Do Consumers Trust the National Inspection Exemption Brands?

Evidence from Infant Formula in China

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Abstract

Consumers are often uncertain about product quality and have to rely on different information, either given or pursued, to assess quality. Developing countries may lack institutional and technical resources to rigorously monitor and enforce product quality standards and/or to implement market-based instruments where market failures are common. The information-based instruments on product quality may work well in these countries as they reduce information asymmetry between firms and consumers. This study investigates one particular information-based instrument, the National Inspection Exemption (NIE) system in China.

China launched the National Inspection Exemption (NIE) System in various industries in 2000 to award firms who are in compliance with the quality standards, to inform consumers of product quality, and to lessen the pressure on regulatory monitoring and enforcement of product quality standards. Once a firm is granted the NIE title by China's National Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), its products are exempted from quality inspections by all governmental agencies at different levels for three years; but it is obligated to report the product quality condition to the local AQSIQ office annually. The NIE titled firms are also allowed to include the title in the product label and to use the status in the advertisement campaign.

Based on the theoretical framework, we establish the hypothesis that consumers are more willing to buy the product with the NIE title and the NIE title is likely to increase sales revenue when consumers lack of means to assess quality. The empirical application of China dairy industry supports the theoretical hypothesis. In particular, using the firm-level panel data, we find that the NIE title boots sales revenue and the impact is both statistically and economically significant based on the difference-in-difference estimate and the random-fixed effect estimations. Furthermore, using the survey data collected right after the 2008 China milk scandal regarding the brand choice of infant formula among 1,228 mothers with infants and young children, we find that consumers' preference for the NIE title still present even the NIE titled firms are involved in a food scare event. The positive NIE preference is particularly strong among highly educated consumers and those who buy domestic brands.

Key words: brand choice, food safety, product quality, national inspection exemption, product quality standards

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1. Introduction

Consumers are often uncertain about product quality before purchase, especially of experience goods [Tirole, 1989]. They rely on different information, either given or pursued, to assess product quality, including (a) advertising [Nelson, 1974, Noll, 2004] and strong brands [Chu and Chu, 1994, Aaker, 1994, Jin et al., 2008, Erdem et al., 2008]; (b) warranties promising to fix or replace a product if it fails to fulfill its performance claims within a given period [Courville and Hausman, 1979, Menezes and Currim, 1992, Noll, 2004]; (c) product demonstrations, such as test drives and free sample for consumables, allowing buyers to test products directly without any obligation [Smith and Swinyard, 1983, Heiman et al., 2001]; and (d) return policies such as replacements, store credits, and money-back guarantees, which allow consumers to try products with a return option [Chenokova, 2007]. These market strategies are ubiquitous in developed countries like the U.S., but some of them are not necessarily offered in developing countries. On the other hand, developing countries like China lack institutional and technical resources to rigorously monitor and enforce product quality standards as the majority of the industry sectors are highly fragmented due to emergence of many small, local companies. The same weaknesses limit regulator's ability to employ market-based instruments in countries where market failures are common and legal and institutional supports for formal market activities are weak. Information-based instrument can be effective in developing countries where strong regulatory institutions and/or well-development markets are absent. The information-based instruments on product quality reduce information

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We investigate the NIE title from perspectives of firms and consumers by answering the following two research questions: (a) Does and by how much the NIE title boost sales revenues? and (b) Do consumers trust the NIE brands when the NIE titled firms are involved in a food scare event? We choose the dairy industry for the empirical application mainly due to the rapid growth of dairy consumption and fierce market competition as well as a significant food scare event occurred in 2008 in China's dairy industry. The 2008 China milk scandal involved milk and infant formula adulterated with melamine. The scandal caused significant health and economic consequences. By December 2008, the Chinese Ministry of Health reported that the toll of ill children was at least 22 million, more than 50,000 babies had been hospitalized, and six infants had died from kidney diseases. The World Health Organization referred to this event as one of the largest [food safety events] in recent year [WHO, 2008]. About 30 countries and regions banned, suspended or withdrew imports of milk and milk products from China, including Malaysia, Singapore, Tanzania, Indonesia, South Korea, Vietnam, Chile, India, and the European Union. Among 22 dairy firms whose products were found to be contaminated with melamine, eight hold an effective NIE title. Such food scare event provides an opportunity to examine whether the perception of the NIE title changes among consumers. Our main finding is that the NIE title boosts sales revenue and consumers have favorable perception of the NIE brands even when the NIE titled firms are involved in the food scare event?.

The rest of this paper unfolds as follows. Section 2 provides a brief review of the NIE system in China. Based on the theoretical model presented in Section 3, we analyze the impact of the NIT title on sales revenue and on consumers' brand choice in Section 4. The final section concludes.

2. Background of the NIE system

Many industry sectors in China, especially food, textile and building materials, are highly fragmented largely built upon a significant number of small, local firms that are usually private and family owned. Although in China there are a plenty of product quality regulations and some regulations are as strict as that in the western countries (e.g., the melamine standard is 1ppm for baby formula in China and the U.S.), the enforcement of these regulations is very weak. It is especially difficult to monitor and enforce small and family firms to comply with quality regulations/standards. It happens often that a small firm who is out of compliance is closed down by regulatory agencies and reopened shortly after. As a result, there are many products in markets that are not up to the legal quality standards. For instance, in 2001 AQSIQ tested a wide range of food products and found that nearly 40% of foods made and sold in China were substandard, with the worst problems found in canned fruit, dried fish and fruit drinks.[1] Many of the food products had been contaminated by toxins or bacteria, or failed to carry the required labeling information. The situation is even worse in rural areas. For instance, 73.9% wheat powder was found being substandard in the rural areas of Hebei province. [2] Moreover, according to a survey conducted by the Ministry of Commerce in 2005, there were 43.7% rural consumers primarily emphasizing cheap price in purchasing food, but only 8% urban consumers take cheap price into account in food consumption, [3] which may lead to vast markets for the substandard in rural areas. As a consequence, the substandard may drive out the qualified and it further causes further market distortion [Akerlof, 1970]. Meanwhile, quality inspections had become serious entry barriers for potential entrants in the late 1990s. For instance, AQSIQ at the provincial and local city levels often conducted repeated quality examinations with respect to the products which intend to enter the local markets. This brought entrants higher costs and therefore deterred their entries.

Early on December 5, 1999, the State Council issued a decision stating that "products with stable, satisfactory quality can be rated as inspection-exemption products." On March 14, 2000, AQSIQ released the "Arrangement for Products Exempted from Quality Supervision and Inspection", in which one critical criterion to receive the NIE title is to have stable, satisfactory quality and having passed state or provincial-level inspections for three consecutive years. Following the Arrangement, China launched the NIE System in 2000 to award firms who are in compliance with the quality standards and to remove the entry barriers of repeated but not necessary product quality

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[1] http://www.gov.cn/zxft/ft2/content_522913.htm. Last access on April 29th, 2011.

[2] http://www.hebgs.gov.cn/yw/yp/ygs_bszn_content.asp?ArticleID=2386. Last access on April 29th, 2011.

[3] http://www.gov.cn/gzdt/2005-11/17/content_100882.htm. Last access on April 29th, 2011.

inspections. Once a firm is granted the NIE title, its products are exempted from quality inspections by all governmental agencies at different levels for three years, but it is obligated to report the quality of its products to AQSIQ and provincial quality enforcement agency annually. The NIE titled firms are also allowed to include the title in the product label and to use the status in the advertisement campaign. The NIT titled firms can apply for the title again once its term of three years expired.

Table 1 shows that the new NIE recipients had a significant increase from a total of 178 in 2001 to 1,302 in 2007. At the beginning of 2008 a total of 4,232 firms in 290 industry sectors held the NIE title. The NIE system is in fact a way through which the government provides inspection-exempted firms quality guarantees. According to the survey on 2,152 inspection-exempted firms conducted by AQSIQ in 2006, the market share of these firms increases 21% annually on average during the years 2002-2005, which implies that an NIE title can potentially increase demand [AQSIQ, 2007].

Table 1: Number of new recipients of the NIE title (2000-2007) [a]

Year	All industries	Dairy industry
2000	202	0
2001	187	17
2002	155	0
2003	395	20
2004	489	0
2005	1108	33
2006	1822	31
2007	1302	0

[a] Source: Data compiled based on the public announcement of firms receiving the NIE title issued by
     AQSIQ (China's National Administration of Quality Supervision, Inspection and Quarantine), which
     is available online at `http://www.chinatt315.org.cn/mjzc/mjzc.asp`. Last access on
     April 8th, 2011.

3. The Model

We extend the framework presented in Shapiro [1983] to model the impact of the NIE title on product price and consumer welfare. We assume an individual firm in a competitive market produces one unit of product with quality q in each period at a cost of $c(q)$. The cost function is convex with

respect to quality q, i.e., $c''(q) > 0$ and $c'(q) > 0$, $c'(0) = 0$; and it equals to zero at $q = 0$, i.e., $c(0) = 0$.

There is a rich literature investigating the impacts of imposing minimum quality standards and how to set the standards optimally [Leland, 1979, Shapiro, 1983, Ronmen, 1991, Crampes and Hollander, 1995, Valletti, 2000]. Leland [1979] points out that a minimum standard protects consumers from quacks, lemons and frauds. Shapiro [1983] argues that when consumers are heterogeneous in their preference for quality, the optimal minimum quality standard is binding. That is, there are some consumers who would consume a lower quality product were the standard lowered, while others prefer high quality exceeding the standard. Ronmen [1991] and Crampes and Hollander [1995] show that an intermediate minimum quality standard improves social welfare when firms compete for prices. However, Valletti [2000] proves an intermediate minimum quality standard unambiguously reduces total welfare when firms are quantity competitors. All these studies assume the minimum quality standard is perfectly enforced. Our scenario is very different from the ones in previous studies in that we allow for imperfect enforcement of legal standards and assume that products with quality lower than the legal standards exist in markets. The consumers may purchase those lower quality products due to budget constraints and uninformed quality information. In China, the vast markets for the substandard are in rural areas (see discussion in Section 2). Thus, we distinguish the minimum quality standard established by the government authority that is denoted by $\underline{q}$ and the minimum acceptable quality level among consumers denoted by q_0 such that $q_0 < \underline{q}$.

Product prices that is denoted by $p(R_t)$ solely depends on firms' quality reputation $R(t)$, but each firm faces perfectly elastic demand at any given period and, thus, it is a price taker. Furthermore, we assume that the expected penalties for producing substandard (namely, $q < \underline{q}$) is negligible either because of the slim chance of getting caught due to imperfect monitoring and enforcement of quality standards, or because of a low amount of penalty if caught. Firms are assumed to be risk-neutral and each firm chooses a sequence of quality levels over time to maximize the expected present value of profits.

The demand side is described by a set of heterogeneous consumers, who differ in their willingness to pay for the product. A continuum of consumers is indexed by s, where $s \in [0, S]$ and S is finite. Let $v(s, q) = s(q)$ be the value that consumer s places on quality q. We assume that a consumer derives utility only from the first unit he/she buys. The consumers' value function used is consistent with that in studies of quality differentiation [Shapiro, 1983, Ronmen, 1991]. The surplus of consumer s who purchases quality q and pays $p(q)$ is therefore $s(q) - p(q)$. They choose a quality q to maximize their surplus.

Timing and reputation formation are the critical features of the model. We consider the case of experience goods, namely consumers can only observe product quality after purchasing. The "unknown" products are though to have minimum acceptable qualities when the NIE system is absent. Therefore, regardless of the firms' choice on actual quality their reputation among uninformed consumers is q_0 in the first period. After the first period, reputation are updated according to the actual quality level revealed after consumption experience in the first period. Therefore, the reputation adjustment equation is simply

$$R_t = \begin{cases} q_0 & \text{if } t = 1, \\ q_{t-1} & \text{if } t \geq 2. \end{cases} \tag{1}$$

Under the national inspection exemption system (NIE), product quality is first inspected by the government and according to which the firms those who produce qualified products (namely, $q \geq \underline{q}$) are granted the NIE title. The NIE titled firms then obtain the reputation $\underline{q}$, but the non-NIE titled firms start with their reputation at q_0. Namely, the reputation dynamics in Equation (1) changes into

$$R_t = \begin{cases} = \begin{cases} \underline{q} & \text{for the NIE firms} \\ q_0 & \text{for non-NIE firms} \end{cases} & \text{for } t = 1 \\ = q_{t-1} & \text{for } t = 2 \end{cases} \tag{2}$$

Following Shapiro [1983] we then define the notation of equilibrium given the reputation dynamics in Equations (1) and (2). The equilibrium is a steady-state configuration in which firms maintain quality over time, and the price as a function of reputation schedule that is unchanging over time. The configuration in equilibrium rules out the situation in which firms enter and exit market. Since $q = R$ in equilibrium, the price schedule will be written as a function of quality $p(q)$. We formally define the following conditions for the equilibrium in the model:

(1) *No-deviation condition*: A firm with reputation q finds optimal to produce quality q rather than to deviate.

(2) *Market-clearing product quality*:Markets clear at all quality levels $q \geq q_0$.

(3) *Zero-profit condition*: No new entry is attractive as each firm earns a zero profit.

(4) *Consumer surplus maximization*: Each consumer takes the price-quality schedule $p(q)$ as given and chooses the level of product quality to maximize his/her surpluses.

The lower and upper bound of the equilibrium price are given by the no-deviation condition and the zero-profit condition above.

In the absent of the NIE system, the price of the minimum acceptable quality q_0 is $p(q_0) = c(q_0)$. However, the price of the quality greater than q_0 is composed of both costs and price premium. In the first period, the quality greater than q_0 are sold at the price of q_0 that is lower than its cost. The price premium in equilibrium just offset the "investment" in first period. Thus, the equilibrium price-quality schedule $p(q)$ is

$$p(q) = c(q) + (c(q) - c(q_0))\, r, \tag{3}$$

where r is the interest rate.

When the NIE system is effective, the equilibrium price-quality schedule $p(q)$ is

$$p(q) = \begin{cases} c(q) + (c(q) - c(q_0))\, r & \text{if } \underline{q} > q \geq q_0 \\ c(q) + (c(q) - c(\underline{q}))\, r & \text{if } q \geq \underline{q} \end{cases} \tag{4}$$

The NIE system makes firms who produce products with the legal quality level invest less in constructing their reputation and therefore require less price premium.

Figure 1 describes the price schedules with and without the NIE system. The horizontal axis represents the quality level and the vertical axis represents price and/or cost. The cost function $c(q)$ is given by the dot upward curve that goes through the origin. The upward curve above $c(q)$ is the price schedule without the NIE system, which is continuous and monotonically increasing. The dashed curve describes the price schedule with the NIE system that is discrete and not monotonically increasing. When $\underline{q} > q \geq q_0$, the price schedule with and without the NIE system coincide. When $q \geq \underline{q}$, the price schedule with the NIE system lies below that without the NIE system by the difference $(c(\underline{q}) - c(q_0))\, r$.
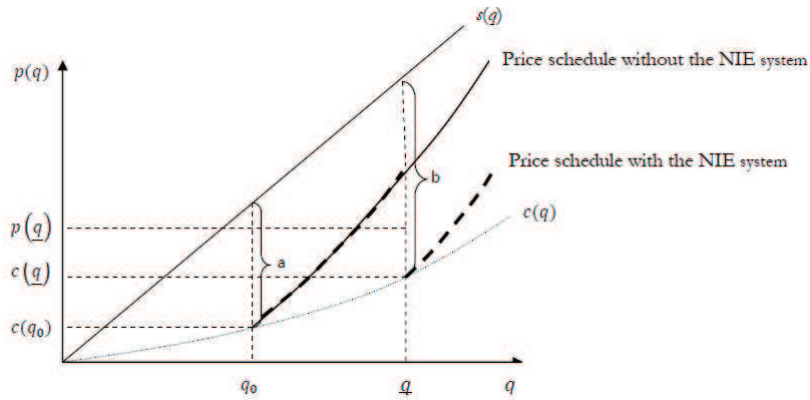

Figure 1: Price schedule with and without the NIE system

We now consider the demand side of the market. Given the quality preference s, the value function denoted by $s(q)$ is simply a ray through the origin with slope s in Figure 1. The surplus is

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then the vertical distance between the value function and the price schedule. Consumers' optimal quality is then given by the q where the value function stay above the price schedule with greatest vertical distance. For product without the NIE title, an individual consumer with quality preference s finds optimal to buy a product with quality q_0 and receives the greatest surplus of a in Figure 1. However, with the NIE title she/he finds optimal to choose q where he/she gets surplus b that is greater than a. Figure 1 suggests that the NIE decreases the demand for the substandard and increase consumers' welfare[4]. The theory thus predicts that consumers are more willing to buy the product with the NIE title and likely to increase sales revenue.

4. Empirical Application of China Dairy Industry

4.1 China Dairy Industry

We choose the dairy industry, especially infant formula, for the empirical application mainly due to the following three reasons. First, China has been experiencing a significant increase in dairy consumption in the last two decades. The Asian-Pacific countries historically exhibit low consumption of dairy products than the European and North American countries largely due to low lactose tolerance [Dong, 2005]. As shown in Table 2, the per capita consumption of all three main dairy products, liquid milk, yogurt and milk powder, increased among urban residents in China from 1997 to 2008. For example, liquid milk was more than tripled from 5.07 kilogram per person in 1997 to 17.75 in 2007 among urban households. The 2007 consumption level was approximately 20% of that in the U.S. and European countries (83.00 and 89.50 kilogram per capita, respectively), and only half as that in Japan (34.90 kilogram per capita). The consumption level is likely to be even lower among rural households. The significantly higher growth in the consumption of fresh milk relative to milk powder may due to more convenience to consume fresh milk and the perception of milk powder being inferior to fresh milk among Chinese consumers [Fuller et al., 2004]. In general, high consumption of dairy products is associated with a high income as documented in the literature [Bai et al., 2008, Zhou et al., 2002] as well as the data presented in Figure 2 among urban households in China. Accompanied with significant increases in dairy consumption, dairy price in China has been increasing (see Table 2).

Second, the China dairy markets are indeed highly concentrated. As shown in Figure 3 , the top three companies accounted for a significant market share – approximately 60.42% for liquid milk, 47.67% for yogurt, and 44.37% for milk powder. The top 10 companies in the each mar-

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[4]Since firms earn zero profits in equilibrium, consumers' welfare is then the total social welfare. Hence, the NIE increases the total welfare too.

Table 2: Consumption and prices of three main dairy products in China (1998-2008) [a]

Year	Level (kilogram per capita)			Price (Chinese Yuan per kilogram)		
	Liquid milk	Yogurt	Milk powder	Liquid milk	Yogurt	Milk Powder
1997	5.07	0.44	2.87			
1998	6.18	0.64	3.01			
1999	7.88	0.87	3.08			
2000	9.94	1.12	3.43		Not available	
2001	11.90	1.36	3.50			
2002	15.68	1.82	3.85			
2003	18.62	2.52	3.92			
2004	18.83	2.85	3.57	4.58	6.11	37.18
2005	17.92	3.23	3.64	4.41	6.32	43.73
2006	18.32	3.72	3.50	4.71	6.45	48.08
2007	17.75	3.97	3.15	5.19	6.34	55.60
2008	15.19	3.54	3.99	6.55	7.35	74.95

[a] Source: China Milk Yearbook (2006-2009) and China Dairy Statistical Report (2009).

ket accounted for more than 90% of the market. The milk powder market, where infant formula takes more than half of the market share, is highly concentrated as the top five companies account for approximately 2/3 of the market share and they are all international companies. Among the top ten companies, only two companies, Yili and Sanlu, were domestic companies and their market share were relatively small (4.40% and 2.25%). Fierce competition exists in Chinas dairy industry between domestic and foreign companies, between large and small-scale companies, as well as among companies in different regions. Small and medium sized domestic dairy companies compete with large companies by establishing and focusing their business mainly in the local and regional markets (Dairy Industry of China 2003, P27). Foreign investment and multinational dairy companies have either established or expanded their business in China. Synutra International Inc. (hereafter Synutra), which is mainly based in Hong Kong, Netherlands, the United States and China, operates subsidiaries under name Synutra and/or Shengyuan in China (Annual Report of Synutra, 2009). American Dairy Inc. (hereafter American Dairy) operates through its fully owned subsidiary called Feihe Dairy in Heilongjiang Province. Merger and acquisition are also used by foreign companies as an strategy to enter China dairy market. Nestle, a Switzerland-based multina-
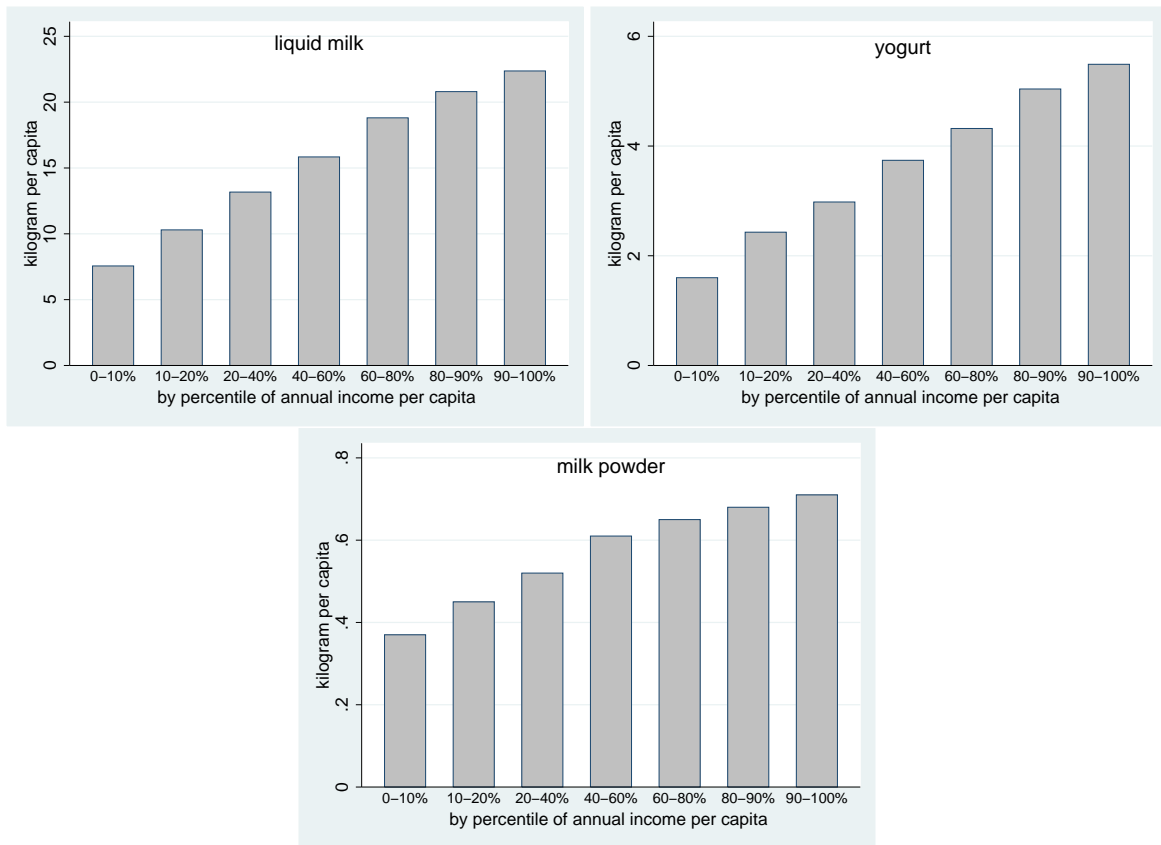
Figure 2: Per capita consumption among urban households by income groups

tional corporation and ranked 48 in the Fortune 500 in 2009, bought Yunnan Dengchuan Diequan as its rehearsal to enter China dairy market (Dairy Industry of China 2003, P28). The American Longdi International Company established Shenyang Huishan that was ranked the 9th in the China liquid milk market in 2006. Among various marketing strategies that dairy firms employ to improve their product reputation and competitiveness, one important strategy is to secure a NIE title. As shown in Table 1, a total of 101 dairy firms were awarded the NIE title from 2000 to 2007.

Third, the 2008 China milk scandal, involved milk and infant formula adulterated with melamine, generated a great deal of buzz in China and overseas. On September 11th, 2008, Sanlu issued a product recall and made a public corporation apology, which put the scandal in the central stage of the national and even global attention on food safety. Based on the AQSIQ product tests for milk powder on September 16th, products of 22 out of 109 companies were found to be contaminated with melamine, including Yili, Bright, Mengniu, and Synutra. On September 18th the AQSIQ conducted tests for liquid milk products of 411 companies. Except Mengniu, Yili and Bright, liquid milk produced by all the other 408 companies such as Sanyuan and Nestle were not found to be contaminated. The relative less contamination in liquid milk is largely attributed to the fact that it
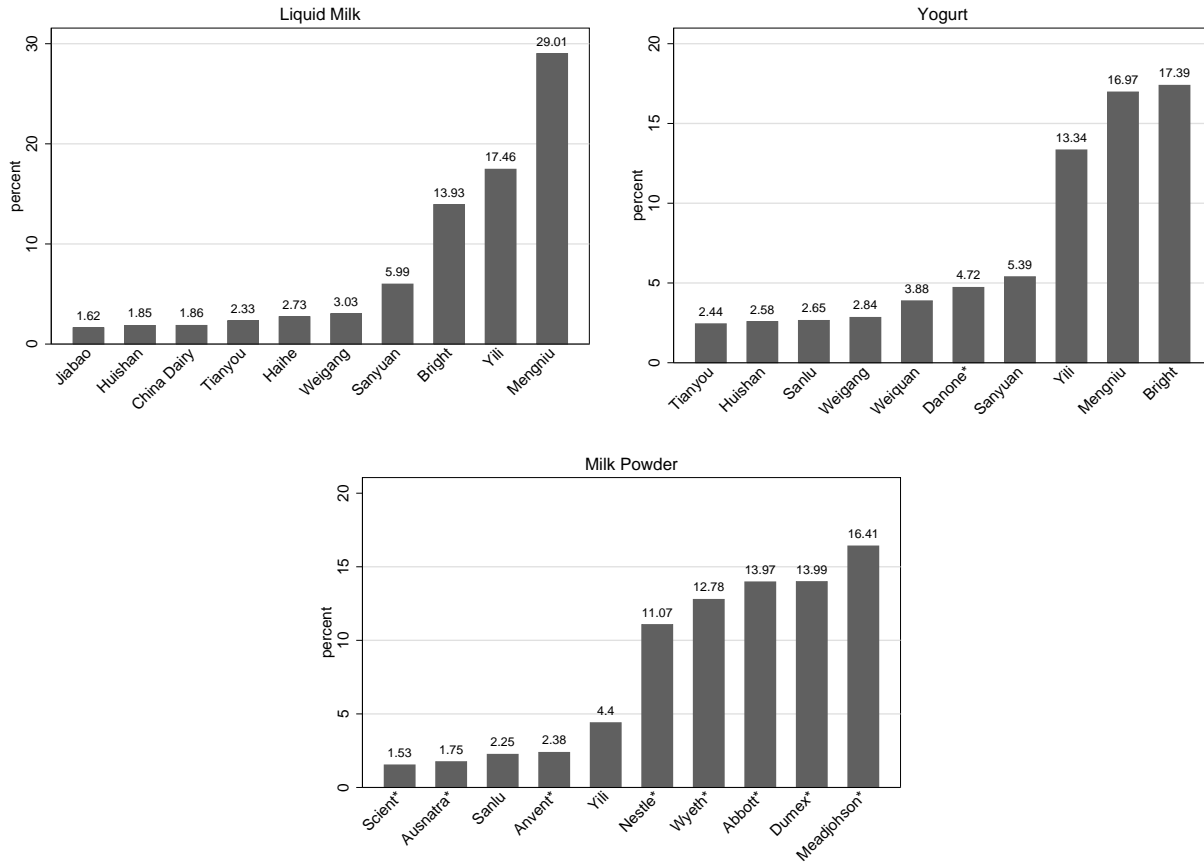
Figure 3: Market shares of top ten dairy companies of three main dairy products, 2006

is technically more difficult and economically more costly to add melamine to liquid milk than to milk powder. Among 22 infant formula producers were found to be contaminated with melamine, eight firms hold the NIE title during the course of the scandal.

4.2 Data

We use both firm-level data provided by National Bureau of Statistics of China (NBSC) and survey data collected after the 2008 milk scandal. The firm-level dataset includes all up-scale industrial firms in China, including all state-owned industrial firms and non-state owned industrial firms with annual sales revenue over 5 million Chinese Yuan (approximately US$770,000). Based on the NBSC's data, we generate an unbalanced panel data set of the dairy firms in 1998-2007. The industry data consists of 1189 domestic dairy companies whose main products are milk powder, liquid milk and/or yogurt. As shown in Table 3, until 2002 the dairy firms did not have the effective NIE title; and less than 8% out of a total of 5011 firm-year observations hold the NIE title (N=394).

Compared with their counterparts, the NIE titled firms are more likely among top ten brands and have less share of state-owned ownership but more share of collectively owned and foreign ownership. Companies with the NIE title also have significant higher sale revenue, advertising costs and R&D investment adjusted by total number of employees.

Table 3: Summary statistics of relevant firm-level information

Year	Non-NIE	NIE	Total	Year	Non-NIE	NIE	Total
1998	318	0	318	2003	508	21	529
1999	319	0	319	2004	581	37	618
2000	323	0	323	2005	572	63	635
2001	373	0	373	2006	528	120	648
2002	424	21	445	2007	523	129	652
Total number of firms-year observations (1998-2007)					4,617	394	5,011

Among the 5011 firm-year	Non-NIE		NIE		Total	
observations	mean	std.dev.	mean	std.dev.	mean	std.dev.
Main product = Milk powder (%)	43.12		56.35		44.16	
Main product = Liquid milk (%)	52.03		43.40		51.35	
Main product = Yogurt (%)	3.23		0.00		2.97	
Main product = Other (%)	1.61		0.25		1.52	
Top Ten brands (%)	8.87		44.47		11.74	
Export (%)	3.50		3.86		3.53	
Age (year)	12.67	(13.76)	10.11	(9.26)	12.47	(13.48)
State-owned (%)*	19.81	(37.58)	5.25	(17.87)	18.65	(36.60)
Collectively owned (%)	38.16	(44.91)	59.37	(45.20)	39.87	(45.30)
Private (%)	35.11	(44.89)	20.21	(37.32)	33.92	(44.51)
Foreign (%)	6.98	(22.77)	15.16	(33.71)	7.63	(23.93)
Sales revenue per employee (million))	0.33	(0.62)	0.68	(0.73)	0.36	(0.64)
Ad. cost per employee (million)	0.01	(0.04)	0.03	(0.10)	0.01	(0.05)
R&D investment per employee (million)	0.07	(0.60)	0.37	(2.30)	0.09	(0.87)

*. firm has its unique ownership structure consisting of different types of ownership.

Following the media buzz of the 2008 milk scandal, we conducted a face-to-face survey among mothers with infants and young children in Shenyang during the first ten days of October, 2008. Shenyang, the capital city of Liaoning Province located in northeastern, is one of the biggest cities in China hosting more than eight million population. A total of 1,228 mothers completed the survey. The data consist of mothers brand choice of baby formula after the scandal, monthly expenses

and consumption of baby formula, as well as their socio-demographic information. During the survey, we told each respondent that liquid milk of some NIE titled dairy companies were found to be contaminated with melamine.

These two data sets allow us to investigate the impact of the NIE title on firm performance and consumer perception without and with severe concerns and uncertainty of food safety.

4.3 The Impact of the NIE title on Sales Revenue

Annual sale revenue per employee (ASRE) is highly skewed as suggested by its skewness coefficients, 2.89 and 11.28 for companies with and without the NIE title, respectively. Thus, the traditional student t test for equal mean is not appropriate as the test is highly sensitive to the normality assumption. We conduct the non-parametric Wilcoxon-Mann-Whitney (WMW) tests [Wilcoxon, 1954, Mann and Whitney, 1947]. Since the test statistic of the WMW test, $\chi^2(1) = 268.35$, exceeds the critical value of 6.63 at the 1% significance level, we conclude that the average ASRE among the firms with the NIE title is statistically higher than those without the NIE title. However, the difference in ASRE between firms with and without the NIE title can be attributed to other firm-specific factors. We continue with regression analyses to further explore the potential positive impact of the NIE title on sales revenue.

4.3.1 Difference-in-Difference Models

We estimate the impact of the newly received NIE title on firm performance in the first award year using the different-in-difference (D-in-D) approach. We generate a working data set for the D-in-D models based on the industry data set. For each year starting from 2001 when the NIE system was launched, we include all the firms who received the NIE title the first time but also presented in the previous year without the NIE title in the treatment groups, but other firms that did not receive the NIE title in both years are classified into the control group. Let $S(1)$ be the treatment group and $S(0)$ be the control group; and $t = 0$ for the first period and $t = 1$ for the second period; and y be the outcome (sales revenue per employee). We write the sales revenue per employee below:

$$Y_{it} = \gamma_0 + \mu t + \theta S(1) + \delta S(1)t + \epsilon_{it}. \tag{5}$$

The difference-in-difference estimate is

$$\hat{\delta} = \left(\hat{Y}_{S(1),t=1} - \hat{Y}_{S(1),t=0} \right) - \left(\hat{Y}_{S(0),t=1} - \hat{Y}_{S(0),t=0} \right). \tag{6}$$

We estimate two models, Model 1 including main and interactive terms of the period dummy and the group dummy, while Model 2 also incorporate the cohort dummy indicating the year that each

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firm received their NIE title (the 2001 cohort is used as a base). Based on the estimation results in Table 4, compared with firms in the control group, firms received the NIE title in the second period (the treatment group) are associated with a statistically significant, higher increase in the sales revenue in the first award year (the second year). The sale revenues difference between two periods for the NIE firm is approximately RBM1,600 ($exp(\hat{\delta}) = exp(0.482) = RMB1.619$ million higher than those in the control group for Model 1 and $exp(\hat{\delta}) = exp(0.464) = RMB1.590$ million for Model 2 of the D-in-D estimates).

Table 4: Difference-in-Difference Estimation Results

Dependent varable = ln(sales revenue per employee)	Model 1	Model 2
$t = 1$	0.131***	0.149***
	(0.041)	(0.040)
treatment group $((S(1))$	0.376*	0.271
	(0.202)	(0.203)
$(t = 1) \times S(1)$	0.482**	0.464**
	(0.217)	(0.218)
cohort 2002		0.238**
		(0.113)
cohort 2003		0.379***
		(0.103)
cohort 2004		0.682***
		(0.093)
cohort 2005		0.776***
		(0.092)
cohort 2007		1.101***
		(0.093)
Constant	-1.763***	-2.410***
	(0.028)	(0.086)
Observations	6047	6047
R^2	0.01	0.06

Standard errors in parentheses; and * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.3.2 Panel Analyses

Even though the change in firm characteristics for the same firm is insignificant, the characteristics are likely to change over time. To take the benefit of the panel data set to run panel estimations. We Assume ASRE is a Cobb-Douglass function of firm attributes and the NIE title,

$$ASRE_{it} = e^{\alpha_0 + \alpha_1 NIE_{it} + \beta F_{it} + \mu_i + \epsilon_{it}}, \tag{7}$$

where F is a vector of firm attributes that are observable to researchers and β is a vector of coefficients associated with these firm attributes; μ_i captures the effects of other firm-specific characteristics; and ϵ_{it} is error terms. Taking logarithm of Equation (7), we have

$$ln\left(ASRE_{it}\right) = \alpha_0 + \alpha_1 NIE_{it} + \beta F_{it} + \mu_i + \epsilon_{it}. \tag{8}$$

We include the following firm-specific characteristics: age in years; type of the main products (milk powder, liquid milk, yogurt, and others); ownership structure represented by the share of state-owned, collectively owned, private and foreign ownership; whether a firm produces one of the top ten dairy brands; whether a firm export their products; advertising costs per employee; and R&D investment per employee. Since the literature has well documented that sales revenue has a positive impact on the level of R&D investment [David et al., 2000], we use R&D investment per employee in the previous year to avoid endeogeneity. We also take logarithm of firm age, shares of different ownership types, advertising cost, and R&D investment and, therefore, the coefficient of these variables are interpreted as elasticity.

We estimate three panel models depending whether advertising costs and R&D investment are included. For each model, Since the Hausman tests favor the random-effects models over the fixed-effects models for each mode, we then report the estimation results of the random-effects models in Table 5. The estimation results are very similar between three models. Ceteris paribus, a NIE title has a statistically significant, positive impact on ASRE. Despite the size difference of the coefficient of the NIE title between the models, the difference of ASRE between a firm with and without the NIE title is similar between the models – ranging from approximately RMB1,279 ($exp^{0.246} = RMB1,279$ million) in Model 3 and RMB1,553 ($exp^{0.440} = RMB1,553$ million) in Model 2. The additional sales that the NIE title can boosts is economic significant given the average sales revenue per employee is approximately RMB362. Table 5 also suggests that a one percent increase in the advertising cost per employee increases ASRE by 0.017% in Model 2, ceteris paribus. As shown in Table 3, the average sales revenue and advertising cost per employee are RMB360 and RMB12.96, respectively. Let assume two identical firms have the average ASRE and the average advertising cost per employee. Firm A received a NIE title and firm B incurs

advertising cost to promote sales. Firm B has to spend approximately RMB3.246 million ($1.553 *$
$12.96/(0.017 * 360) = RMB3.246$ million) to have the same ASRE as firm A. Therefore, the NIE
title is more cost effective than advertising for these two similar firms.

4.4 Consumer Perception of the NIE Title when Facing a food scare event

The analyses above using the industry data suggests that the NIE title boosts sales revenue, which
suggest that consumers are responsive to the NIE title. However, their perception of the NIE title
may change the NIE firms are involved in food scare events. We use the survey data of 1,228
mothers in Shengyang to explore the impact of the NIE title on brand choice among consumers.

Random utility theory states that indirect utility function for individual i choosing alternative
brand j is

$$U_{ij} = \delta X_{ij} + \epsilon_{ij}, \tag{9}$$

where X is a vector representing brand attributes and individual characteristics, δ is a vector of
coefficients to be estimated, and ϵ is the error term or random component that captures unobserved
factors that may affect brand choice. In particular, we include the fixed-effect and average price of
different brands, an indicator for the NIE title, monthly household income, and interactive terms
between income or education and the NIE and import dummies. As shown in Table 6, consumers
are more likely to choose an infant formula with the NIE title. The preference for the NIE title
is significantly associated mother's education, but not with the household income. On the other
hand, consumers are less likely to buy the imported brands, but a highly educated or low income
individual will prefer the imported brands. The unexpected negative, statistically significant effect
of the imported brands on brand choice may due to the fact that the imported brands in general are
more expensive than domestic brands – the price difference is approximately RMB30 per kilogram
based on the 11-city retail prices of infant formula. Based on the coefficients of the NIE dummy
and prices, the estimated average price premium for the NIE brands is approximately RMB8.98
per kilogram ($0.63/70.79 * 1000 = 8.89$).

We also estimate the nested logit models. Ideally, we want to estimated a three-level nested
logit model – individuals decided whether to buy the imported or domestic brand, whether to buy
formula with and without the NIE title, and which brand to buy. However, STATA does not allow
us to include the same independent variables in the different nest levels. We then fit the data into
the nest logit model sequentially. First, we estimate whether individuals choose the imported or
domestic brands and the consequent brand choice decision. Second, we estimate the NIE choice
and the consequent brand choice given the decision on buying the imported or domestic brand is

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Table 5: Panel Estimation Results

	Model 1	Model 2	Model 3
NIE title	0.423***	0.440***	0.246***
	(0.069)	(0.071)	(0.042)
log of firm age	0.191***	0.211***	0.015
	(0.049)	(0.051)	(0.042)
log(share of different types of ownership): base = state-owned			
collectively owned	0.025***	0.025***	0.010***
	(0.004)	(0.004)	(0.003)
privately owned	0.029***	0.029***	0.013***
	(0.004)	(0.005)	(0.003)
foreign	0.041***	0.041***	0.028***
	(0.008)	(0.008)	(0.006)
Top Ten brands	0.673***	0.641***	0.653***
	(0.139)	(0.141)	(0.119)
Liquid Milk relative to milk powder	0.037	0.046	0.153
	(0.096)	(0.097)	(0.108)
Yogurt relative to milk powder	-0.159	-0.158	-0.216
	(0.232)	(0.234)	(0.387)
Dummy for export	0.142*	0.147*	0.043
	(0.079)	(0.079)	(0.079)
Financial indicators: Debt-to-Asset ratio	-0.050	-0.044	-0.000
	(0.040)	(0.041)	(0.022)
Capital-to-Asset ratio	-0.006	-0.002	-0.034
	(0.033)	(0.033)	(0.034)
Log(Advertsing cost per employee)		0.017**	0.003
		(0.008)	(0.005)
Lag of log(R&D investment per employee)			0.031***
			(0.004)
Constant	-1.877***	-1.795***	-1.464***
	(0.239)	(0.249)	(0.242)
No. of observations	4664	4663	3492
within R^2	0.035	0.042	0.015
between R^2	0.117	0.107	0.163
overall R^2	0.116	0.111	0.158

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

made. The test statistic of the LR tests for the IIA (irrelevant independence of alternatives) property in each nested logit model exceeds the critical values (see Table 6. Thus, we concluded that the IIA property may not be satisfied and, the nested logit model performs better than the conditional logit model.

The results of the nested logit models are reported in Table 6. Individuals with a high income and/or highly educated are more likely to prefer the imported brands over the domestic brands, which is the same as that in the conditional logit model. Once the decision on the imported vs. domestic brands is made, respondents are more likely to choose the NIE brands. Once an individual decided to buy the imported brands, income and education does not play a statistically significant role in the NIE choice. However, highly educated mothers prefer the NIE brands if they decide to buy the domestic brands. Thus, the results seem to implies that despite of the severe food scare events involving the NIE firms, consumers still prefer the NIE brands over non-NIE brands, especially among highly educated mothers.

5. Conclusions

This study uses both the secondary firm-level data and the survey data to explore the impact of the NIE title on firm performance and consumer brand choice. We find that the NIE title boosts sales revenues and its impact is both statistically and economically significant. Furthermore, consumers prefer the NIE brands over the non-NIE brands, especially among highly educated consumers and those who buy domestic brands. Such preference presents even if the NIE companies were involved with food safety events.

Since eight of 22 dairy companies involved with the 2008 milk scandal held an effective NIE title, the NIE system has been widely criticized and the credibility of AQSIQ has been severely ruined. As a result, AQSIQ annulled the NIE system in the food sector. However, the question is whether it is socially optimal to take such a radical action. One possible reason for a strong preference for the NIE brands among consumers can be lack of quality information and consumers rely on the NIE title for quality assessment as the awarded firms have to meet certain quality standards. The question next is whether it is possible to make significant changes of the NIE system such that the NIE title can serve as a good quality signal rather than simply annulling the system. One possibility is to conduct random quality inspection during the term of the effective NIE title in addition to the annual quality report to the local AQSIQ office. Such unexpected visit may give firms incentives to maintain their quality level at least as high as the legal standard. The other measure is to charge a significant amount of penalty if substandard is caught during the NIE title, which deter the deviation of the quality under the legal standard.

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Table 6: Estimation Results of Discrete Choice Models Using the Survey Data

	conditional logit model*	nested logit models					
		import vs.	brand †	given import = 1		given import = 0	
				NIE	brands†	NIE	brands†
NIE dummy	0.63*	domestic	4.09**				
	(0.37)		(2.06)				
Import dummy	-1.56***						
	(0.39)						
price	-70.79***		-14.97*		3.76		-213.74
	(13.7)		(7.67)		(8.01)		(3113.80)
monthly HH income		0.71***		0.05		0.04	
(RMB1,000)		0.06		(0.06)		(0.19)	
Mother's education		1.86***		0.40		0.44**	
(college and above)	(0.23)			(0.43)		(0.19)	
NIE*income	0.05						
	(0.05)		* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.				
NIE*edu	0.42**						
	(0.17)		Figures in parentheses are standard deviations				
imported brand	-1.56**		†: Brand-fixed effects are incorporated.				
	(0.39)						
import*income	0.72***						
	(0.06)						
import*edu	1.94***						
	(0.24)						
LR tests for IIA:		$\chi^2(2) = 421.15$		$\chi^2(2) = 108.34$		$\chi^2(2) = 6.19$	

One limitation of this study is that we are not able to quantify the change in consumer preference for the NIE brands before and after the 2008 milk scandal as we only conduct the survey post-event. One possibility is to extend the industry data till the end of 2008 with the permission from the National Bureau of Statistics of China, which allows us to investigate the change in the NIE effect on firm performance (sales revenue) before and after the scandal. Another direction could be the analysis using the store level data of infant formula purchase in the pre- and post-event periods. Furthermore, we expect the impact of the NIE title is more significant and/or greater in an industry where the quality of products are more difficult to observe or at a high cost to observe

than in other industries. Instead of using the industry data of one particular product category, we use the industry data of different sectors to compare the effect of the NIE title between different industries.

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