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Long-term effects of food safety incident: Example of Sanlu milk powder incident

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Abstract: The purpose of this study is to examine the long-term consumer response to food safety incidents. The Sanlu incident that broke out in 2008 offers us an example to discuss the long-term impact of the incident on consumption behavior. In 2018, a survey was distributed to consumers in selected regions. Probit and Tobit techniques are used to analyze the long-term effect of food safety incidents on consumers' trust in various subjects through memory and cognition and how trust further influences their consumption behaviors. Results indicate that consumers showed the highest level of trust in the central government and the lowest in domestic salespeople and producers. The effects caused by trust in foreign producers were more significant than those caused by trust in authorities and the central government. Additionally, the middle-income group preferred to buy domestic milk powder the most. Little research has explored the long-term consumer response to food safety incidents. This study enriches the previous literature by exploring whether consumer choices can be influenced by trust and how.

Keywords: food safety; consumer trust; food consumers; food supply chain; long-term effects

1. Introduction

Global food markets have faced many food safety incidents in the past. Examples include lead found in crab in South Korea in 2000, beef discovered to contain horsemeat in Europe in 2013, and so on [1]. Food safety incidents not only directly affect public health but also result in significant economic losses. For example, it was the carcinogenic dioxin contamination that affected poultry and cattle in Belgium in 1999. The losses amounted to more than 10 billion euros [2]. Meanwhile, food safety incidents also result in indirect economic losses such as lost markets, loss of consumer demand, litigation, and company closures [3]. It has been found that consumer purchases will decline significantly in the short term after food safety incidents [4]. However, little research has explored the long-term consumer response to food safety incidents. In the long run, whether consumer choices can be influenced by trust and what is the mechanism of the influence.

In this paper, we used the example of the Sanlu incident, an infamous food safety incident in China, to study the long-term impact. This example was chosen because of the huge influence and attention it has received internationally in recent years. In 2008, Sanlu, a leading milk supplier, was discovered to have adulterated their milk products with melamine to artificially enhance their protein content [5]. In the aftermath of China's dairy industry inspection by pertinent agencies, it was revealed that the infant formula produced by 22 prominent domestic dairy companies contained melamine.

Subsequently, approximately 300,000 children were found to have suffered deeply from kidney stones, and at least six infants died from consuming melamine-contaminated milk powder [6]. The incident destroyed consumers' trust in domestically produced milk powder in China [7].

The distrust of domestic milk powder changed the consumption behavior of domestic consumers by switching to imported milk products [6]. Although considerable efforts, such as implementing the Chinese Food Safety Law, have been made to search for solutions to the problems plaguing China's dairy sector [6], Chinese consumers have continued to show distrust of domestic milk powder. The results of a national dairy consumption survey conducted by the China Dairy Association in June 2010 showed that 70% of respondents trusted imported dairy products, whereas only 16% continued to trust domestic ones. The impact has lasted until 2021 or even longer. The volume of milk powder imported in China has experienced a noteworthy escalation, surging from 98,000 tons in 2007 to 1.54 million tons in 2021 [8].

As time goes by, when will consumers forget? Is the increasing importing volume of milk powder due to the remaining impact of the Sanlu milk powder incident? Has consumers' trust in domestically produced milk powder recovered? What is the impact of trust on consumers' purchasing behaviors? What are the factors affecting trust? Answering these questions could not only give insights on the reconstruction of the Chinese dairy industry but also provide the entire agriculture and food sectors worldwide with long-term coping strategies. This discussion focused on two aspects. The first are the different levels of trust consumers place on "trust objects"¹ after the Sanlu incident. The second are the effects of different "trust objects" on consumer behavior and the mechanisms behind such behavior.

This paper provides insights into consumers' long-term responses to food safety incidents and makes a marginal contribution in two important ways. First, it addresses the long-term effects of such incidents on consumer behavior, filling a research gap that often focuses on immediate or short-term effects after the incident took place. However, the effects usually last for a long time. It is important to understand them to make better food safety policies and business strategies for both the public and private sectors. Second, it adds new empirical evidence to the agricultural marketing literature by examining consumer trust from the perspective of key supply chain actors. Through an in-depth analysis of consumer trust in entities such as the central government, local governments, domestic and foreign sellers, and domestic and foreign producers, this study reveals the psychological and cognitive mechanisms that affect consumer choices.

The paper is organized as follows: literature review, background, data, variables, methodology, results, discussion, and conclusion.

2. Literature review

Trust is complicated to measure. Some have posited that trust is composed of two parties, among whom one party, i.e., the trustor, can choose whether or not to voluntarily place trust in the other party, i.e., the trustee [9]. Umer and Li viewed trust in two dimensions: optimism and pessimism [10]. Trust can also be defined in both specific and general senses [11]. General trust means to trust all members of a

particular social system [12]. Specific trust can be measured by different stakeholders, for example, trust in the government, retailers, manufacturers, and farmers, and trust in consumer organizations [13,14].

Numerous factors affect trust, and in turn, it has diverse implications for consumer behavior across various channels. External incidents have been found to erode trust levels [15], resulting in lower consumer trust in food safety [16] and decreasing sales of affected products [17]. Meanwhile, internal demographic characteristics, such as gender, income level, and education level, were highly related to consumer trust in the food chain. Furthermore, trust has been identified as a core factor affecting consumer behavior among various factors [18], including confidence, attitude [19,20], consumer loyalty [21], and buying intention [22].

While the existing research base has extensively explored consumer trust, it has primarily focused on defining consumer trust, analyzing influencing factors, and studying their impact on short-term consumer behavior. However, the evolution of consumer trust following food safety incidents over time remains inadequately addressed in the literature. In particular, there is a gap in understanding the long-term, lagged effects of such incidents on consumer trust and how this trust, in turn, affects consumption behavior over time. Furthermore, the existing literature lacks a comprehensive delineation of trust modalities in terms of their impact on purchase behavior in the long run. Building on these gaps, this study investigates the impact of consumer trust on long-term consumption behavior in the context of the Sanlu incident. In addition, it categorizes and classifies trust based on the perspectives of key industry chain actors to explore how different categories of trust influence purchasing behavior.

3. Background

In 2008, China experienced a significant melamine² contamination incident in the dairy industry. This crisis was caused by dairy farmers increasing the melamine content of milk, resulting in widespread contamination of milk products. Over 300,000 infants were sickened, 50,000 were hospitalized, and six died after consuming powdered milk contaminated with melamine. This food safety incident shattered the confidence of people in the entire Chinese food supply. This incident highlighted the failure of the government, media, dairy farmers, milk collection stations, and companies to uphold regulatory standards and ensure product safety. This section aimed to provide an introduction to the Sanlu incident, including its background and related information.

Figure 1 illustrates the Chinese dairy industry chain in 2008, comprising key stakeholders: dairy farmers, milking stations, dairy processing companies, governments, and social media [13]. From left to right, dairy farmers raised cows and produced milk in family units, with an average breeding size of five cows in 2008 [23]. Such scattered productions as small household family units have resulted in low traceability of milk sources. Sanlu provided dairy cows and technical advice free of charge to small dairy farmers who paid off their loans with milk [24]. In addition to raising cattle, dairy farmers also took up farming for a living.

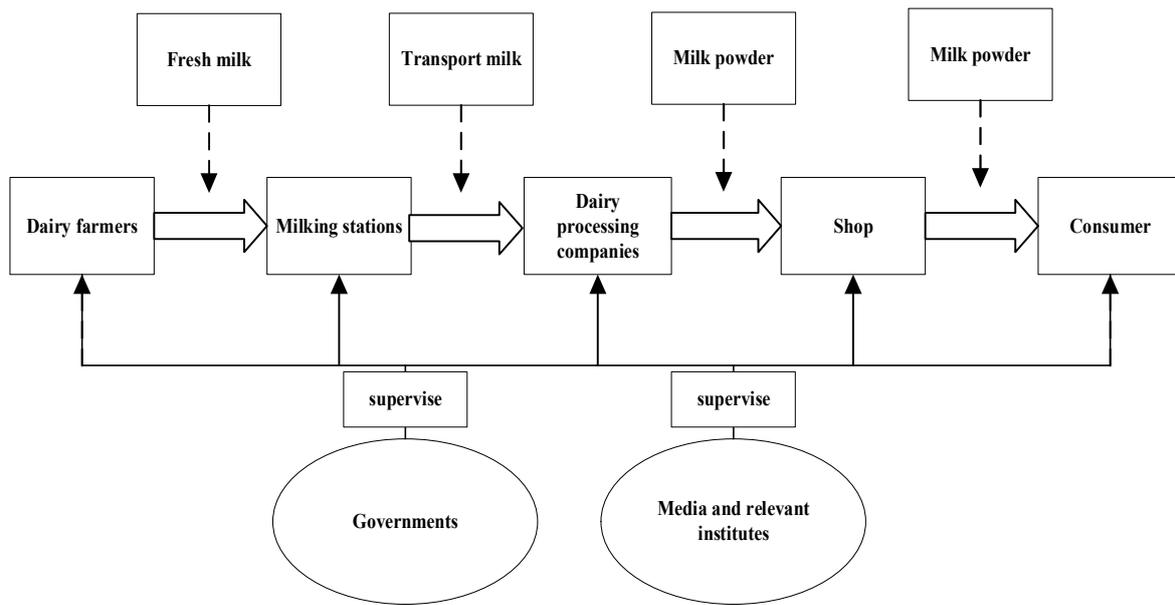


Figure 1. Supply chain and supervision of milk products in China.

Then cows or milk were sent to a milking station. Dairy processing companies set up milk stations in villages where cows were concentrated. The milk collection station’s regular daily activities included sterilization of cows’ udders, milking, milk storage, and shipment. After that, the milk was shipped to dairy processing companies for milk powder production. At dairy processing companies, quality tests were conducted by both the processor and inspection authorities, such as research institutes and other relevant institutes [25]. However, the top processors were exempt from inspections as the government allowed them to set their own standards and carry out their own inspections [26]. Finally, milk powders were sold to consumers through various retailers, such as large supermarkets and milk powder stores.

Another two key stakeholders, the government and the media, were not directly involved in the supply chain but were supervising throughout the entire process. The dairy industry chain was generally supervised by the central government’s ministry and also by local governments, such as township and village governments. In addition, the media supervised the dairy industry chain indirectly by monitoring and reporting.

How did the Sanlu incident happen, and which stakeholders were involved in it? Who should take responsibility? The fundamental cause of the Sanlu incident was the extremely rapid growth of the dairy industry in China [27]. This has resulted in the failure of each stakeholder in the Chinese dairy supply chain. According to the official report of the Sanlu incident [28], details are summarized in **Table 1**.

Table 1. Fault and improvement.

Stakeholders	Dairy farmer	Milking station	Dairy processing company	Government	Media and relevant institutes
How did they fail in the incident	Added melamine to their milk to reduce production costs	Lacked of rigorous and clear means of quality monitoring	Overused melamine to increase the protein content in the milk	Failed to prioritize the supervision of food safety	Failed to report promptly and objectively.
Improvement after the incident	Improved the production mode and adopted technology	Strengthened the collection and management of milk sources	Bettered production management and quality control methods	Introduced laws and strengthened the management of practitioners	Strengthened supervision on food safety issues

Dispersed feeding patterns made it difficult to trace and control milk sources. Then cows or milk were sent to a milking station. Because quality inspections have not been a part of these stations' regular daily activities, inspecting the milk's quality was also difficult before it was taken to dairy processing companies. Milk was then taken to dairy processing companies. Dairy processing companies overused melamine to increase the protein content in the milk to "improve" product quality as a way to compete for market share [29]. However, melamine was not expressly listed as an illegal additive at that time. The top four dairy processing companies, including Sanlu, were exempt from official controls because the government was focused on improving productivity, which enabled these companies to take risks.

The failures of dairy farmers, milking stations, and dairy processing companies also reflected the dereliction of duty in food safety supervision by the Chinese government. The government has focused on increasing production without keeping pace with inspections [30]. Furthermore, certain media reports on the incident were inadequate, lacking a sense of public responsibility to promote food safety. In light of the above situation, the Sanlu incident happened due to a collective failure.

To regain consumers' trust and rebuild the dairy industry, stakeholders have been actively searching for solutions. According to the government's report on the effectiveness of the reforms [31], we summarized their actions in the second row of **Table 1**. Dairy farmers began to strengthen the quality control and management of milk. For example, they chose to join organizations such as feeding communities or cooperatives to purchase feed and veterinary services. Dairy processing companies established quality control systems and conducted comprehensive testing and monitoring of all aspects of the production process. The government took a series of reform measures to improve food safety levels after the Sanlu incident. For example, they revised the food safety law and set up food safety institutions [32], leaving dairy processing companies with no exemptions from monitoring. The Ministry of Health announced that the standard for protein in raw milk should be lowered to 2.8% [33]. Meanwhile, the media strengthened their coverage and supervision of food safety issues, as well as public propaganda and education measures [34].

Although stakeholders in the dairy industry have taken steps to rebuild trust, the effects have been limited in the short and medium terms. **Table 2** provides consumer preferences for various trust objects after the incident in the short and medium terms. Regarding domestic milk powder, trust in the government has recovered significantly. The highest willingness to pay was for government-certified traceable milk, followed by industrial association-certified and third-party-certified milk. However, consumers still had low trust in domestic milk powder. Chinese parents switched from domestic milk powder to imported milk powder and relied on food supplies from friends and relatives in the interim. In the long term, consumers showed more pessimism than optimism toward domestic milk powder, largely because of their distrust in its safety and the fear caused by previous safety incidents. Exploring the exact long-term influence of incidents through different trust objects could help the reconstruction of the Chinese dairy industry and provide relevant industries (e.g., food) worldwide with long-term strategies to cope with incidents. Therefore, this study examined the long-term impact of melamine on consumers and analyzed how trust affects the results later.

Table 2. Preference of trust objects.

Most trusted				Least trusted
Authorities ¹ Governments	>		>	Merchants; Farmers; Producers
		>		

¹ Expert, research institutions and universities.

4. Data, variables, and methodology

4.1. Hypothesis

During the Sanlu incident, it was discovered that almost all domestic dairy brands had failed to meet the required quality standards. While the government and dairy processing companies have taken measures to address the issue, the media coverage has not kept up with the progress, especially compared to the initial disclosure of the incident. As a result, consumer memory and cognition of the Sanlu incident may still be fleshed out and remain negative. Therefore, this paper tested two hypotheses.

Hypothesis 1: The Sanlu incident affected long-term purchasing behavior via consumers' trust. We expected that the more consumers trusted foreign producers, the more likely they were to buy imported milk powder; the more they trusted the Chinese government and domestic producers, the less likely they were to buy imported milk powder.

Hypothesis 2: memory and cognitive level would change consumers' trust in relevant objects. We expected that the better the consumer memory, the lower the trust level in domestic products; the higher the cognition consumers had about melamine, the more they bought imported milk powder.

4.2. Survey introduction



Figure 2. Map of China.

To test the long-term impact mechanism of the Sanlu incident on consumer decision-making, this study conducted a survey in Beijing, Nanjing, Yangzhou, and Tangshan (**Figure 2**) in November and December 2018. The sampling cities were representative for geographic, economic, and political characteristics referring to different relationships with the central government (**Table 3**). The sample included a national capital, a provincial capital, and two local cities. The survey was designed to cover most key factors that might affect long-term consumption after the incident, such as trust factors, diet, consumption habits, and others. The specifications are as follows.

Table 3. Characteristics of sample cities.

Sample Cities	Geographic	Economic	Politic
Beijing	North	First-tier	Country capital
Tangshan	North	Third-tier	Adjacent to the country's capital
Nanjing	South	Second-tier	Province capital

(1) Geographical representativeness. Geographical differences, such as climate and water resources, affected agricultural production and living habits, including cultural and political customs that may alter consumers' social networks and consumption behaviors. China has a vast territory with great differences in climate and geographical conditions between the north and south. Therefore, two southern cities and two northern cities were selected for the sample. Among them are Beijing and Tangshan, located in the north of China, and Nanjing and Yangzhou, located in the south.

(2) Political representativeness. Beijing is the capital of China as well as the political and cultural center of China, so it was strongly influenced by the central government. Nanjing is the capital city of Jiangsu province, where the provincial government is located. It was easier to accept information from both levels of government. In this regard, it is equivalent to Beijing in terms of its political impacts. Tangshan and Yangzhou are two cities in Hebei province and Jiangsu province, respectively. Tangshan is close to the capital, while Yangzhou is adjacent to Nanjing.

(3) Economic representativeness. In China, Beijing is a first-tier city³, and Nanjing is a second-tier cities⁴, representing the more economically developed regions of north and south cities. Tangshan and Yangzhou are two third-tier cities⁵ that are geographically adjacent to Beijing and Nanjing. Although first-tier, second-tier, and third-tier cities do not have geographical differences, economic differences exist, such as in GDP and population factors. Families with a higher monthly income have more knowledge about safe food and a higher likelihood of purchasing it [35]. A total of 500 questionnaires (**Figure 3**) were distributed (Nanjing 150; Beijing 150; Yangzhou 100; and Tangshan 100). Among them, 303 were valid questionnaires, and the effective rate was 60.6% (**Figure 4**). Among the survey samples (**Figure 5**), 115 were from Nanjing, 70 were from Beijing, 69 were from Yangzhou, and 49 were from Tangshan.



Figure 3. Distribution of 500 questionnaires.

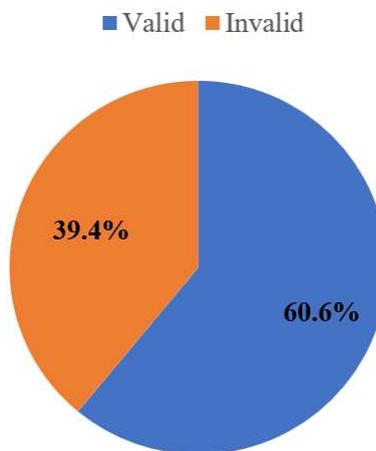


Figure 4. The proportion of valid questionnaires.



Figure 5. Distribution of 303 valid questionnaires.

4.3. Data and variable descriptions

At first, in order to test whether hypothesis 1 holds, this paper measured whether or not consumers bought, and we defined the variable decision. For each consumer, the variable Decision was a dummy variable that took the value of 1 if consumers bought imported milk and 0 otherwise. Then, the variable quantity was defined, which measured the amount of imported milk powder purchased. This amount can reflect consumers' level of trust in different trust objects in the long term after the Sanlu

incident and takes a value larger than or equal to 0. If a consumer chose to buy domestic milk powder, the value of the variable quantity was 0.

For explanatory variables, trust was adopted as a core variable. Many studies integrated trust into economic models [36]. Regarding trust, individuals make decisions by strongly considering trust factors [37]. To measure the variable trust, eight trust objects were selected. They were key players in the China dairy chain and the Sanlu incident. If consumers placed trust/distrust in trust objects, their behavior would be positively/negatively influenced by them [38]. There were eight questions with trust or distrust (trust = 1, distrust = 0) to define the variable Trust⁶. The value of the variable trust was either 0 or 1.

To test hypothesis 2, this paper tested variables memory and cognition that influenced consumption behavior in the long term. Consumer choices depend on their memory capacity [39]. The decision to repeat a behavior was based on the memory of a similar prior experience [40]. The long-term effects of the Sanlu incident were related to consumers' memories. If a consumer had a better memory, he or she would remember the incident longer, thereby negatively influencing his or her domestic milk powder consumption behavior. Moreover, consumers' cognition was a direct influencing factor for consumer behavior [41]. According to the theory of planned behavior, cognition of events is one of the important reasons that affect consumers' purchasing decisions [42]. For example, green consumption cognition significantly promoted consumers' consumption. Cognition indicated the consumer value of melamine harm and implied how people perceived the risk of food unsafety [43]. If a consumer showed a high level of cognition about melamine and the Sanlu incident, he or she would consider the negative effects of them when making relevant purchase decisions. As a result, variable memory and variable cognition were included in the models.

The number of details recalled by survey participants was used to define the variable memory. The more details a participant recalled, the better memory he or she had. A test⁷ was taken to measure how many details a consumer can remember. A total of 5 points were used, with a higher score representing that the consumer had better memory [44]. The value of the variable memory was between 0 and 5.

The variable cognition was defined by the survey responses to the melamine and Sanlu milk powder incidents. According to the research on the cognition evaluation of Zhou, six questions were included in the survey⁸. Each question gave five options of four similar statements of the incident facts and "unknown". Subjects were asked to choose the only true statement. If the answer was correct, the subject's cognitive value was increased by one. The value of the variable cognition was between 0 and 6.

Other variables affecting consumption behavior were included. Duralia et al. reported that consumers' behavior related to food consumption was a function of four main factors: personal, economic, socio-cultural, and marketing [45]. Thus, geographic, consumer, family, and child characteristics were selected as control variables to measure personal and economic characteristics. Variable Beijing, Nanjing, and Tangshan were selected as control variables to limit the various economic effects caused by geography, and variable Yangzhou was selected as a base group to prevent collinearity. Consumer characteristics, such as gender, age, and education, were selected because they significantly affected purchasing decisions.

Table 4 showed that domestic consumers preferred imported milk powder over domestic milk powder. In the sample, the proportion of decisions to purchase imported milk powder was close to 77.7%. The mean of the variable (3.086) was more than half the full mark (5 points), implying that consumers may clearly remember the Sanlu incident. The mean value of the variable cognition was equal to 1.132, representing that consumers in the sample had limited knowledge about melamine facts and Sanlu milk powder incidents. The mean value of the variable quantity was 8.440, implying that each family consumes 8.440 cans of imported milk powder in three months⁹. The mean of the variable Child (0.293) indicated that the proportion of infants and adults in the sample family was about 1/5.

Table 4. Variables and definitions.

Variables	Definition	Mean	Std. Dev.
Decision	Purchase decision in three months (1 = imported 0 = domestic)	0.777	0.417
Quantity	Total purchase quantity in three months (900g/can)	8.440	9.536
Trust objects			
Trust central government	I trust the central government. (trust = 1 distrust = 0)	0.640	0.481
Trust local government	I trust the local government. (trust = 1 distrust = 0)	0.317	0.466
Trust authorities	I trust experts and research institutes. (trust = 1 distrust = 0)	0.356	0.479
Trust media	I trust magazines and newspapers. (trust = 1 distrust = 0)	0.221	0.415
Trust foreign producers	I trust milk powder producers. (trust = 1 distrust = 0)	0.118	0.324
Trust sales people	I trust milk powder sales staff. (trust = 1 distrust = 0)	0.102	0.303
Trust relatives	I trust relatives. (trust = 1 distrust = 0)	0.244	0.430
Trust friends	I trust friends. (trust = 1 distrust = 0)	0.234	0.424
Memory	The higher the better (0–5)	3.086	1.061
Cognition	Cognitive level of melamine and Sanlu incident (the higher the better; 0–6)	1.132	1.272
Gender	1 = male 0 = female	0.228	0.420
Age	Age of purchaser (years)	31.323	5.439
Education	Education years (years)	17.346	3.558
Family member	Total household population (heads)	4.231	1.141
Family income	Ten thousand yuan/per year	24.736	22.093
Senior members	Proportion of elder	0.159	0.211
Child	Proportion of children	0.293	0.099
Child age	Age of child who drinks baby formula (years)	1.811	1.375
Child gender	1 = male 0 = female	0.577	0.495
BMI	Health condition of the child (18.5–23.9 means healthy)	19.599	7.096

Initially, an overall view of consumer trust was provided, and the incidental effects on trust were attempted to be identified. Survey results showed (**Figure 6**) that most consumers trusted the central government (0.640), but trust in the local government was weaker (0.317), followed by trust in authorities (give positive information about domestic milk powder). Consumers trusted them (0.356) more than they trusted the media (0.221), which covered the Sanlu incident. Similarly, consumers' trust in relatives (0.244) and friends (0.234) who provided information from their

experiences was low. Closer directly related to the milk powder sector, the lower the trust (e.g., milk power producers and milk powder sales staff). According to **Figure 6**, consumers had the lowest trust in stakeholders closely relevant to milk powder, including milk powder producers (0.118) and milk powder sales staff (0.102).

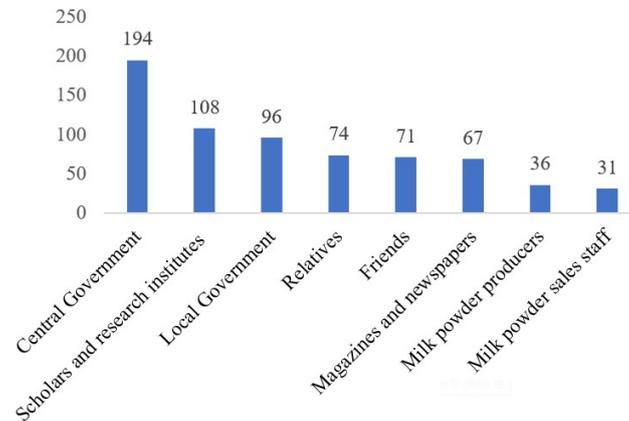


Figure 6. Numbers of trust in 303 subjects.

4.4. Econometric specification

The empirical investigation had two critical measures for consumption behaviors. To test the two hypotheses mentioned above, this paper built Probit and Tobit models, respectively, to analyze consumers' purchasing behaviors and the influencing mechanisms.

First, we established a Probit model to analyze consumers' decisions to purchase imported milk powder. Because the dependent variable Decision was in the form of "binary discrete", the nonlinear Probit model was selected for estimation. Then we used the Probit model to explore how consumers' purchasing decisions were affected by trust factors. The model can be written as follows:

$$Decision = \beta_1 + \beta_2 * Trust + \beta_3 * Z + \mu \quad (1)$$

$$Decision = \begin{cases} 1, & \text{imported} \\ 0, & \text{domestic} \end{cases}$$

where variable the decision denoted whether the consumers bought imported milk powder or not. The trust variable represented consumers' trust in trust objects. The matrix Z contained the following set of control variables: (1) memory of the Sanlu incident; (2) consumers' cognition of melamine facts and the Sanlu incident; (3) city dummies; (4) personal characteristics of milk powder consumers; (5) family characteristics of milk powder consumers; (6) characteristics of children who consumed milk powder. The variable μ was the error term that covers all unobserved variables and random noise.

Next, we established a Tobit model to analyze consumers' actual purchase quantity. The actual consumption of imported milk powder was measured. Because 23% of consumers (68 people) purchased domestic milk powder, the value of the variable quantity (consumption of imported milk powder) took the value of 0 for 68 times. Given the property of the Tobit model, which included observations with a positive probability of 0, adopting the Tobit model in this analysis was appropriate.

The independent variables in model (2) were the same as those in model (1), and model (2) can be written as:

$$Quantity = \beta_1 + \beta_2 * Trust + \beta_3 * Z + \mu \quad (2)$$

Consumers' heterogeneity may also affect their preferences for trust objects and consumption behavior [46]. The cities where consumers live and their family income may directly influence their consumption behaviors. These effects were captured by running a sub-sample regression by dividing family income. The Tobit model was adopted to analyze the impact of the purchase quantity of imported milk powder under different classifications.

An interaction analysis was run to explore the mechanism of trust effects on consumers' purchasing decisions long-term after the Sanlu incident. Trust may affect consumers' behaviors through factors such as memory and cognition in the long term. The variable memory reflected consumers' ability to remember something, which implied whether consumers still remembered the Sanlu incident. People with better memory were more impressed by the Sanlu incident, and their consumption decisions were more affected by the incident. The variable cognition could be written as (3) and (4). means consumers' knowledge of melamine and the Sanlu incident. A higher value indicated consumers were likely to know the damage of melamine and the negative effects of the Sanlu incident, hesitating to purchase domestic milk powder. For example, if consumers knew that melamine may cause infant death, consumers would be more afraid to buy domestic milk powder. The model could be written as (3) and (4).

$$Quantity = \beta_1 + \beta_2 * Trust + \beta_3 * Trust * Memory + \beta_4 * Z + \mu \quad (3)$$

$$Quantity = \beta_1 + \beta_2 * Trust + \beta_3 * Trust * Cognition + \beta_4 * Z + \mu \quad (4)$$

5. Results and discussion

5.1. Preliminary regression

First, Equation (1) was used to determine whether a consumer bought imported milk powder. Then, Equation (2) was used to explore the quantity purchased and the factors that affect the behavior. **Table 5** provided the results.

Table 5. Probit and Tobit regression.

Variables	Decision	Quantity
Trust objects		
Trust central government	0.270	-2.405*
Trust local government	-0.248	1.089
Trust authorities	-0.394**	-3.491***
Trust media	-0.158	-1.653
Trust foreign producers	0.602*	5.473***
Trust salespeople	0.0533	-1.600
Trust relatives	-0.406	-1.749
Trust friends	0.176	-2.241
Memory	-0.0511	1.102*

Table 5. (Continued).

Variables	Decision	Quantity
Cognition	0.0508	-0.167
Gender	-0.330	0.381
Age	0.00168	-0.0351
Education	0.0333	-0.210
Family member	0.0363	-0.129
Family income	-0.00102	0.00449
Senior members	-1.174**	-5.817
Child	-1.775	-21.03***
Child age	0.0708	-0.280
Child gender	0.155	3.134**
BMI	-0.0186	-0.0818
Geographic		
Beijing	-0.794*	-2.319
Nanjing	0.0989	1.659
Tangshan	-1.920***	-11.30***
Constant	1.776	20.89***
Observations	303	303

SoNoNotes: Asterisk (*), a double asterisk (**), and a triple asterisk (***) denote the 10%, 5%, and 1% significance levels, respectively.

The results showed that trust had long-term effects on consumer behavior. However, the effects differed for different trust objects. The variable trust of the central government showed that such trust had a significant negative impact (-2.405) on the volume of imported milk powder consumed. One reason may be that, of all the trust factors, Chinese consumers had the highest willingness to pay for government-certified products [47]. Alternatively, not long after the Sanlu incident, the central government implemented the Chinese Food Safety Law, which improved the supervision and management of food products. This action helped to regain consumers' confidence in the food production industry [48]. Until now, because these actions were still being executed, some Chinese consumers had switched back to purchasing domestic milk powder gradually.

The variable trust authorities showed that such trust can significantly decrease the possibility (-0.394) of purchasing imported milk powder and the quantity (-3.491) purchased. One reason may be that most Chinese consumers consider specialized institutions to be the second-most trustworthy source of information. Chinese consumers had positive attitudes toward food that can be demonstrated to be authentic and expressed strong intentions to purchase such food [49]. In recent years, domestic milk powder safety information released by research and testing institutions has significantly reduced consumers' distrust of domestic milk powder.

The variable Trust among foreign milk powder producers showed that such trust increased consumer demand for imported milk powder. Specifically, through such trust, the possibility of purchasing imported milk powder rose by 60.2%, and the demand for the number of imported cans increased by 5.473 cans.

Why do consumers trust foreign dairy companies more? On one hand, the risk of domestic milk powder made Chinese consumers look for imported products as alternatives. Even the domestic milk powder brands “helped” emphasizing the good quality image of foreign milk powder. In many domestic milk powder commercials, they mentioned that the milk source of their milk powder was from overseas, such as New Zealand or the Netherlands. On the other hand, the rising price of domestic milk powder in recent years may also be a reason. After the Sanlu milk powder incident, the domestic dairy industry chain raised production standards. The high cost of feed, labor, and food safety testing has pushed up the price of domestic milk [50]. According to the China Business Information Network, the China Dairy Industry Quality Report showed that the price of domestic brand infant formula milk powder had increased by 17.4% over the past five years, and the price of domestic infant milk powder still maintained the rising trend in 2021 [51]. Therefore, consumers chose to buy more imported milk powder.

We also found that the results of the control variables were consistent with our expectations. The coefficient of the variable senior members (-1.174) showed that senior people were less likely to buy imported milk powder due to stronger ethnocentric factors among the general wise [52]. The variable child gender showed that families with male babies bought more imported milk powder than families with female babies. It was consistent with the traditional Chinese thought of son preference¹⁰ [53]. At the same time, the closer the region was to the capital, the less likely it was for consumers living in the area to buy foreign milk powder. This also confirmed the view that the Chinese people trust the central government more than the local government.

The coefficient of variable Child (-21.03) showed that the more children the families have, the less imported milk powder they bought. This may be because families with more children may have tighter budgets to rely on milk powder (whether foreign or domestic) in the first place. Moreover, low-income families tend to have more children because they believe that having more children will be more rewarding [54].

5.2. Sub-samples regressions

The effects of heterogeneity on consumer behavior through trust were studied (see **Table 6**) by dividing the samples. In each sub-sample, samples were divided into low-income, middle-income, and high-income families according to the data on family income. Among them, the average income of the low-income group was 100,000 yuan, the middle-income group was 210,000 yuan, and the high-income group was 570,000 yuan, respectively.

Income had significant effects on consumer behavior via trust. Both low-income and high-income families trusted foreign milk powder producers increased their imported milk powder consumption. Low-income families trusted by foreign milk powder producers have increased (8.126) their purchases of imported milk powder. The possible reason was that consumers in the low-income group were more sensitive to safety risks than those in the high-income group [55]. The Sanlu incident has caused them to lose trust in domestic milk powder producers. For high-income families, the

possible reasons were twofold. One reason might be their better cognition of the incident because income level is often positively associated with education level. Another reason might be that high-income families access to foreign products produces mild power when they travel abroad.

Table 6. Family income tests of parameters in Tobit regression.

Variables	Low	Middle	High
Trust objects			
Trust central government	0.981	−4.050**	−3.375
Trust local government	−0.171	1.028	−2.971
Trust authorities	−4.396	−2.251	−3.922*
Trust media	−2.552	−1.216	−0.397
Trust foreign producers	8.126**	1.173	7.888**
Trust salespeople	2.301	−1.762	−3.808
Trust relatives	−3.842	0.196	−1.259
Trust friends	−1.717	−5.729*	0.163
Memory	1.931	−0.636	2.176**
Cognition	−0.162	−0.715	0.340
Gender	9.898***	−3.932*	−0.671
Age	−0.118	0.172	−0.453*
Education	−0.0857	−1.454	2.059
Family member	1.708	−0.862	−3.358**
Family income	−0.669**	0.489	0.00133
Senior members	−1.881	−7.683*	−1.480
Child	−25.38*	−17.15*	−26.61
Child age	0.0464	0.0868	−1.010
Child gender	3.149	2.682	1.506
BMI	−0.266	0.0160	0.0427
geographic			
Beijing	−12.70	0.592	−10.27**
Nanjing	6.232*	1.189	−6.123**
Tangshan	−14.01***	−7.782**	−52.48
Constant	17.11	14.67	38.54***
Observations	116	93	94

Notes: Asterisk (*), a double asterisk (**), and a triple asterisk (***) denote the 10%, 5%, and 1% significance levels, respectively.

Middle-income families' trust in the central government caused them to reduce (−4.050) their purchased quantities of imported milk powder. Trust in friends made them consume less (−5.729) imported milk powder. Most Chinese families fell into the middle-income group. The friends and relatives of middle-income families also tended to be middle-income. Similar backgrounds led to similar ways of thinking and consumption patterns. Friends who may have tried domestic milk powder that provided authenticity and safety assurances had higher confidence in the reliability of

authenticity cues. And because of their trust in the government, they would choose domestic milk powder.

5.3. Interactive analysis

In addition, an interactive analysis of trust was done to test the mechanism of the long-term impact of trust on consumption decisions. We introduced the variables memory and cognition as interaction terms with different trust actors. **Table 7** provides the results of the interactive analysis. If no additional interaction items were considered in the regression, trust in the central government and authorities would lead consumers to purchase less foreign milk powder. Believing in imported producers made consumers buy more imported milk powder.

Table 7. Interactive analysis.

Variables	Quantity	Quantity	Quantity
Trust objects			
Trust central government	-2.405*	-0.00821	-3.747**
Trust local government	1.089	1.389	0.963
Trust authorities	-3.491***	1.893	-0.642
Trust media	-1.653	-1.515	-2.016
Trust foreign producers	5.473***	-3.294	3.689
Trust salespeople	-1.600	-1.981	-1.362
Trust relatives	-1.749	-1.566	-1.748
Trust friends	-2.241	-2.663	-2.400
Memory	1.102*	1.845	1.033*
Cognition	-0.167	-0.211	-0.366
Control variables	YES	YES	YES
Trust central government*Memory		-0.884	
Trust authorities *Memory		-1.769	
Trust foreign producers*Memory		2.893*	
Trust central government*Cognition			1.175
Trust authorities* Cognition			-2.364**
Trust foreign producers* Cognition.			1.548
Constant	20.89***	18.65**	20.15***
Observations	303	303	303

Notes: Asterisk (*), a double asterisk (**), and a triple asterisk (***) denote the 10%, 5%, and 1% significance levels, respectively.

Trust influences consumer behavior in the long term through memory and cognition. A consumer with better memory tended to purchase imported milk powder (the coefficient of variable memory is positive). When consumers trust foreign milk powder producers, the impact of their long-term memory increases (2.893) purchases of imported milk powder. Because their better long-term memory allowed them to retain a clear memory of the negative influence of the event, Better memory can

strengthen consumers' trust in foreign producers, leading to more purchases of foreign milk powder for about three cans.

Trust can change consumer behavior by mitigating the negative effects of cognition. The coefficient of variable Trust authorities * Cognition (-2.364) implied that when consumers trust in authorities (who support domestic milk powder), the negative impact on domestic milk powder consumption from the melamine and the Sanlu incident can be offset by 2.364 cans.

6. Conclusion

In this paper, survey data from 303 valid questionnaires from Beijing, Nanjing, Tangshan, and Yangzhou were used to analyze the long-term impact of food safety affairs on trust and consumption behavior. The Probit and Tobit regression models were applied, and the following key findings were revealed from the econometric analysis:

1) With years of endeavor after the Sanlu incident, the central government has regained the trust of most Chinese consumers, followed by authorities and local governments. Trusts in the above objects had significantly influenced Chinese consumers' milk powder purchasing choices in the long term. 2) Among the descriptive characteristics of consumers, income level played an important role in influencing purchasing behaviors. Families with different income levels varied in purchasing behavior changes in the long run compared to the short-term immediate reaction. 3) Memory and cognition are important factors that can interact with trust to influence consumer behavior in the long term.

Based on the above findings, discussion and policy suggestions were made to cope with the long-term impact of food safety incidents, not only specific to the Sanlu incident but also to general cases.

Thanks to the high trust consumers place in government objects and authorities, the central government should continue to reform dairy product management and improve associated laws, regulations, and technical standards. The local government should continue to increase support to rebuild the industry by combining their better knowledge of the local economy and market. Governments in rich areas should highlight information from the central government. In contrast, those in poor areas were allowed to supervise certifications more strictly because they were more sensitive to risk. They can also promote domestic milk powder through the media, as consumers in small cities trust the media more, according to the survey.

Authorities should also play a guiding role in food safety incidents. It has been confirmed that trust in them had a positive influence on domestic milk powder purchases. Research institutions and experts should conduct and publish food safety inspection reports and relevant information on domestic milk powder regularly. Authorities should make more efforts in outreach and dissemination to improve awareness of domestic-produced milk powder after the incident.

Different strategies should be adopted to target consumers with different income levels. Both accurate information dissemination and products with reasonable prices are key factors. Improving the domestic milk supply chain to reduce unnecessary costs and lower milk powder prices is critical. Domestic milk powder producers had

completely lost the market after the Sanlu incident. Although quality has improved after years of efforts (up to international standards), regaining market share has been more difficult. Therefore, in the past years, Chinese domestic milk powder producers have spent most of their money on commercials, hiring celebrities as image ambassadors, competing to monopolize local supplies, and so on. These costly expenses have been transferred to consumers by increasing the price of the price of milk powder. Meanwhile, to cater to consumers' impression that "higher price equals better quality", Chinese domestic milk producers had classified their products into too many grades. There are premium, super-premium, gold, and diamond categories of milk powder products. However, the quality of those products does not differ much. Most costs were spent on marketing and commercials to promote and establish the premium status of products. Consumption of domestic-produced milk powder has started to relate directly to income and social status.

However, milk powder sectors in other countries spent the most money on research, development, and quality improvement. The price of milk powder has been regulated by the government as a necessity to be accessible to all families and all kids. Regaining market share and regaining consumers' trust are important; however, a structural change in the Chinese domestic milk powder sector is urgently needed.

Through trust and cognition, strategies should be developed targeting different income groups. Universities, research institutes, and other relevant authorities have been another reliable source for milk powder information for most Chinese families. Solid scientific evidence could affect consumers' cognition and lead to a potential switch from imported milk powders to domestic ones. Trusting in those objects that support domestic milk powder offsets the negative influence of high cognition of melamine harm, reducing foreign milk powder purchases.

However, the above impacts were still limited. For consumers, not much trust was placed in domestic milk powder producers directly. When consumers trust foreign producers, they remember the incident more clearly. This negative impression from the incident memory would increase their foreign milk powder purchase. Therefore, it would take more efforts to influence the purchase decisions of people who have a good memory.

At last, learning from the cause of the Sanlu incident, controls over product safety and quality should also be strengthened, including establishing quality management systems, promoting the use of organic pasture [56], and constructing traceability systems [57]. These control systems should comprise the entire food supply chain, from production to marketing, and focus on building trust and communicating credibility.

Food safety incidents are happening and may still continue. It is crucial to first prevent them from the very beginning. In addition to taking immediate actions to compensate for the loss and minimize the costs, collective efforts are essential to cope with the long-term impacts. The impact of the Sanlu incident has been lasting for more than ten years, while witnessing the extreme hardship to regain trust and the market. Findings in this paper could shed light not only on the Chinese milk powder sector but also ring a bell for the entire agriculture-food industry.

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Notes

1. Central government, local government, authorities, media, foreign producers, sales people, relatives, and friends.
2. Melamine is an industrial chemical used for producing plastic.
3. Metropolises that are in important position in the country's political, economic and other social activities and have leading roles and the abilities to drive radiation.
4. A provincial capital city with active development, an economically strong city in the eastern region or a regional central city in an economically developed region.
5. Small and medium-sized cities that have strategic significance or are relatively developed or have a relatively large economic aggregate.
6. (1) I trust the central government. (2) I trust the local government. (3) I trust experts and research institutes (who promote domestic milk powder). (4) I trust magazines and newspapers (that previously reported the Sanlu incident). (5) I trust foreign milk powder producers. (6) I trust milk powder sales staff. (7) I trust relatives (who have used domestic milk powder after the Sanlu incident). (8) I trust friends (who have used domestic milk powder after the Sanlu incident).
7. The test is a mobile phone game. Participates were firstly given in-order numbers and they should not forget the order of numbers. Then they should reorder the disrupted numbers depending on the former order. The more a participate matched the same order, the higher the score he got.
8. What substances can be improved when adding melamine? What is the damage melamine caused to infants? Whether there is evidence that melamine can lead to cancer? Where does the Sanlu milk powder scandal happen? Which kind of victims have been compensated for the Sanlu milk powder scandal? Which kind of punishment does the mastermind of the Sanlu milk powder scandal receive?
9. Each can of milk powder is about 900 g, which can be used for a newborn for about 20 days.
10. Son preference is a social prejudice that values men and despises women.

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