46)	0.12*** (5.07)	-0.01 (0.71)
4. Age	0.004* (1.94)	-0.003 (1.40)	-0.002 (1.53)	0.001 (0.37)
5. Education	0.01* (1.74)	-0.01 (0.98)	0.004 (0.66)	-0.01 (1.12)
6. Asset value per capita	0.003 (1.47)	0.001 (0.40)	-0.002 (1.45)	0.001 (0.29)
7. Herd size	-0.003 (1.29)	0.01** (2.03)	0.003*** (3.08)	-0.03*** (2.79)
8. Distance to the nearest dairy processor	0.001 (0.04)	-0.003*** (3.31)	0.001 (0.90)	0.002** (2.52)

Notes. <sup>a</sup>Absolute values of t-ratio in parentheses; \*, \*\*, and \*\*\* indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. The sample includes all dairy households that had cows in 2004 (150 households), in 2008 (121 households) and in 2009 (104 households). Total sample is 375.

Source: Authors' survey.

that the coefficients either reverse their sign or turn out to be insignificant.<sup>6</sup> This is further evidence of the likely correlation between the milk scandal and the marketing management

<sup>6</sup>The results of estimating all three shock variables (i.e.,  $Policy_{kt}$ ,  $Complex_{jt}$ , and  $Scandal$ ) and the descriptive statistics of main variables in the regression are available upon request.

TABLE 6. Estimating the Effects of the Dairy Scandal and Policy Directives on Dairy Farmers' Volume Share of Marketing Channels Using Tobit Models in Greater Beijing, 2004, 2008 and 2009<sup>a</sup>

	Mobile broker (1)	Milk station (2)	Dairy complexes (3)	Did not sell (4)	(5)	(6)	(7)	(8)
1 Marketing Management Policies	-5.21*** (5.05) <sup>a</sup>		-2.62*** (3.62)		1.02 (1.78)		2.32*** (4.49)	
2. Scandal		-58.99*** (5.41)		-28.73*** (3.61)		3.67*** (4.47)		35.95*** (5.61)
3. Dairy complex in village	-13.42 (1.19)	-11.93 (1.06)	-0.12 (0.01)	0.32 (0.03)	8.50** (3.05)	9.20** (3.99)	-9.44 (1.59)	-11.16 (1.97)
4 Other Control <sup>b</sup>	...	...	...	...	...	...	...	...

Notes. <sup>a</sup> Absolute values of t-ratio in parentheses; \*\*, \*, and \*\*\* indicate statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. The sample includes all dairy households that had cows in 2004 (150 households), in 2008 (121 households) and in 2009 (104 households), for a total of 375 observations.

<sup>b</sup> For a better illustration, we remove the results of other control variables. The results are consistent with Tables 4 and 5, and are available upon request.

Source: Authors' survey.

policies. As such, in the rest of the analysis, we focus on the combinations of the two shock variables separately (Tables 4–6).

Our results show that the marketing management policies reduced the likelihood of farmers selling milk to mobile brokers. The coefficients are statistically significant and negative ( $-0.05$ , row 1, column 1, Table 4). This means that, *ceteris paribus*, the probability of farmers selling their milk to mobile brokers decreased by 5% if their villages received marketing management policy directives from the federal government. The results hold when we examine the marketing volume through different channels (Table 6). The coefficients are robustly negative and significant ( $-5.21$ , row 1, column 1), suggesting that the marketing management policies reduced the volume of farmers' milk sold to mobile brokers by more than 5%. Note that the coefficients of *Trend* are significant and positive, and this means that, *ceteris paribus*, mobile brokers would have been increasingly chosen by dairy farmers in the absence of the milk scandal and the policy directives (row 3, columns 1, Tables 4 and 5).

The results for milk stations also show the effectiveness of the market management policies. The coefficients are significant and negative (row 1, column 2, Table 4), suggesting that the inspection programs of the milk procurement agents led to farmers' decreased participation in the marketing chain through milk stations. We also found that the downward effects of the marketing management policies on the channel of milk stations were smaller than on the mobile brokers ( $-0.02$  vs.  $-0.05$ , row 1, columns 1 and 2, Table 4). The results remain the same when the dependent variable is measured as marketing volume for milk stations (row, 1, columns 1 and 3, Table 6).

The rapid emergence of dairy complexes created a chance for dairy farmers to sell their raw milk after production was hit by the milk scandal. The coefficients of the dairy complex are significant and positive (row 2, column 3, Tables 4 and 5; row 3, columns 5 and 6, Table 6). This means that the emergence of dairy complexes became an important and new marketing channel for dairy farmers to sell their milk after the crisis. Meanwhile, we found that implementing marketing management policies presented a "push" to drive the dairy farmers to market their milk through dairy complexes, because the ban on mobile brokers and illegal milk stations increased marketing difficulties at the farm gate. The pushing effects are somewhat smaller than the effects of marketing management policies ( $0.01$  vs.  $0.08$ , rows 1 and 2, column 3, Table 4).

Our results also show that the milk scandal and the marketing management policies resulted in marketing difficulties at the farm gate, and that the emergence of dairy complexes significantly mitigated these problems. The coefficients for the marketing management policies and the

TABLE 7. Safety and Quality Inspection by Channels in Greater Beijing in 2004, 2008 and 2009

	Sample	Share of Households Inspected (%)			
		Safety: Anti-Biotic	Safety: Somatoplasm	Quality: fat rate	Quality: lacto-protein
2004					
Direct consumers	6	0	0	0	0
Mobile brokers	24	54	0	0	0
Milk stations	99	56	0	0	0
Dairy complexes	0	na	na.	na.	.na
Did not sell	21	na	na.	na.	.na
2009					
Direct consumers	2	0	0	0	0
Mobile brokers	1	0	0	0	0
Milk stations	13	77	8	69	77
Dairy complexes	38	95	24	79	79
Did not sell	50	na	na	na.	na

Source: Authors' survey.

scandal are significant and positive (rows 1, columns 4, Tables 4 and 5; row 1 and 2, column 7 and 8, Table 6), suggesting that the probability of dairy farmers having a volume of unsold milk increased after the milk scandal. Meanwhile, the coefficient for the policies (0.02, row 1, column 4, Table 4) is much smaller than that for the dummy variable of the scandal (0.36, row 1, column 4, Table 5). This was because many dairy processors stopped procuring milk because of the collapse in the demand side in the early months of the crisis. This led to falling demand for raw milk at the farm gate. Interestingly, the coefficients of dairy complexes are significant and negative, suggesting that the new production system mitigated the probability of marketing difficulties by 11–13% (row 2, columns 4, Table 4 and 5).

Furthermore, the results also show that several other control variables affected dairy farmers' marketing choices. First, large dairy farmers tended to sell raw milk through dairy complexes (as the coefficients are significant and robust in row 7, columns 3, Tables 4 and 5), and they were less likely to have marketing difficulties (as the coefficients are consistently negative in row 7, columns 4, Tables 4 and 5). Farm size indeed affected dairy farmers' marketing choice. Second, the distance to dairy processors affected farmers' dairy marketing. When located far away from dairy processors, dairy farmers were more likely to be subject to market difficulties (as the coefficients are significant and positive in column 4 in both Tables 4 and 5).

## 7. DISCUSSION

Before the milk scandal, food safety and quality supervision in the upstream dairy marketing chain was weak in China. Being poorly supervised, the compliance and supervision of safety and quality standards of milk sold to mobile brokers and milk stations were very weak. In the 2004 survey, only half of dairy farmers were asked to test for antibiotics (Table 7). Further, none of the dairy farmers in our sample reported being tested for somatoplasm or any other quality indicators (e.g., fat rate and lacto-protein).

However, after the milk scandal, safety and quality inspection improved significantly. In 2009, 95% of farmers who sold milk to dairy complexes reported being tested for antibiotic parameters (column 2, Table 7). The frequency of quality inspection also increased. For example, 79% of dairy farmers who sold their milk to dairy complexes reported that their milk was tested for fat content and lacto-protein. Under heavy regulations, both milk stations and dairy complexes have gradually strengthened the supervision of safety and quality standards.

After the milk scandal, vertical coordination through contracting also started to emerge between the suppliers and the milk procurement stations. As shown in Table 8, in 2004, only 12% of dairy farmers contracted with buyers. The content of such contracts concerned the

TABLE 8. Share of Written Contracts for Dairy Farmers Who Sold Milk by Channels in Greater Beijing in 2004, 2008, and 2009 (%)

	2004	2008	2009
Without contracts	88	90	32
With contracts	12	10	68
Direct consumers	0	0	0
Mobile brokers	2	4	0
Milk stations	10	4	0
Dairy complexes	0	2	68

Source: Authors' survey.

volume of milk and date of delivery between the two parties. The share decreased to 10% in 2008, indicating spot-market type marketing in the upstream before the milk scandal. After the crisis, contracts were gradually used between dairy farmers and dairy complexes (68%, Table 8) in which dairy cows and dairy farmers were brought to a centralized complex for both production and marketing. Dairy complexes were also expected to facilitate the production of more sanitary conditions and higher quality through better supervision and training services.

While the emergence of dairy complexes provides opportunities for farmers to sell their milk and enhance safety and quality standards, our field interviews and personal contact with farmers and experts reveal that it also poses challenges to dairy farmers and food safety.

*First*, transferring cows and dairy farmers to a different place commits farmers to both physical and psychological costs. As farmers need to take care of the cows in the dairy complexes, it incurs higher commuting costs. The psychological costs of living and farming away from home also cannot be neglected. In our survey, the inconvenience of dairy farming in a distant place was the primary complaint of farmers in dairy complexes.

*Second*, if not managed systematically, production and marketing will be problematic in dairy complexes, for example, concerning disease control and excretion management (Kong & Zhong, 2009; Zheng, 2011).

*Third*, governing dairy complexes is sophisticated. If not well coordinated, managers or investors of dairy complexes can manipulate marketing by squeezing purchasing price to individual farmers, or by under-grading the quality of raw milk (Wang, Guo, Liu, & Hou, 2010).

*Fourth*, the role of government regulation in the dairy chain is critical. So far, the major problem of regulation in China has been that there are no on-site inspections as part of official controls (Pei et al., 2011). After the milk scandal, on-site programs were basically conducted by the dairy processors and controlling authorities. However, a process-oriented approach has been established in European countries to optimize quality control during production and all subsequent steps in the dairy chain. In addition, although the quality regulation (presented in Section 1) and the new standards (presented in Section 2) highlighted the quality control and grading in the upstream dairy chain, there has not been any third-party agency of function. An institutional structure without the potential for inter-agency conflicts of interest is urgently needed (Yang, Huang, Zhang, Thomas, & Pei, 2009).

## 8. CONCLUSION

China's milk scandal and subsequent policy directives have resulted in a dramatic transformation in the upstream dairy marketing chain. In the initial period of the crisis, it brought tremendous marketing difficulties for dairy farmers—most of whom were small-scale holders. To restore and to restructure China's dairy industry, the government implemented policies ranging from marketing to production. The policies were found to be effective in affecting marketing channels at the farm gate. Mobile brokers disappeared. Milk procurement agencies were heavily regulated. Importantly, a new production system of dairy complexes began to emerge that integrated individual smallholder farmers to a large farm, and became the primary marketing channel for individual dairy farmers.

The marketing transformation at the upstream dairy chain has profound policy implications for food safety and vertical coordination in the Chinese dairy chain. Safety testing has been strengthened, and written contracts are being used through dairy complexes, as farming in dairy complexes commits smallholder farmers to additional costs. However, the agency problem for dairy complex owners and dairy farmers remains a challenge. The governance structure of dairy complexes is ambiguous and warrants future research. In addition, although great improvements have been made to the regulatory framework after the milk scandal, China still faces challenges in improving the food safety monitoring system and in strengthening coordination across different institutions, namely, government administration, private sectors, and the industry itself (Pei et al., 2011). In particular, a legal framework should establish an on-site official inspection system for assessing and grading milk quality. Some of these measures are being undertaken, whereas others are still in the process of planning and design.

## ACKNOWLEDGMENTS

We gratefully acknowledge financial support from the National Natural Science Foundation of China (Grant No. 70903063; Grant No. 71173204), LICOS of the University of Leuven (Methusalem Grant), the 41st Scientific Research Foundation (SRF) for the Returned Overseas Chinese Scholars (ROCS), and the State Education Ministry of China (SEM).

## APPENDIX A

### Quality and safety standards in China: old standards and new standards.

	Old Standards in 1986	New Standards in 2010
Relative density (20°C/4°C)(g/L)	≥1.028	≥1.028
Protein (g/100g)	2.95	2.8
Fat (g/100g)	3.1	3.1
Degree of impurity (mg/kg)	≤4.0	≤4.0
Titrateable acidity	≤16.2	≤18
Mesophilic bacteria [CFU/g(mL)]	≤4,000,000	≤2,000,000

Source: GB/T 6,914—86, GB 19,301—2010.

## REFERENCES

- Barboza, D. (2008). China's dairy farmers say they are victims, vol. 2009.
- BBC. (2008) "China to punish baby milk makers." <http://news.bbc.co.uk/2/hi/asia-pacific/7611732.stm>.
- China Daily. (2009). "4,000 – Milk Collection Stations Closed." [http://www.chinadaily.com.cn/china/2009-06/03/content\\_8019447.htm](http://www.chinadaily.com.cn/china/2009-06/03/content_8019447.htm)
- China Dairy Statistical Report. (2010). Beijing: Department of China Dairy Yearbook, China Ministry of Agriculture.
- ChinaNews. (2008). "102 Milk stations were shut down and another 33 were suspended in Hebei Province [(In Chinese) hebeisheng qudi 102 wenti naizhan; tingye zhengdun 33 ge]." Retrieved Oct. 7th 2008 from <http://www.chinanews.com/cj/cyzh/news/2008/10-07/1402932.shtml>.
- . (2009). "Illegal milk stations were shut down in Hebei Province [hebeisheng naizhan jiang gui ruqi guanli; buhege naizhan yilv qudi]." Retrieved March 3rd. 2009 from <http://www.chinanews.com/jk/hyxw/news/2009/03-03/1585698.shtml>.
- Huang, J., Jia, X., Luan, H., Rozelle, S., and Swinnen, J. (2012) "Consolidating Dairy Farming in Cow Complexes after China's 2008 Milk Crisis: The Case of Greater Beijing." (Working Paper). Center for Chinese Agricultural Policy, Chinese Academy of Sciences.
- Huang, J., Wu, Y., Yang, Z., Rozelle, S., Fabiosa, J., and Dong, F. (2010). Farmer participation, processing, and the rise of dairy production in greater Beijing, P.R. China. *Canadian Journal of Agricultural Economics* 58(3):321–342.
- . 2013. Marketing China's milk: A case study of the sales activity of dairy farmers in greater Beijing. *China Economic Review* 23(3): 675–689. doi:10.1016/j.chieco.2010.09.006.

- Jia, X., Huang, J., Luan, H., Rozelle, S., and Swinnen, J. (2012). China's milk scandal, Government policy and production decisions of dairy farmers: The case of greater Beijing. *Food Policy* 37(4):390-400.
- Kong, X., and Zhong, Z. (2009). Organizational forms of dairy farming in China (in Chinese). *Dairy Economics* 4:22-25.
- Liu, C., Ed. 2003-2009. *China Dairy Yearbook* Beijing: China Agricultural Publisher.
- Lu, J., and Tao, Z. (2009). Sanlu's melamine-tainted milk crisis in China. *Harvard Business Review* (439C):1-24.
- Ministry of Health. (2011). Explanatory for the calibration of the "National Food Safety Standard of Raw Milk" in China." Retrieved from <http://www.moh.gov.cn/publicfiles/business/htmlfiles/mohwsjdj/s3594/201106/52181.htm>
- Mo, D., Huang, J., Jia, X., Luan, H., Swinnen, J., and Rozelle, S. (2012). Checking into China's cow hotels: Have policies following the milk scandal changed the structure of the dairy sector? *Journal of Dairy Science* 95(5):2282-2298.
- Pei, X., Tandon, A., Alldrick, A., Giorgi, L., Huang, W., and Yang, R. (2011). The China melamine milk scandal and its implications for food safety regulation. *Food Policy* 36(3):412-420.
- Wang, Y., Guo, Y., Liu, H., and Hou, L. (2010). Present situation and policy analysis of cow hotel: Based on Yuci District of Shanxi Province (shanxisheng yuciqu nainiu yangzhi xiaoqu xianzhuang ji zhengce fenxi). *China Dairy* 5:22-23.
- Xinhua News. (2008) China central gov't to subsidize dairy farmers after tainted milk scandal. Retrieved Oct. 4, 2008 from <http://english.sina.com/china/2008/1004/189793.html>
- Yang, R., Huang, W., Zhang, L., Thomas, M., and Pei, X. (2009). Milk adulteration with melamine in China: crisis and response. *Quality Assurance and Safety of Crops & Foods* 1(2):111-116.
- Zhao, X., and Chen, L. (2011). Research and demonstration of standardized yangzhi xiaoqu construction technology (biaozhunhua nainiu yangzhi xiaoqu jianshe jishu de yanjiu yu shifan). *China Dairy* 113:22-25.
- Zheng, S. (2011). Problem and response to disease prevention and control in *yangzhi xiaoqu* (in Chinese). *Breeding Technology Consultant* 7:195.
- Zhou, Z.-Y., Tian, W., and Zhou, J. (2002). The Emerging dairy economy in China: Production, Consumption and trade prospects. *Australasian Agribusiness Review* 10 (Paper 7):1-24.

---

**Xiangping Jia** is an Associate Professor in the Center for Chinese Agricultural Policy, Institute for Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences. Email: [jiaxp.ccap@igsnr.ac.cn](mailto:jiaxp.ccap@igsnr.ac.cn). Mailing address: Jia 11 Datun Road, Anwai, Beijing, CHINA 100101. Obtained PhD in agricultural economics from University of Hohenheim (Germany) in 2008. Current research interest includes agricultural policies and rural development.

**Hao Luan** was a Phd student in the Center for Chinese Agricultural Policy, Institute for Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences. Email: [luanhao2008@gmail.com](mailto:luanhao2008@gmail.com). Mailing address: No. Jia 11, Datun Road, Anwai, Beijing, CHINA 100101. He earned PhD in agrcultural economics at Chinese Academy of Sciences (China) in 2013. Current research interest includes development economics and international trade.

**Jikun Huang** is a Director and Professor in the Center for Chinese Agricultural Policy, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences. Email: [jkhunag.ccap@igsnr.ac.cn](mailto:jkhunag.ccap@igsnr.ac.cn). Mailing address: Jia 11 Datun Road, Anwai, Beijing, CHINA 100101. Earned PhD in agricultural economics from University of of the Philippines at Los Banos in 1990. His research interests include agricultural and rural development and policies.

**Shengli Li** is a Professor at College of Animal Science and Technology, China Agricultural University. E-mail: [lishengli@cau.edu.cn](mailto:lishengli@cau.edu.cn). Mailing Address: No.2 west Yuanming Road, Haidian District, Beijing, P.R.China 100193. Earned PhD in college of Animal Science and Technology (China Agricultural University) in 1996. His researching field is ruminant nutrition and dairy farming.

**Scott Rozelle** is a Senior Fellow in the Center for Food Security and the Environment, Freeman Spogli Institute, Stanford University. His email is [rozelle@stanford.edu](mailto:rozelle@stanford.edu) and his mail address is 407 East Encina Hall, Stanford University, Stanford, CA 94305. Scott earned his doctorate degree in agricultural economics in 1991 from Cornell University. His research interests include the economics of agriculture, development and education and health in China.