STOCK MARKET RESPONSE TO THE 2008 CHINA MILK SCANDAL

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ABSTRACT OF THE THESIS

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Food safety has consistently drawn attention in domestic and even international markets, especially when severe food scare events occur. The overall objective of this thesis is to investigate the stock market response to the 2008 China milk scandal by employing an event study approach and a GARCH model to examine asymmetric impacts of the scandal on the level and volatility of stock prices of dairy companies and utilizing a random effects model to investigate how information uncertainty and media coverage attenuate or facilitate the impact of the scandal in different stock markets. A total of all eight relevant dairy companies traded in five stock markets are included for the analysis.

I find supporting evidence on the asymmetric impacts as well as the impacts of information uncertainty and media coverage. Overall, the results suggest that firms listed in the overseas stock markets were more responsive to the scandal than those publically traded in China, but the former reacted slowly than the latter when the positive safety information occurred. Furthermore, I find that among the firms whose products were not found to be contaminated, media coverage contributed to the price rebound and even the price gain as it had a statistically significant, positive impact on the stock prices.

This thesis provides policy relevance and implications to food safety in China and

beyond China. The private sector may learn from this study as it suggests that firms traded in different stock markets react differently to food safety information and the market distinguishes between positive and negative food safety information. Furthermore, the regulatory agencies communicate with the public and the firms to mitigate the impact of food-scare events.

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CHAPTER 1: INTRODUCTION

It is well known that consumers become more concerned about food safety and quality as they become more affluent. The food supply chain faces more challenges from both naturally occurring contamination with bacterial pathogens and animal disease outbreaks. Numerous food scare events, such as BSE (Bovine Spongiform Encephalopathy) in North American, European countries, and Japan as well as severe national food recalls, caused significant market responses and economic consequences in the domestic or even international markets.

The food safety concern in China reached a climax upon the exposure of contaminated infant formula with a chemical substance called melamine in 2008. The 2008 Chinese milk scandal involving dairy products, particularly milk and infant formula, generated a great deal of buzz in China and overseas. Melamine was found to be purposely added to milk to enhance protein content. Tainted milk products have adverse health impacts. Infants and children who regularly take melamine contaminated milk or formula are more likely to have kidney disease. By December 2008 the Chinese Ministry of Health reported the toll of ill children to be at least 22 million, with six infants dying from kidney diseases and more than 50,000 babies hospitalized (SAQSIQ 2008a). Following the scandal, more than 20 countries and regions banned, suspended or withdrew imports of milk and milk products from China, Malaysia, Singapore, Tanzania, Indonesia, South Korea, Vietnam, Chile, India, and the European Union. The World Health Organization referred to this event as “one of the largest [food safety events] in recent years” (WHO 2008). The 2008 milk scandal provides an excellent example to investigate the stock market response to food scandals in China. Besides causing the significant market responses in both

China and overseas, the 2008 China milk scandal has its uniqueness as it involved dairy companies traded in both domestic and international stock markets.

1.1 Research objectives and methodologies

Overall, this thesis investigates the stock market responses to the 2008 China milk scandal. The detailed research objectives are twofold. First, I employ both an event study approach and a GARCH model to examine asymmetric impacts of the events on the level and volatility of stock prices by market information uncertainty (pre- vs. post-test periods), by the test results (negative vs. positive), and across different stock markets. Second, I employ a random effects model to investigate whether and by how much information uncertainty, media coverage, and firm characteristics attenuate or facilitate the event impact.

1.2 Thesis structure

The rest of the thesis unfolds in the following order. Chapter 2 provides an overview of the China dairy industry. Overall, China has been experiencing a steady, significant increase in dairy consumption despite the price increases. The China dairy industry is highly concentrated as the top five companies accounted for more than 60% of the market of all three main dairy products (milk powder, liquid milk and yogurt). The overview also outlines various regulations and standards in the China dairy industry.

Chapter 3 discusses food safety problems, especially severe food scare events in the recent decade in China. It also provides a detailed discussion of the 2008 milk scandal, including the main events during the course of the scandal and the consequences.

Chapter 4 presents a literature review of stock market responses to different types of events and market information. It also discusses an event study approach and

GARCH model that are employed in this thesis.

Chapter 5 presents the data used for this thesis and conducts diagnosis tests. The results of different types of unit root tests confirm that all data series of stock prices are non-stationary in levels (logarithm) but stationary in first order differences.

Three Chapters, 6, 7 and 8 present empirical results. Chapters 6 and 7 focus on the event impacts on the level and volatility of stock prices. Overall, the estimated changes in stock prices based on an event study approach and the GARCH estimation are consistent. All the companies experienced a price decrease while the market was waiting for the test results. Following the public release of the test results, the companies whose products were found to be contaminated with melamine had a further price drop, but the stock prices of those firms which received positive results (not contaminated) rebounded and went back to the pre-event level. The companies traded in the foreign stock markets had greater responses to the scandal than those traded in the domestic markets. Price volatility experienced a strong fluctuation around the date when the test results were publically announced, and the fluctuation was greater for firms traded in the oversea stock markets. Chapter 8 investigates whether and how market information, media coverage, and firm characteristics attenuate or facilitate the event impacts based on a random-effects model.

Chapter 9 concludes the thesis and discusses policy implications.

CHAPTER 2: BACKGROUND ON CHINA DAIRY INDUSTRY

China's GDP has been continuously expanded along with the fast and inevitable economic development attributed to significant state investments and the expansion of private sector. Such significant economic growth has made China an important player in the integrated global economy (Economist 2008). Along with China's economic development, Chinese consumers pay more attention than ever to food safety, dietary intake, and health (IIASA 2004). Dairy products have been an important part of a traditional diet in western countries for centuries (EuroFir 2004). Various dairy products such as milk, cheese, ice cream, and yogurt are brought from farm to table to satisfy individuals' dietary and nutrient requirements. Among these products, yogurt, cottage cheese, sour cream and dips are called "cultured products" (IDFA 2009). Dairy products have comprised one of the main food categories in several USDA food assistance programs that emphasize on food safety and nutrition. The USDA MyPyramid food guidance system, which provides science-based recommendations on food for Americans, promotes "getting your calcium rich food" where dairy products are the main component (USDA 2008a). The Women, Infants and Children program (WIC) provides low-income women, infants and children up to age five with nutritious foods, nutrition counseling, and health services for free. WIC food includes iron-fortified infant formula that is the WIC infant formula rebate system of negotiating rebates with infant formula manufacturers (USDA 2009b). "Body by Milk" and "Special Milk Program" (USDA 2009c) are designed to encourage people, especially teenagers and children, to drink milk to improve their physical well-being. Various factors, including the growing awareness of benefits of dairy products,

advanced technologies, the growth of disposable income and population in the world, boost demand for dairy products (Blayney *et al.* 2006).

Compared with the European and North American markets, the Asian-Pacific markets historically exhibit low dairy consumption mainly due to high lactose intolerance (Dong 2005). Table 1 suggests that the per capita consumption of liquid milk in the European and North American markets remained at a stable but high level in 2000-2008. In particular, the annual per capita consumption was 83-88 kilograms in the United States and 90-93 kilograms among 25 European countries. The annual per capita consumption of liquid milk in Japan was approximately 38 kilograms, which was less than half of that in the United States. China had even lower per capita consumption of liquid milk – less than a quarter compared to Japan and less than one tenth compared to the United States. However, a rapid growth of dairy consumption has been found in the Asia-Pacific regional markets in recent decades (Allbusiness 2000), creating great market potential and luring both domestic and multinational dairy companies into the dairy market (Knips 2005). Among countries listed in Table 1, China has experienced the greatest growth of dairy consumption though the per capita consumption level is significantly lower (Fuller *et al.* 2004b). Various factors including income growth, price changes, urbanization, and westernization contribute to the increasing dairy consumption in China (Fuller *et al.* 2006; Dong 2005).

2.1 Demand and supply of dairy products in China

Table 2 shows the per capita consumption of three main dairy products – liquid milk, yogurt and milk powder - among urban residents in China from 1997 to 2008. Notably, per capita consumption of all these three categories had an upward trend. Liquid milk (fresh product contains primarily fluid milk) had the largest amount of consumption

(13.46 kilograms) and the highest growth rate of 19.67%. Table 2 also suggests a possible consumption shift from milk powder to liquid milk and especially to yogurt. The share of yogurt in the total dairy consumption had exceeded milk powder since 2006. Fuller *et al.* (2004b) attributes such consumption shifts to the following two factors. First, fresh dairy products (liquid milk or yogurt) are more convenient to consume. Second, the perception of dairy's nutritional benefits leads people to believe that milk powder may be an "inferior product". Within the category of milk powder, the composition has a notable change as infant formula became more dominant. In 2007 infant formula accounted for approximately 77% of the per capita consumption of milk powder (Chinese Milk Yearbook 2008). The 2008 milk scandal may affect the consumption of the three main dairy products. Consumption of liquid milk had the biggest drop in 2008, as it was the first time that yogurt consumption had a negative growth of -10.83% since 1997. Compared with the same quarter in 2007, the fourth quarter of 2008 witnessed a sizeable decrease in the consumption of the three main dairy products. The scandal may also have affected the dairy product prices. Many parents turned to buy imported dairy products (especially infant milk formula) that are priced higher, thus, three dairy products had a rise in price in the fourth quarter (see Table 4). Figure **1** and Figure **2** illustrate the association between dairy consumption and income. Based the provincial per capita income data, I first rank provinces into seven income groups, namely, 0-10%, 10-20%, 20-40%, 40-60%, 60-80%, 80-90% and 90-100%. I then plot the per capita dairy consumption by different income groups. In the case of 2008, with only one exception (the second lowest income decile group), a higher income is associated with higher dairy consumption among both the rural and urban households. The second group differs from others because there was one outlier – Xizang province - which had low income

associated with high dairy consumption due to a traditional dietary culture. Figure 2 shows the time trends of dairy consumptions among urban households by the seven income levels for each of the main dairy products. It first confirms the results presented in Figure 1 – a higher income is associated with higher dairy consumption. Second, per capita annual consumption of liquid milk decreased; consumptions of yogurt increased before 2006 and then decreased in 2007 and 2008; and milk powder consumption fluctuated. In the light of the Engle's Law, the proportion of income spent on food is more reasonable and applicable in reflecting the living standard (Lewbel 2006). In general, the lower the share of food expenses in income, the better the living standard. Figure 3 further explains the proportion of dairy expense within overall food expense. Both food expense and dairy expense increased from 2003 to 2008 (see Figure 3(a) and (b)), but the share of the dairy expense in total food expense slightly decreased over time (see Figure 3(c)).

The visible regional difference between high and low income levels contributes to different socio-economic conditions that would not fade over the long term. Urban residents with high income (like those in the highest decile group, 90-100%) increase their dairy consumption (Bai *et al.* 2008) as they become better aware of the importance of dairy products and/or they can afford to buy dairy products relative to rural residents (Zhou *et al.* 2002). Even among the relatively low income groups, there is tremendous market potential for dairy products.

Like the rest of the global dairy markets, dairy prices in China have been increasing but less dramatically. As shown in Table 4 , relative to the 2004 price, the price of milk powder doubled in 2008, and both liquid milk and yogurt had a significant price increase of 43.01% and 20.33% respectively. Figure 4 suggests an overall increasing trend for prices of liquid milk, yogurt and milk powder in the top

10 urban areas between 2004 and 2008. One exception is that yogurt prices decreased in 2007 compared to 2006 but bounced back with a significant price gain in 2008.

Table 5 summarizes the production and trade of dairy products in China from 2004 to 2008. During this time frame, the domestic dairy production accelerated by nearly 1.6 times (23,684,000 ton vs. 37,600,000 ton). In particular, the domestic production of milk powder and liquid milk increased by half. The imports of liquid milk, yogurt and milk powder increased in both quantity and expense in 2008, and exports had an upward trend before 2008 but decreased in 2008. Most of the exports go to Hong Kong, Venezuela and the Eastern Europe~~,~~ while the main sources of the imports are from the U.S., European Union and New Zealand (Dairysite 2009). The increase in the net export was attributed to the rising dairy price in the international market in 2007 (Milk Year Book 2008). The export decrease and import increase of dairy products in 2008 were likely due to the milk contamination incidents (Milk Year Book 2009).

2.2 China dairy market structure

In recent decades China's food industry has been highly fragmented due to the emergence of many small, local food companies and the expansion of large, nationally known companies (Wang, Mao and Gale 2008). However, as shown in Table 6, 7 and Table **8** as well as Figure 5, the China dairy markets are indeed highly concentrated.

In the liquid milk market, the top three companies, Mengniu Dairy Company Limited (Mengniu), Inner Mongolia Yili Industrial Group (Yili) and Shanghai Bright Dairy & Food Company Limited (Bright), accounted for approximately 60.42% of the market (see Table 6). Yili, the second largest domestic dairy company in the liquid

milk market, has the highest annual growth rate of 26%, followed by Mengniu with an 18.62% increase in its market share from 2003 to 2006. Both Bright and Sanyuan had a notable share in the liquid milk market in 2003 (16.78% for Bright and 10.00% for Sanyuan), but their market shares were cannibered by their competitors over recent years (13.93% for Bright and 5.99% for Sanyuan in 2006).

In the yogurt market illustrated by Table 7, Bright was undoubtedly the leader every year from 2003 to 2006, despite a small reduction in its market share over time. Mengniu and Yili had great potential in the yogurt market with average annual growth rate around 45% and 56%, respectively. These top three companies accounted for almost half of the market (47.67%).

The most apparent difference between the milk powder market and the liquid milk and yogurt markets is that the top five companies in the milk powder market which accounted for more than 2/3 of the market share (68.32%) were all foreign companies (see Table 8). Nestle and Meadjohson were dominant foreign dairy firms and accounted for ¼ of the entire market share. Among the top ten companies, only two companies, Yili and Sanlu, were domestic companies and their market share was small (4.40% and 2.25%).

Among all the firms presented in Figure 5, Yili was the only company ranked in the top ten in all three main dairy markets. Mengniu had tremendous potential and capability as suggested by its significant market share and growth in both the liquid milk and yogurt markets. Both Yili and Mengniu are based on Inner Mongolia where cattle are raised and dairy diet is appreciated as a traditional dietary culture. Bright, based in Shanghai showed a great competitive advantage in the liquid milk and yogurt markets (Fuller *et al.* 2004a) and its subsidiary in Jiangxi Province, called Jiangxi

Bright accounted for 70% dairy market share of Jiangxi province (ChinaDairy.net). Sanyuan, a regional dairy company in Beijing, and Sanlu in the neighboring Hebei province, have benefited from the greater market of Beijing and have taken a prominent position in the Beijing and neighboring markets. China Dairy (Group) based in Xi'an, the capital of Shaanxi Province, focused on the Northwest of China (Annual Report of China Dairy 2007). As a transformed dairy company[1], China Dairy competed in the liquid milk and milk powder markets, ranked the 8th in the liquid milk market recently and had significant market share in the milk powder market. However, it did not have its footprint in the yogurt market. Some regional dairy companies held considerable market shares. Take Weigang for example, a regional dairy company in Nanjing and the capital of Jiangsu Province, Weigang was in possession of 2.9% in the liquid milk market and 3.4% in the yogurt market.

Seven domestic dairy companies are ranked in China's Top 500 Enterprises (see Table 9). Bright, Yili, Mengniu and Sanlu produce only dairy products, but dairy production is one of the main production and businesses for the other two companies, New Hope Group and VV Food and Beverages. New Hope Group (Xinxiwang), aiming to connect the supply and demand of dairy products that are geographically disconnected along the Yangtze River, became a top brand along the Yangtze River as well as in Southwest China (Dairy Industry of China 2003, P28). VV Food & Beverage Group (Weiwei), with dairy as its second pillar in its core business, has already established extensive dairy production plants as well as its brand reputation and marketing network in Northern China (Diary Industry of China 2003, P28). These dairy companies are well-established big firms. As shown in Table 10, the sales

[1] China Dairy Group is held by Xi'an Yinqiao Biological and Technology Ltd, which went public in 2003 in Singapore Exchange market. In November 2004, it divested its marble and granite business and completed its transformation into a professionally managed dairy company.

revenue of Mengniu, Yili and Bright was above 5 billion CNY (approximately US$758 million). Another seven dairy companies listed in Table 10 have their sales revenue between 1 billion CNY (approximately US$152 million) to 5,000,000,000 CNY. In particular, Synutra, Sanyuan, American Dairy and China Dairy are not in the China's Top 500 Enterprises but have annual sales revenues over 1 billion Chinese Yuan.

Domestic dairy companies are the main players in the China dairy markets, except in the milk powder market where international dairy companies lead the market. The reason that international companies mainly focusing on milk power is that it is hard for them to obtain and develop the dairy sources locally for those fresh dairy products like liquid milk (China Commodity Net 2006). Despite preferences for domestic dairy products among Chinese consumers (Wang, Mao, and Gale 2008), foreign investment and multinational dairy companies have been enhancing their market and sales efforts in China. Synutra International Inc., which is mainly based in Hong Kong, Netherlands, the United States and China, operates subsidiaries under the name Synutra and/or Shengyuan in China (Annual Report of Synutra, 2009). American Dairy Inc. operates through its fully owned subsidiary called Feihe Dairy in Heilongjiang Province. Foreign investment in China dairy industry also takes merger or acquisition as a potential channel. Nestle, a Switzerland-based multinational corporation and ranked 48 in the Fortune 500 in 2009 (CNN Fortune 2009), bought Yunnan Dengchuan Diequan as its "rehearsal" to enter China dairy market (Dairy Industry of China 2003, P28). Shenyang Huishan, which was ranked 9th in the China liquid milk market in 2006, was established through investment by the American Longdi international Company (China Agricultural Products Trade 2008).

By and large, fierce competition exists in China's dairy industry among domestic and foreign companies, between large companies and small-scale companies, as well as among companies in different regions. Large domestic dairy companies are speeding up competition and setting up marketing and sales networks in cities. Meanwhile, domestic, small and medium-sized dairy companies emerge and try to have a strong foot in the dairy market, and especially in their local and regional markets (Dairy Industry of China 2003, P27). At the same time, international dairy companies enter the China dairy market and exploit the market potential. They furnish the dairy market with a beneficial investment environment and share the domestic dairy market in an unavoidable trend. The 2008 milk scandal may cause some structural changes (China Year Book 2009). Concerned over the safety of dairy products, especially infant formula and milk powder for young children, Chinese parents turned to foreign brands, which provided a chance for foreign dairy companies to enter or expand in China's dairy markets. Other countries imposed import bans or restrictions on China's dairy products, which also provided opportunity for other dairy exporting countries.

CHAPTER 3: FOOD SAFETY ISSUES AND INCIDENTS IN CHINA

Food safety is a growing concern in China. This chapter provides a brief review of food safety issues and regulations in China and discusses the 2008 China milk scandal.

3.1 Food safety issues

The State Food and Drug Administration of China, established in 2003, stated that 65% of respondents expressed concern about food safety based on a national survey conducted in 2007 (China Daily 2007). Various food scandals have been widely publicized in recent years, including adulterated pickled vegetables (China Dialogue 2006), counterfeit alcoholic drinks (People's Daily 2004), cancer-scare noodles with an illegal additive that may be carcinogenic (Shanghai Daily 2006), Sudan I red Dye (China Daily 2005), and school food poisoning incidents (People's Daily 2006). The milk contamination incident in April 2004, which was widely publicized as the "big head disease" because sick infants' head were abnormally bigger than their body sizes, caused at least 13 babies to die of malnourishment after they were fed with fake, malnutrition milk powder in Anhui Province (BBC 2004). Also, food safety related to meats has attracted increasing attention since several outbreaks of animal avian influenza (AI) as well as human infection cases in the mainland China and Hong Kong (Brown, Longworth and Waldron 2002). From 2004 to 2009, there were more than 100 AI outbreaks in China, which resulted in a massive depopulation of infected and contact birds.[2] At the same time, approximately 40 confirmed AI human cases

[2] See http://www.oie.int/wahis/public.php at World Organization for Animal Health (OIE).

were reported to the WHO and 26 of them died.[3] Microbial contamination is another ongoing problem in food safety resulting in many illnesses and deaths in China (Wang, Mao and Gale 2008).

The food safety concern in China reached a climax upon the exposure of contaminated infant formula with a chemical substance called melamine in 2008 which is the subject of this thesis. The World Health Organization referred to this event as "one of the largest food safety events in recent years" (WHO 2008). The chemical appeared to have been added to milk to enhance protein content. Children who regularly take melamine contaminated milk formula are likely to have kidney disease. By September 22nd the toll of sick infants and children increased up to 53,000 and at least 4 babies died (China Ministry of Health 2008; BBC 2008e). The toll of sick children almost doubled amounting to 94,000 by the end of September. On December 10th Chinese Ministry of Health reported that the toll of children was at least 22 million (Ministry of Health 2008; China View 2008).

3.2 Regulations and safety measure of dairy products

Both the central and local government plays an important role in the China dairy industry through implementation of a series of programs and promotion of dairy production and consumption (Fuller *et al.* 2004b). Zhou *et al.* (2002) list programs issued by the Chinese government aiming to promote dairy consumption, including

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[3] http://www.who.int/csr/disease/avian_influenza/country/cases_table_2010_08_31/en/index.html from from World Helath Organization (WHO).

"Guidelines for Encouraged Industries, Products and Technologies" in 2000 and "Development Guidelines for China's Food and Nutrition (2001-2010)". On the other hand, several programs or regulations are undertaken to meet consumer demand for safer food including dairy products.

Hazard Analysis Critical Control Point (HACCP)

One typical measure of inspection and testing is the Hazard Analysis and Critical Control Point (HACCP). Beginning in 2002 the HACCP certification was required by the authority of China's inspection and quarantine for exporting food processors (Xiao *et al.* 2004). Since August 2003 the HACCP certification began to be phased in for domestic food processors required by the China Ministry of Health. By 2005, a total of 2888 companies gained the HACCP certification. A quarter of these companies are exporting enterprises and 1% is food companies (Wang, Mao and Gale 2008).

School Milk Program (SMP)

In November 2000, the School Milk Program (SMP) was promulgated in attempt to "improve the overall physical quality of the young generation" and to "guide consumption and optimize the nation's diet" (Guide to China's Dairy Industry 2003, p70). The organization and management system of China's School Milk implements the program at three vertically integrated levels ("the central is the leading, the municipal is the basic part, and the provincial is the key part") and emphasizes "Safety" first in the four basic principles - safe, nutritious, convenient, and affordable. "Safety is the most concern in the school milk program" as the national survey revealed (Guide to China's Dairy Industry 2003, p71). The Chinese School Milk Program Committee controls the rules and regulations of the SMP and negotiates a 25% - 30% price discount for school milk. It monitors and enforces the dairy

suppliers to fulfill the contract terms to make sure they meet the requirement of safety and quality (FAO 2003).

Five major cities, Beijing, Tianjin, Shanghai, Shenyang and Guangzhou carried out a successful pilot project of School Milk Program (China Dairy 2001). In 2009, more than two million children benefited from school milk (WSMD 2009).

State Administration of Quality Supervision, Inspection and Quarantine

State Administration of Quality Supervision, Inspection and Quarantine (SAQSIQ) is in charge of establishing national quality standards as well as regulation and enforcements of those standards (SAQSIQ 2009). For instance, SAQSIQ issued the "Notice of Strengthening Inspections and Quarantine on Imported Dairy Products ([2007] No. 298)" on April 30, 2007 to strengthen the test for Sakazakii (Dairysite 2007). Right after the 2008 milk scandal, SAQSIQ and the State Council issued a series of quality control regulations for dairy products (Xinhua News 2008d). In the same year, SAQSIQ and the European Union signed a joint statement of a revised "Memorandum of Understanding strengthening bilateral co-operation" in order to "enforce product safety standards and strengthen cooperation and exchange of information on food safety" (SAQSIQ 2008c).

New regulations after 2008 milk contamination incidents

The Chinese government has issued new regulations especially for dairy products following the 2008 milk contamination incidents. On October 9th 2008, the State Council announced "Regulation of Dairy Quality and Safety Supervision ([2008] No.536)" (Xinhua News 2008a) (hereto "the Regulation"). On November 19th 2008, the General Office of the State Council together with the National Development and Reform Commission, the Ministry of Agriculture and 13 departments jointly issued an

"Outline of Dairy Industry Rectification and Plan" (Xinhua News 2008b) (hereto "the Outline"), aiming to reconstruct the market structure of China dairy industry and to improve quality and safety of dairy products through standardization and institutionalization. The Regulation and the Outline are the first official documents that specify functional assignments of supervision in China dairy industry and impose strict requirements of quality and safety management along the different stages of the dairy product supply chain.

China launched the National Inspection Exemption (NIE) System in various industries including the food industry 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 up to three years; the firm is also allowed to include the title in the product label and to use the status in the advertisement campaign. Among the dairy companies we have discussed, YiLi, Sanlu, and Nestle were awarded the NIE title. The NIE title system was annulled in the food industry after the scandal. Right after the second product tests for liquid milk on September 18th, Chinese government ceased to bestow a NIE title on any food producers. Top dairy companies, Mengniu, Yili and Bright, were revoked "Chinese Top Brand Products" right by government for their liquid milk products (Bloomberg 2008). Mainly due to the 2008 China milk scandal, a new Food Safety Law passed in 2009 (USDA 2009d). The new law establishes a "national food safety committee" and a "national food risk assessment committee" to strengthen food safety risk monitoring, assessment, and food safety standard (USDA 2009d).

3.3 Detailed timeline of the 2008 China milk scandal

Figure 6 highlights a series of important events which evolved during the course of the melamine contaminated milk scandal (more detailed time line is provided in Appendix 1). By July 16th, 2008 an abnormal increase in incidents of kidney ailments among infants in Gansu Province was noticed and reported to the Chinese Ministry of Health. On July 24th, the State Administration of Quality Supervision, Inspection and Quarantine (SAQSIQ) received a message in the bulletin board indicating that the rare high occurrences of kidney stones among children in Gansu Province were likely attributed to the consumption of milk formula produced by Sanlu based on product tests. But no public action was taken by SAQSIQ in response to the message. Fonterran, foreign partner of Sanlu in New Zealand, was aware of the possible milk contamination since August 2nd and reported to the Chinese government. News of the milk contamination incidents was possibly purposely filtered out from the public because of the coming 2008 Beijing Summer Olympics (China Digital Times 2008). Shortly after the 2008 Beijing Summer Olympics, the milk contamination incidents caught national and even global attention. Sanlu issued a product recall notice in the mainland China and Taiwan effective on September 11th. The US Food and Drug Administration (FDA) issued a product advisory warning of infant formula imported from China on the following day (U.S. FDA 2008).

The SAQSIQ conducted tests for milk powder produced by 109 companies on September 16th. On the same day, the Evening News of CCTV (China Central Television), the major state television broadcaster in China, officially announced the names of 22 companies, whose milk powder products were found to be contaminated with melamine, including Yili, Bright, Mengniu, and Synutra. It also indicated that milk powder produced by the other 87 companies received negative test results (no contamination) (SAQSIQ 2008a). However, the names of those 87 companies, including Sanyuan, American Dairy, Nestle, and China Dairy, were announced by the CCTV Evening News the following day on September 17th (SAQSIQ 2008b). On September 18th the SAQSIQ conducted tests for liquid milk products of 411 companies that cover approximately 70% of the market share. Liquid milk products of American Dairy, Synutra and China Dairy were not tested (SAQSIQ 2008c). The CCTV Evening News on September 18th announced that except Mengniu, Yili and Bright, liquid milk produced by all the other 408 companies including Sanyuan and Nestle were not found to be contaminated. The relative less contamination in liquid milk is largely attributed to the fact that it is technically more difficult and economically more costly to add melamine to liquid milk than to milk powder.

Following the release of the SAQSIQ test results, three top diary companies, Mengniu, Yili and Synutra, issued recalls of their milk powder products and made the corporate apology statement to the public on September 17th, 2008 (Mengniu.com 2008; Yili.com 2008; Bloomberg 2008). Bright issued recalls of its liquid milk products as well as tainted milk powder products from its subsidiary company on September 18th (Xinhua News 2008; SAQSIQ 2008c).[4] Nestle (China) received

[4] Looking back to milk powder test, Shanghai Bright Dairy didn't involve in the 22 companies directly but Jiangxi Bright Dairy did. Actually, Shanghai Bright Dairy is the shareholder with 51% stock of

negative test results (not contaminated) for its milk powder and liquid milk products on September 17th and 18th. However, on September 21st the Center of Food Safety of Hong Kong confirmed that Nestle's milk products produced in China were tainted. Nestle declined any possible contamination and buffed off the public scrutiny until October 2nd when Taiwan officially confirmed the contamination of powder milk products produced by Nestle in China. Nestle admitted the test results and started to recall its products on the same day, October 2nd (Washington Times 2008; New York Times 2008a).

Despite a large number of firms whose dairy products were found to be contaminated with melamine, dairy products produced by several companies including American Dairy, Sanyuan and China Dairy, were not found to be contaminated with melamine.

Tainted milk has direct adverse health impacts on consumers, especially infants and children. The Ganshu province reported a total of 14 sick babies by September 10th and one infant died of kidney stones on September 11th (People's Daily 2008). The toll of sick infants and children increased to 53,000. At least 4 babies died by September 22nd (BBC 2008e). The toll of sick children almost doubled to 94,000 by the end of September. On December 10th, the Chinese Ministry of Health reported that the toll of well children was at least 22 million in China (China View 2008).

The milk contamination scandal provoked worldwide attention in a short time span. The U.S. Food and Drug Administration (FDA) issued a health advisory note on infant formula imported from China on September 12th. The US then released a nationwide import alert for food products in general made in China on November 10th

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Jiangxi Bright Dairy. That's the reason Shanghai Bright Dairy didn't stand out with announcement until liquid milk test exposed.

(U.S. FDA 2008). Between September 20th and 27th, 28 countries and regions (including Hong Kong and Taiwan) banned, suspended, or withdrew imports of milk and milk products from China, Malaysia, Singapore, Tanzania, Indonesia, South Korea, Vietnam, Chile, and India (China Trade Remedy Information 2008). The European Union banned imports of infant food-containing milk produced in China on September 25th (EUROPA 2008; BBC 2008e). Furthermore, the milk contamination events significantly affected imports and exports of dairy products. As shown in Figure 7 compared with the same month of 2007, China exported significantly less of dairy products in the fourth quarter of 2008. The scandal significantly triggered dairy consumption switching into foreign brands, which dramatically boosted the imports of dairy products from overseas in the fourth quarter of 2008.

The scandal caused significant consequences on dairy companies. Yili posted a net loss of $US33 million in the third quarter of 2008, much greater than its loss of $US1.9 million in the same quarter of 2007 (China Daily 2008d). Bright had a $57 million gross profit in the third quarter of 2007, but it had a loss of approximately $US40 million in the same quarter of 2008 (China Daily 2008c). Mengniu, the nation's largest liquid-milk producer, estimated its loss due to the scandal totaled $US131 million in 2008 (China Daily 2008e). Sanlu Group, the center of the milk scandal that killed at least six babies and sickened 290,000 others, filed for bankruptcy (China Daily 2008f).

CHAPTER 4: LITERATURE REVIEW

An economic agent is likely affected by various events. An individual firm may announce a new product release, there may be a merger or acquisition (Peterson 1989), or earning reports (MacKinlay 1997), especially if it is a publically traded company. To great extent, those events are under the firm's control. However, there are some events beyond the control of an individual firm. Examples include, but are not limited to, a legislative act being passed, regulatory ruling being announced, product recalls (McWilliams and Siegel 1997), and confirmation of animal disease outbreaks (Jin, Power, and Elbakidze 2008), which may be relevant to meat companies. Inevitably, expected or unexpected events will affect individual firms' market value. It is of the firms' interest to examine the impacts of relevant events. Such investigation on the size and persistence of the event effects will help firms have better crisis management and be better prepared for the possible similar events in the futures.

This chapter provides a review on three relevant literatures on stock market response to abnormal events, on empirical approaches used to investigate such market response, and on the impact of information uncertainty and media coverage.

4.1 Reactions of stock price

Rich literature investigates reactions of stock prices to either expected or unexpected information. Dohlman *et al.* (2002) find price decreases after an announcement of unfavorable regulatory restrictions announcement among biotech firms. Billger (2007) examines stock price reaction to the Occupational Safety and Health Act and finds falling returns after the release of the Act due to the concern that the act may reduce firm profitability. Farka (2008) examines the effect of monetary policy shocks on the

level and volatility of stock returns and finds a spike in returns during the policy announcement.

In the category of environmental events, Hamilton (1995) finds a statistically significant loss in stock prices among pollution firms on the first release of pollution information based on Toxics Release Inventory (TRI). Dasgupta *et al.* (2001) document the impact of public information on environmental behavior on stock prices in developing countries and show that markets are responsive to the environmental information released. Grand and D´Elia (2005) show that positive environmental news does not have an effect on stock returns; but negative news does decrease the returns (focusing specifically on Argentina). Laplante and Lanoie (2001) examine the impact of the announcement of diverse environmental incidents and find declines in stock prices on the day of environmental suit cases resulting in fines.

Financial markets respond negatively to serious threats in meat and poultry recalls (Thomsen and McKenzie 2001). Market values of small firms are found to suffer a steep drop immediately after food recalls in Sanlin and Hooker's study (2001) The initial food recalls with bacterial contamination in Wang et al (2002) research show declined returns and high volatility as a result. Significant and negative effects of Bovine Spongiform Encephalopath (BSE) outbreak are found on market values of related beef firms (Jin and Kim 2008).

The economic impact of food quality problems is a critical issue addressed in the literature with different focuses applying a variety of approaches. The literature mainly focuses on the impacts of food scares on consumer demand, price and price transmission along the supply chain, commodity futures prices and stock prices. Given the objective of this thesis, I focus on stock market responses to food scare

events. Thomsen and McKenzie (2001) indicate that financial markets respond negatively to severe meat and poultry recalls but face no negative impact from less serious violations in recalls. Furthermore, they suggest that the persistence of the losses lasted at least one month after the recalls. Sanlin and Hooker (2001) find that market values for small firms suffered a drop immediately after food recalls, but no large losses in returns for large firms resulted. The initial food recalls with bacterial contamination tested by Wang *et al.* (2002) show lower returns and higher volatility as a result, while, following food recalls by the same company do not react strongly. Jin and Kim (2008) find significant and negative effects of Bovine Spongiform Encephalopathy (BSE) outbreak on security values of related beef firms. Mazzocchi *et al.* (2009) examine the impact of European Commission Regulation 1881/2006 and the English Contaminants in Food Regulation 2007 on 30 food securities listed in the London Stock Exchange. Their results reveal neutral or slightly positive patterns in market returns since the regulations don't bring significant changes to the contamination levels.

4.2 Literature review of approaches investigating market responses

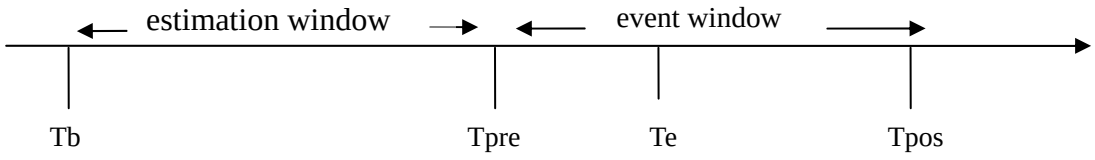
This thesis employs both an event study approach and a GARCH (generalized autoregressive conditional heteroschedastity) model to quantify the event impacts. An event study approach has been extensively used in accounting, finance, as well as economics. A stream of rich literature on event study has accumulated over the past decades since it was first introduced by Fama, Fisher, Jensen and Roll (FFJR) in 1969 (Binder 1998). McWilliams and Siegel (1997) argue that event study is based on the following three assumptions, including (a) market efficiency -- all relevant information is accessible to market traders; (b) events unanticipated by traders as traders cannot gain information prior to the announcement or confirmation of an event;

(c) no confounding events - no other event (or other event can be controlled) during the same event window. Brown and Warner (1980) argue that event study is a direct test for market efficiency rather than an assumption.

The basic procedure for an event study involves the following steps: (1) defining relevant events; (2) collecting relevant data (eg. stock prices of relevant firms) and market indices; (3) running a regression of micro-level data on market indices pre-event; (4) estimating the abnormal rate of returns for relevant agents in the event window (the difference between the predicted and actual rate of returns); and (5) optionally, additionally running further regressions to explain the abnormal returns by firm characteristics.

The basic idea is to quantify the difference between the predicted rate of returns based on information prior to the event and with the actual rate of returns post event. Under the case of business as usual, the predicted rate of returns should be close to the actual value. The difference between the predicted and actual rate of returns, which is termed as abnormal rate of returns, reflects the event impact to great extent.

Following the notation in Peterson (1989), let T_b and T_{pre} denote the starting date in the estimation and event windows; T_e be the date or dates on which relevant events occur; and T_{pos} indicate the last period in the event window. The estimation and event window can then be illustrated below:



The length of both estimation and event windows can be daily, weekly, or monthly. The length of an estimation window mainly depends on data availability. Brown, Lockwood and Lummer (1985) state that the longer period, the better the improved prediction is, but, much more instable model parameters show at the same time. Researchers may need to examine possible structural breaks if the estimation window covers long time periods. An event window is mainly determined by the expectation of the event duration but constrained by data. Practically speaking, researchers include several time periods before the event to control for the possible information leakage. Peterson (1989) gives a typical length for an estimation window: 100-300 days using daily data and 24-60 months using monthly data. The typical length of an event window ranges from 21-121 days using daily data and from 25-121 months using monthly data.

The difference between the predicted and actual rates of returns, which is often called abnormal rates of returns, reflects the event impacts. Brown and Warner (1980, 1985) present three classes of models in deriving abnormal rate of returns in the context of security: mean-adjusted model that defines the abnormal rate of returns as the deviation in the rate of returns from the average rate of returns in the estimation window; market-adjusted model that defines the abnormal rate of returns as the difference between the actual rate of returns and the market portfolio index; and regression model (they called OLS market model).

In this thesis, I use a regression model following the notation in Brown and Warner (1980, 1985). Let n denote the selected companies and t denote each time period. The observed rate of returns and the abnormal rate of returns for company n at time t are given by R_{nt} and AR_{nt}, respectively. The regression model states that an

individual firm's rate of returns is a function of the relevant market indices *m* (R_{mt}) and other relevant factors:

$$R_{nt} = \alpha_n + \beta_n R_{mt} + \varepsilon_{nt} \quad (3)$$

Once α_n and β_n are estimated based on data in the estimation window, researchers forecast the firm's rate of returns in the event window and calculate the difference between the actual and out-sample predicted rates of returns:

$$AR_{nt} = R_{nt} - (\hat{\alpha}_n + \hat{\beta}_n R_{mt}) \quad (4)$$

Abnormal rates of returns are warranted to be standardization mainly due to the following reasons. First, abnormal rates of returns can be divided by standard deviations to make comparable across different firms. Second, analysis of the statistical significance of abnormal returns requires the standardization. Peterson (1989, p43) designates three primary approaches to perform standardization of an individual security's rate of returns at period *t*:

"1. Standardization of an individual security's return in period t by the standard error or standard error of the forecast of that security's mean return in the estimation window;

2. An adjustment of abnormal returns by the standard error of the security return deviation from predicted in the estimation window for all securities in the sample, for all periods within the estimation window; and

3. Standardization of an individual security's abnormal return by the sample crosses sectional standard error for period t in the event window."

Previous studies use the standard error of the forecasted rate of returns either in the event window (e.g. Mikkelson *et al*. 1985) or in the estimation window (e.g. Masulis 1980). Many studies following Dodd and Warner's standardization approach (1983):

$$SAR_{nt} = AR_{nt} / SD_{nt}, \quad (5)$$

where the abnormal return is standardized by its standard deviation.

The OLS regression model in Fama, Fisher, Jensen, and Roll (1969) and Brown and Warner (1985) improve the power of tests for abnormal performance. In the OLS regression, each OLS equation corresponds to individual agent and a total of *n* equations are estimated separately. However, since all these *n* firms are hypothesized to be affected by the same event, some correlation may exist in the error terms. Take the 2008 milk contamination incidents in China as an example. Cross-correlation substantially exists with respect to the same event (milk contamination event), the same estimation windows (before September of 2008), the same industry (eight companies are in China dairy industry) and some other commonalities. To capture such correlations, Zilner's seemingly unrelated estimation is adopted in this thesis where these *n* equations are estimated as a system.

Yang, Haigh and Leatham (2001) used the GARCH model to estimate time-varying patterns of stocks or commodity prices. Other models such as economic model (MacKinlay 1997), capital asset pricing model (CAPM) (Sharpe 1964; Lintner 1965), and arbitrage pricing theory (APT) (Ross 1976), exist in the literature of event study as well.

4.3 Literature review of market information and media coverage

Mass media release following food scare events may play an important role in market reactions. Smith, van Ravenswaay and Thompson (1988) find a significant impact of media coverage following food contamination incidents on milk purchases. Herrmann, Warland and Sterngold (1997) examine the 1989 Alar and find that awareness was linked to more frequent television news watchers and to attention to news on government food and product safety actions. Mazzocchi (2006) uses a media coverage index (MCI) in the demand function to explain consumer response in the aftermath of a food safety incident and suggests that possible spiraling impact of media coverage is taken into account, especially at the early stage of a food scare event. Maynard, Goddard and Conley (2008) find the impact of media coverage is statistically and economically significant in reducing beef consumption following the BSE discoveries. Vilella-Vila and Costa-Font (2008) provide an exploratory analysis of how the press media reports influence GM food as a “direct effect”.

However, other studies find the impact of media coverage is not statistically significant. Marsh, Schroeder and Mintert (2004) use two indexes, the total number of recalls and the total number of news media reports in a quarter to analyze the impact of meat and poultry product recalls on US meat demand between 1994 and 1998. They find that the mass media index was not statistically significant in explaining changes in consumer demand, but consumers’ responses to recalls were negative and statistically significant.

The literature also documents the impact of media coverage on stock prices. Pearce and Roley (1985) claim that daily stock price movements in reaction to economic events in media are commonplace. The relation between the amount of media information and measures of market response including trading volume is proved to be direct and significant (Mitchell and Mulherin 1994). Burton, Young and

Cromb (1999) address the stock information index to account for decreasing lagged impacts. Meschke (2004) finds a strong “run-up” that stocks experience after mass media interviews. Antweiler and Frank (2004) analyze the prediction of market volatility by stock messages and explain their small effect on returns. Fang and Peress (2009) show the cross-sectional relation between media coverage and expected stock returns, and their findings prove the substantial impact of information dissemination on stock returns.

Furthermore, market responses distinct between positive and negative information. Smith, van Ravenswaay, and Thompson (1988) conclude that negative media coverage has a larger effect than positive coverage and imply that public statements by producers or government may be ineffective in restoring consumer confidence following the discovery of a food safety problem, ban, or recall. However, Mazzocchi (2006) show that the distinction between positive and negative media coverage is not necessary when evaluating the impact of news on a food safety incident. More recently, Fang and Feress (2009) document that stocks without media coverage receive higher returns than stocks with high media coverage even after controlling for well-known risk factors.

CHAPTER 5: DATA

The data set used for this thesis consists of stock prices of all dairy companies that play in China's market as well as market food indices in different markets. In order to exclude the impact of exchange rates between countries and ensure comparability among stock prices, daily stock prices are adjusted by exchange rate and converted into the US dollars.

5.1 Selected dairy companies

I select eight dairy companies for the empirical analysis based on the following three criteria: (1) The company is publically traded; (2) Dairy should be the core business of the selected company so that the possible price changes attributed to other product lines are minimal; and (3) The company should have its footprint in China's dairy market. That is, I include both domestic and international dairy companies as long as it has a notable market share in China's dairy market.

As shown in Table 11, the selected eight companies are publically traded in five stock markets. Yili (600887.SS), Bright (600597.SS), and Sanyuan (600429.SS) are listed on the Shanghai Stock Exchange; Mengniu (2319) that was initially a private dairy company went public on the Stock Exchange of Hong Kong; American Dairy (ADY) on the New York Stock Exchange; Synutra (SYUT) on NASDAQ; Nestle (NESN.VX) on the Swiss Exchange; and China Daily Group (T16.SI) on the Stock Exchange of Singapore. China Daily Group (T16.SI), formerly held by Xi'an Yinqiao Biological and Technology Ltd, went public in 2003 on Singapore Exchange market (SGX). In November 2004, it divested its marble and granite business and fully transformed into a professionally managed dairy company.

These selected domestic companies are large firms not only in the dairy industry

but also in China's whole commerce. Bright, Yili and Mengniu are listed in China's top 500 Enterprises (Table 9) with annual sales revenue above 5,000,000,000 (approximately US$758 million) (Table 10). Synutra, Sanyuan, American Dairy, and China Dairy have significant annual sales revenue between 1,000,000,000 CNY (approximately US$152 million) to 5,000,000,000 CNY (Table 10). Table 12 shows the annual revenues of the selected eight dairy companies from 2004 to 2008. Yili and Mengniu are the leading dairy companies in China suggested by the level and growth of their revenue. Bright is a major competitor (Fuller *et al.* 2004a) and ranked third in revenue. Sanyuan, a regional dairy company in Beijing, experienced a steady revenue growth. American dairy and China Dairy had the lowest revenue but in an upward trend. Bright and Synutra are the only companies among the group that had a decrease of 10% and 16% respectively in the annual revenue in 2008.

These eight companies play important roles in China's dairy market, which is demonstrated by their significant market shares (see Figure 5). Mengniu, Yili, and Bright are the top three companies accounting for more than 60% of the market share of liquid milk and half of the yogurt market. Sanyuan is ranked fourth in both liquid milk and yogurt markets with a market share of 5.96 and 5.39% respectively. Yili and Nestle are among the top ten companies in the milk power market.

One limitation pertaining to the selection of dairy companies is that it excluded the main player, Sanlu, from our analysis. Sanlu plays a critical role in China dairy market, especially in yogurt and milk powder markets. It is the first dairy company whose product was found to be contaminated by melamine and the company eventually went bankrupt on December 25th, 2008 (New York Times 2008b). It was a private company whose financial data were not available to the public. In fact, Sanlu's plan to go public was aborted due to the milk contamination scandal. Fonterra, the

core foreign partner of Sanlu and a cooperative owned by nearly 11,000 New Zealand dairy farmers, controls about 95% of the New Zealand's milk business. Fonterra had two brands under its name in China. After it invested in Sanlu and held the second biggest ownership of Sanlu, both brands have been operated by Sanlu. Because of its absence in the Chinese dairy market and the unavailability of its financial data, Fonterra is not included for the analysis.

5.2 Nonsynchronized trading

The problem of nonsynchronized trading should be taken into consideration since these five relevant stock markets operate in different time zones (Eun and Shim 1989). As shown in Figure 8, the stock markets in Shanghai, Hong Kong and Singapore (Asia-Pacific markets) open when the European (Switzerland) and North American (U.S.) markets are closed with the exception of a 1-hour overlap between markets in Singapore and Switzerland. The Switzerland market has 2-hour overlap with the U.S. market. I provide a similar solution for nonsynchronized trading as that in Bessler *et al.* (2009). I assume that the U.S. market cannot influence both European and Asia-Pacific markets contemporaneously, and European markets cannot influence Asia-Pacific based on the assumption that markets, that open ahead and close before another's open, cannot influence the latter.

5.3 Data sources

Daily open and adjusted close prices, daily high and low prices, and daily trading volume of these eight companies are obtained through @Yahoo!Finance. Data of the five corresponding food product indices are obtained through @DataStream, an electronic database system providing historical financial data.

Following data manipulations are implemented. First, stock prices and trading

volume should have missing values when trading is closed either during national holidays and weekends or for some unexpected reason (e.g., September 11th, 2001). However, it is found that in some cases stock prices stayed the same as the previous day, but zero trading volume occurred for some national holidays. Thus I mark all the national holidays for each of the five stock markets and code official holidays when the market is closed as a no-trading day during the time frame of the thesis. Second, I adjusted the stock prices by exchange rate and convert prices into US dollars to make the stock prices comparable

For media coverage, a key-words search with different combinations of “milk contamination”, “melamine” and “China” was used in the database called “Access World News” for articles published worldwide covering local, regional, and world issues. The total number of the new articles in the previous week was used for the media coverage index in each day of the event window. As far as five stock markets are concerned, I collected the weekly cumulative number of media coverage in different markets as well as in the whole world.

5.4 Data descriptions and diagnosis testing

Mikkelson (1981) suggested that the greater degree of correlation between index and security returns, the greater the precision of the estimation. Food product index for each market was chosen as a market index for the selected companies in that particular market. In general, the stock prices of the selected dairy companies are highly correlated with the food product index in the corresponding market. Yili, Bright and Sanyuan are highly correlated with China Food Index as suggested by the correlation coefficients ranging from 0.55 to 0.71. The correlation coefficient between Mengniu and the Hong Kong Food index is 0.61; and 0.69 between Nestle and the

Switz Food Index. American Dairy and Synutra are less correlated with the U.S. Food index (0.25 and 0.19, respectively), and 0.18 between China Dairy and the Singapore Food Index.

Some interesting findings can be obtained at the first glance of market indices as shown in Figure 9. The five food products indices illustrated have an increasing trend till 2008; peaked in later 2007 and early 2008 mainly due to the world food shortages and price spikes (WSWS 2007; CNN 2008); then turned into a downward direction in later 2008 that may be attributed to the economy recession in the U.S. and other countries worldwide.

Figure 10 plots the stock prices of individual companies and the corresponding food index. It suggests the co-movement between individual stock prices and the corresponding food index, especially in the Shanghai, Hong Kong, and Swiss markets.

Table 13 provides summary statistics of the stock price and rate of returns of the eight selected companies and the associated market food products indices for the estimation and event periods (before and after the scandal). Stock prices of the companies publically traded in Hong Kong and foreign stock markets are more volatile as suggested by the higher standard deviation of the price in the estimation and event periods with an exception of China Dairy.

Many economic and financial time series are characterized by a unit root (Hendry and Massmann, 2007). The Dickey-Fuller (DF) and Philip-Perron (PP) tests are commonly used to test the unit root hypothesis. These tests are, however, biased in the presence of omitted structural breaks (Zivot and Andrews, 1992), leading to forecast failure (Hendry and Massmann, 2007). An alternative approach is the Zivot and Andrews (ZA) unit root test that allows for one possible shift in mean, trend, or both. The null hypothesis in the DF type tests (DF, PP, and ZA) is of a unit root (nonstationary), which is accepted unless there is strong evidence against it. The DF type tests have low power against the alternative hypothesis (DeJong et al., 1992; Diebold and Rudebusch, 1990). Kwiatkowski et al. (1992) developed tests (so called KPSS tests) of the null hypothesis of stationarity either around a level or around a

linear trend. I employ both DF type tests and KPSS tests and report the results in Table 14. The DF, PP, and ZA tests fail to reject the null hypothesis that the data series (in logarithm) in level contain a unit root at the 5% level of significance under all three tests (DF, PP and ZA), except the Sanyuan and American Dairy for the ZA tests. The same tests are applied to the first order differences of logarithm of each series. In each case, the unit root hypothesis is rejected at the 5% level of significance. The KPSS tests reject the null hypothesis of stationary in level, but fail to reject stationary in first order difference. Based on results reported in Table 14, it can be concluded that all series are non-stationary in levels but stationary in first order differences. The first order difference of the logarithm of each series is used, which is the rate of return, in the event study analysis and the GARCH estimation.

Table 15 describes the actual daily rate of returns in the first three weeks after the event. The companies highlighted in grey are these companies with negative test results (no contamination). The values highlighted in thick box border on September 11th show a big drop especially for the companies listed in Shanghai and Hong Kong stock markets immediately after Sanlu issued a product recall. Highlighted in grey, on September 16th SAQSIQ conducted tests on milk powder products of 109 companies, but the positive test results were disclosed after trading on September 16th and the negative test results went public during the trade on the following day, September 17th (highlighted in thick box border). When the test results were waiting on September 16th, the stock prices of Yili, Bright and Sanyuan traded in the domestic market decreased by approximately 6-9%, Mengniu traded in Hong Kong and China Dairy in Singapore had a slight price decrease.

On September 17th, both the negative (not contaminated) and positive (contaminated) results became public information in the Asian markets, Yili, Bright

and Mengniu that received the positive test results had limit down on September 17th and their price decreased by approximately 10% for Yili and Bright and by 7.84% for Mengniu. Mengniu halted its trading from 18th to 22nd (20th and 21st were weekends) and resumed on September 23rd (Caijing Magazine 2008a). Sanyuan that received the negative results enjoyed a price gain of 3.73% and its price recovered to the level before the tests were conducted. On the other hand, due to the time difference both the negative and positive test results became public information on September 16th (U.S. Eastern Time). American Dairy whose milk powder products found to be not contaminated has a price increase by 26.15%, but Synutra that received negative results had a significant price loss of 78.76%.

Based on Table 13 and Table 15 on average the stock prices and rate of returns are lower in the event period compared with that in estimation period. To further quantify the impact of the milk contamination, I apply both an event study approach and a GARCH model to control for other confounding factors.

CHAPTER 6: EVENT STUDY ANALYSIS

A literature review on the event study approach is provided in Chapter 4. This chapter presents detailed steps to carry out the event study approach pertaining to the particular food safety event for this thesis and provides empirical findings and discussions.

6.1 Model estimation

Since we are interested in testing the impacts of market information, we specify two particular periods (k =1, 2) in the event window, the pre- and post-test windows, depending whether the test results were released to the public. We denote the event period k of firm i by an interval (t_{ik}^1, t_{ik}^2) such there are T_{ik} days during the window. Due to the nonsynchronized trading, I chose the pre-test window from September 11th to 16th for the Asian-Pacific markets, and September 11th to 15th for the European and US markets. The post-test window is from September 17th to 24th for the Asian market and from 16th to 23rd for the European and U.S. markets. The only exception is Nestle. Nestle (China) received negative test results (not contaminated) for its milk powder and liquid milk products on September 17th and 18th, but positive test results for milk powder in Hong Kong on September 21st and in Taiwan on October 2nd. It did not recall its product until October 2nd (Washington Times 2008; New York Times 2008a). We define the post-test window as October 2nd to 10th for Nestle.

We denote the rate of returns of firm i at time t by R_{it}. It is assumed to be influenced by the relevant market index of food products m denoted by M_{mt} and other unobserved factors captured by the error term ε_{it}:

(1) $R_{it} = \alpha_i + \beta_i M_{mt} + \varepsilon_{it}$

The use of market indices as a covariate helps remove effects of "economy wide factors" from return on individual equity and leaving the portion of the return "attributable to company specific information" (Binder 1998). Since cross-correlation is expected to substantially exist as the companies face a similar food safety risk, we employ Zilner's seeming unrelated regression. Given the estimated parameters, $\hat{\alpha}_i$ and $\hat{\beta}_i$, we forecast the firm's rate of returns in the post-event periods. The estimated difference between the actual and out-sample predicted rates of returns, which are conventionally called as abnormal rate of returns and denoted by AR_{it}, reflects the event impact:

(2) $AR_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i M_{mt})$

The average rate of returns over a total of T_{ik} days during the course of the specific event window *k* for firm *i* is:

(3) $AAR_{ik}(t_{ik}^1, t_{ik}^2) = \dfrac{\sum_{t=t_{ik}^1}^{t_{ik}^2} AR_{it}}{T_{ik}}$

I propose the following hypotheses to test the stock market responses to the milk scandal

Hypothesis 1: The milk scandal affected the stock prices. That is, for each company *i*, the average rates of returns for the entire event window as well for pre- and post-test windows was statistically different from zero: $AAR_{ik}(t_{ik}^1, t_{ik}^2) \neq 0$.

Hypothesis 2: The public disclosure of the product test results at time *r* induced the greatest price reduction for each company that received the positive results

(contaminated), i.e., $AR_{ir} \le AR_{is}$ for $r \neq s$, but companies received the negative results gained on price $AR_{ir} \ge AR_{is}$.

Hypothesis 3: The state of market information affected the significance and the size of the event impact. All the companies experienced a price drop while the market was uncertain about the test results; but some of them had further price drop upon on the positive results and others rebounded on negative results. That is, $AAR_{ik}(t_{ik}^1, t_{ik}^2) \neq AAR_{jk}(t_{jk}^1, t_{jk}^2)$ for $i \neq j$

6.2 Empirical results based on an event study analysis

The Breusch and Pagan (1980) test is conducted in this study to examine the contemporaneous correlation of error terms across cross-sectional units specified in Equation (1). The test statistics equals to 60.18, which exceeds the critical value of $\chi^2(128)=50.99$ at the 1% significant level. We then conclude that contemporaneous correlation of error terms across individual companies exists, which supported Zilner's seemingly unrelated regression.

The top part of Table 16 provides a summary of statistics of the estimated abnormal rate of returns in the entire event window as well as in the pre- and post-test windows, which greatly supports Hypothesis 1. In the entire event window, Yili and Nestlé suffered a significant price drop; Sanyuan received a significant price gain, and others didn't have statistically significant price change. The five companies whose products were found to be contaminated with melamine had negative abnormal rates of returns – the price drop for Yili, Sanyuan, and Nestle was statistically significant up to approximately 4% and insignificant for Bright, Mengniu, and Synutra. Among three companies received negative test results (not contaminated), Sanyuan and American Dairy had a positive return on average in the entire event window and the

price gain for Sanyuan was statistically significant; and China Dairy had a negative average rate of returns but statistically insignificant.

Figure 12 illustrates both the actual (dash line with stars) and predicted (solid line with squares) rates of returns in the event window. The shaded area represents the 95% confidence interval of the forecasted rate of returns. In each panel, the far left vertical dash line indicates the start of the event as Sanlu recalled its products (September 11th), and the far right vertical dash line indicates the date when the test results transmitted to the particular market. The results illustrated in Figure 12 largely support Hypotheses 2. Immediately after the test results transmitted to the stock market, Yili, Bright, Mengniu and Synutra who received positive test results (contaminated) had a further significant price drop. Specifically, the prices of Mengniu traded in Hong Kong and Synutra in the U.S decreased more than 75%; Yili and Bright traded in the domestic stock market experienced a less price drop by approximately 10%. On the other hand, Sanyuan and American Dairy which were found with no contamination had a significant price rebound by approximately 10% and 25%, respectively. Nestle and China Dairy didn't show any significant price change around the confirmation of the test results, although Nestle was found with contamination first in Hong Kong while China Dairy was not contaminated. One possible explanation is that Nestle is a large international company and the dairy business in China is only one small part of its entire business - 12% sales revenue in China in 2007 (ChinaQuality.org). China Dairy is actually a new, small dairy company who was even not included in the liquid milk test. As predicted by Hypothesis 2, the changes in the stock prices were the greatest when the market received the test results. The stock markets appeared to be efficient as it had an instant

response to the disclosure of the market information as well as distinguished between positive and negative market information.

The results summarized in Table 16 provide answers to Hypothesis 3. As the market suspected that all eight companies were involved in the scandal, seven dairy companies experienced negative average abnormal rate of returns in the pre-test window, especially, Bright, Mengniu, and American Dairy had a statistically significant price decrease. Nestle is an exception but the return was also very low (around zero) and statistically insignificant. Among all the firms Mengniu has the largest price decrease of 15% on average in the pre-test window. In the post-test window, the price movement depends on the test results. Companies, especially Yili and Nestle, whose products were founded to be contaminated, continued to have a further price decrease with an exception of Bright. Shanghai Bright Dairy is the shareholder with 51% stock of Jiangxi Bright Dairy. Shanghai Bright Dairy was not tested with contamination in the milk powder (September 16th) but its subsidiary company - Jiangxi Bright Dairy was. Then, Shanghai Bright Dairy made the recall and announcement after the liquid milk test and Bright was tested with contamination. That is the reason Shanghai Bright Dairy didn't stand out with announcement until liquid milk test exposed. The three firms, Sanyuan, American Dairy, and China Dairy, who received negative test results, i.e., no contamination was confirmed, had a price gain. Especially, Sanyuan and American Dairy had significantly positive returns. The positive abnormal return for firms with positive test results is expected and consistent with the results for the pre- and post-event periods showed in Table 16.

Nonparametric student t tests are also conducted for average rates of returns between each pair of companies in the pre- and post-test window. The left lower triangle in Table 17 presents the equal mean test of the abnormal rate of returns

between each pair of the companies, and the right upper triangle is for the post-test window. For each pair of companies, the abnormal rate of returns the company listed in the first column is used as a comparison base. For example, the value of 7.18 in the interaction of the third column and the first row in Table 17 shows that in the post-test window, the average abnormal return of Bright was 7.18 percent points greater than that of Yili and the mean difference in the abnormal rate of returns was statistically significant at the 10% significance level.

The results in the pre-test window suggest that there was not statistically significant difference on the abnormal rate of returns among companies except Nestle. Nestle was the only company had a positive, but statistically insignificant abnormal rate of returns at a small magnitude (0.03%) in the pre-test window. That is, given the information uncertainty, the relevant dairy companies experienced a similar level of a price decrease. On the other hand, in the post-result event window shown in the shaded upper right area of Table 17, more statistical differences of the mean abnormal rate of returns emerged between companies. It's noted that the markets were able to distinguish between quality information and award good performers -- the abnormal rate of returns of companies who received negative test results such as Sanyuan, American Dairy, and China Dairy, were greater than those who were confirmed to be contaminated in the post-test window. Among all the companies, Sanyuan had the statistically significant, highest abnormal rate of returns, and the lowest for Yili and Mengniu but the difference between Yili and Mengniu was not statistically significant. Thus, the equal mean tests for the abnormal rate of returns summarized in Table 17 supports Hypothesis 3.

6.3 Discussion

Two main conclusions can be drawn based on the event study analysis. First, stock

markets respond to market information. The relevant firms all experienced a price drop in the post-event window while the market was waiting for the test results. However, firms who received positive results (contamination is confirmed) had a further price drop, while others who received negative results gained in price, even bounced back to the pre-event level. Second, firms traded in overseas stock markets respond more significantly to the food scare events. Among the firms whose products were found to be contaminated with melamine, the price decrease was greater of the companies traded in the foreign stock markets (Mengniu, Synutra, and Nestle) compared those traded in the domestic market. On the other hand, among the firms whose products were found not contaminated with melamine, American Dairy traded at NYSE recovered to the pre-event level faster than Sanyuan traded in Shanghai Stock Market shortly after the negative test results were confirmed. The stock prices of these two companies went even higher in the rest of 2008.

CHAPTER 7: TIME SEIRES ANALYSIS –GARCH MODEL

The event study approach assumes that the error terms follow a normal distribution with constant variance, which does not always hold in the case of regressions involving stock returns (Corhay & Rad, 1994; Wang, Salin, Hooker, & Leatham, 2002). If the assumption of homoscedasticity is not satisfied, the standard tests for the effects of a specific event on stock prices need to be adjusted for heteroscedasticity. In order to validate the results on the event impacts on price levels as well as to further examine the event effects on price volatility, we also conduct time series analyses, in particular, a GARCH (generalized autoregressive conditional heteroscedasticity) model.

7.1 GARCH model

Determining the impact of certain events on the level and volatility of stock returns is a critical step in understanding and investigating the events (Farka 2008). The GARCH (p, q) model, where *p* is the lag length of the squared residuals and *q* is the lag length for the conditional variance (Tsay 2005), is formally expressed by a mean equation (12a) and variance equation (12b) below:

$$R_{it} = a_{i0} + b_i M_{kt} + a_{i1} R_{i(t-1)} + a_{i2} R_{i(t-2)}. + ... + a_{is} R_{i(t-s)} + \varepsilon_{it} \quad (12a)$$

$$\sigma_{it}^2 = \alpha_{i0} + \sum_{j=1}^{p} \alpha_{ij} \varepsilon_{i(t-j)}^2 + \sum_{j=1}^{q} \beta_{ij} \varepsilon_{i(t-j)}^2 \quad (12b)$$

The mean equation incorporates the corresponding market index to control the overall market influence. It also includes lags of the dependent variable to account for possible serial correlation in successive stock prices, where the number of lags is optimally determined by the estimation of autocorrelation function, partial

autocorrelation function and extended autocorrelation function. The conditional variance equation consists of lagged squared residuals illustrates the price volatility.

I test for ARCH/GARCH effects using equation (12) and joint estimation of Autoregressive model (AR) and GARCH model is considered. The null hypothesis is H0: there are no ARCH effects at the 5% significance level. In this thesis, the process to determine GARCH terms follows the steps outlined in Tsay (2005): (1) look at the autocorrelation function (ACF) and partial autocorrelation function (PACF) of squared residuals of the ARMA model; (2) Ljung-Box Q2(m) statistics using the squared residuals; (3) test Akaike information criterion (AIC) as a measure of the goodness of fit; (4) if the GARCH model is optimal, the resulting squared residuals from GARCH models should look like a white noise process. I mainly rely on the AIC and Ljung-Box statistics to determine the model fit among different alternatives. The time series models best fit the data are: Yili and Bright is a GARCH (1,1) model; Sanyuan is a joint AR(1,4) - GARCH (1,1) model; Mengniu is a joint AR(2) – GARCH(1,1) model; American Dairy is a joint AR(3) – GARCH(1,1) model; Synutra is a joint AR(3) – GARCH(1,1) model; Nestle is a ARCH(1) model; and China Dairy is a joint AR(1,2) – GARCH(1,1) model.

I first conduct out-sample forecast of the mean and conditional variance of the rate of returns in the event window based on the GARCH model using the data in the estimation window. Then I fit another GARCH model using all the data in the estimation and event window and obtain in-sample prediction of the mean and conditional variance. Based on sample size, identifying the degree of freedom, calculating predicted variance, and finding critical value corresponding to the given level of confidence, I calculate two-sided confidence interval for variance. The event impact on the price level is estimated by comparing the out-sample prediction and

actual rates of returns. The comparison on the conditional variance between the out- and in-sample predictions reflects the event impact on the volatility of rate of returns and therefore stock prices.

7.2 Empirical results

Figure 13 illustrates both the actual (dash line with stars) and predicted (solid line with squares) rate of returns in the post-event window based on the GARCH estimation. The shaded area represents the 95% confidence interval of the forecasted rate of returns. In each panel, the far left vertical dash line indicates the start of the event as Sanlu recalled its products (September 11th), and the far right vertical dash line indicates the recall date by each company, except Sanyuan, American Dairy and China Dairy whose products were not found to be contaminated with melamine.

The results are similar to those based on the event study analysis illustrated in Figure 12, which provide a good cross validation. Overall, the rate of returns of eight companies had a decrease since the start of the event before the test results went public. Immediately following the positive test results, Yili, Bright, Mengniu and Synutra had a further significant price drop as their products were found to be contaminated. Specifically, Mengniu traded in Hong Kong and Synutra in the U.S. decreased more than 50%, while, the price drop of Yili and Bright traded in the domestic market were less significant. On the other hand, Sanyuan and American Dairy, tested without contamination, had a significant price gain immediately following the release of the test results. Again, Nestle who was tested with contamination and China Dairy who was tested without contamination did not have a significant price change, which is the same as found in the event analysis.

The results in Figure 14 reflect the change in the volatility of rates of returns. Firstly, the incidents increased the volatility of rate of returns, and the increase in volatility was stronger on the day when the test results went public, especially for American Dairy and Synutra as well as Bright. Yili and Mengniu showed strong volatility but in the following days and the difference between predicted and real one was considerable. Secondly, from the aspect of size, Mengniu, American Dairy and Synutra – all listed on international stock markets – had statistically significant volatility on the test results day with a large spread (hundreds or thousand times more). Thirdly, looking at the trend afterwards, Sanyuan's volatility kept increasing after most dairy companies recalled, while Nestle and China Dairy showed a decreased trend after recall dates.

7.3 Discussion

The conclusions can be drawn for both level and volatility of rates for returns, and ultimately the stock prices based on time series GARCH model analysis. Symmetric impacts on prices are identified between firms with negative and positive test results as well as across different markets. In particular, following the media announcement of the incidents, firms tested with contamination suffered a further price drop and ones without contamination bounced back and gained in price then. Firms listed in international stock markets reflected to the food safety hazard more sensitively. It's noted to point out that, for the price level, the findings based on the GARCH estimation are consistent with that based on the event analysis. For price volatility, an increased fluctuation showed around recall dates. Moreover, the fluctuation performed with bigger scale range for the firms listed in international stock markets.

CHAPTER 8: IMPACTS OF MARKET INFORMATION AND MEDIA COVERAGE

Both the event study analysis and the GARCH estimation suggest that the 2008 China milk scandal have had significant impacts on stock prices and the impacts differ among companies, across markets, and among different market information. I employ regression analyses to further examine the roles that market information and media coverage have had on the asymmetric event effects.

8.1 The model

The indicators of market information are given by S_{it}^{z} , where $Z = U$ indicating information uncertainty where the public was awaiting for the test results; $Z = C$ implying the positive test results (confirmed contamination); and Z = NC for the negative test results (no contamination). I use C_{mt} to denote the weekly cumulative number of news in each relevant market *m* up to time period *t* that measures media exposures. Two firm attributes, years of a firm traded in the stock market denoted by *age* and percent of governmental ownership denoted by *own*, are also incorporated. I formulate the abnormal rate of returns in the event window below:

$$ARR_{it} = \sum_{z} \alpha_z S_{it}^{z} + \sum_{m} \beta_m M_m + \sum \lambda \, S_{it}^{z} \otimes M_m + \sum \theta S_{it}^{z} \otimes C_{mt} + \gamma_1 age_i + \gamma_2 own_i + F_i + \mu_{it} \quad , \quad (14)$$

where M_m and F_i indicate each market and firm, respectively; and μ_{it} are the error terms. The interactive terms between the market information and the market dummies, $S_{it}^{k} \otimes M_m$, allow us to examine whether the event impacts differ between firms in different markets with the same market information. Similarly, the interactive terms between the market information and media exposure, $\theta S_{it}^{z} \otimes C_{mt}$, allow us to

examine whether the impact of media exposure depends on the type of market information. The summary statistics of the independent variables specified in equation (14) are given in Table 18. The weekly accumulative media coverage is the number of the new articles in the previous week which was used for the media coverage index in each day of the event window. Around the food safety scandal outbreaks and recalls, media coverage number was much more than the number before or after the events. In different markets, international markets explored more news articles about the scandal events. Moreover, firm's characteristics variables show that these firms have been traded in the stock market about 5.6 years on average; and the companies in China domestic stock market (Yili, Bright and Sanyuan) have the percent of governmental ownership with maximum 35.27% and companies traded oversea don't have it at all.

Two models are estimated, one with firm attributes and the other without these attributes. For each model specification, the Hausman test favors the random-effects model over the fixed-effects models.

8.2 Empirical results

Table 19 summarizes the estimated results of the random-effect model and Table 20 further quantify the impacts of market information, media exposure, and firm attributes on the event size. The following findings can be drawn.

First, the market information plays a statistically significant role on the event impacts reflected by the abnormal rate of returns in all the stock markets, except Nestle in the Swiss Exchange. In particular, relative to the companies confirmed without contamination, those companies found to be contaminated had a statistically significant lower abnormal rates of returns in all the markets, except the Stock Exchange of Swiss (see the last column in the upper section of Table 19). In the Shanghai and Hong Kong markets, the abnormal rate of returns was the lowest if the

companies are found to be positive on contamination; the highest if no contamination was found; and the abnormal rate of returns was in between when uncertainty of the test results exists. However, in the U.S. market, the rate of returns under the information uncertainty is the lowest, which differs from the results in the Shanghai and Hong Kong markets. The difference may due to the significant market reaction to information uncertainty with a great suspicion of the positive results (contaminated).

Second, the impacts of the market information differ between two similar firms traded in different stock markets. Compared to a firm traded on the Shanghai Stock Exchange, similar firms traded in Hong Kong, Swiss and U.S. markets have a statistically significant lower abnormal rate of returns for each type of the market information, which further support the finding in the event study and time series analyses that companies traded in the overseas markets, especially in the U.S., responded more strongly than those in the domestic market. Furthermore, the difference of the abnormal rate of returns was greater for two companies traded in different markets when the market information transmitted to the market than when they face market uncertainty.

Third, media exposure decreases the abnormal rate of returns of the companies found to be contaminated with melanin, but the impact is not statistically significant. On the other hand, companies found no contamination in their products gained from media exposure as it has a statistically significant, positive effect on the abnormal rate of returns among those firms. In particular, an increase of the weekly cumulative media news by a thousand count increases the abnormal rate of returns by 2.5 percent points.

Fourth, it’s also founded that tenure in the stock market and percent of the

government ownership have statistically significant, positive effect on the abnormal rate of returns. Firms traded in the stock market longer may learn from different market crises in the past and, thus, have better crisis management to subdue the adverse impact of the food scare events like the 2008 milk scandal.

8.3 Discussion

A random-effects model reveals the consistency but further insights of the event impacts on stock prices. First, the market distinguishes between good and bad performers -- dairy firms gain when their products are found not to be contaminated, but others experienced a significant price drop and volatility. Second, compared to the Shanghai market, the oversee markets (Hong Kong and U.S.) reacted more significantly to market uncertainty as the market was waiting for the test results. Third, good performers, i.e., those companies found no contamination in their products, gained from media coverage. Fourth, firms' characteristics did have significant impacts on the event impact.

CHAPTER 9: CONCLUSIONS

The 2008 milk contamination incidents in China caught the attention of the world. Employing an event study approach and a GARCH model, this thesis quantifies the impact of the scandal on stock prices of dairy companies traded in five different markets. I find distinct event impacts between the results of product tests (negative vs. positive), across different stock markets, and between different market information (pre- and post-test periods). I also employ a random-effect model to explore whether and by how much market information, media coverage, and firm attributes attenuate or facilitate the event impacts.

The major findings can be summarized below. I find that the 2008 milk scandal did have significant effects on the level and volatility of dairy firms' stock prices. When the scandal was extensive in media coverage but the market was waiting for the results of product tests, all selected dairy companies suffered a price drop; and the estimated abnormal rate of returns show no statistical difference between companies. The test results steered the impacts. In general, companies tested with contamination suffered a further price loss, while the stock prices of companies tested without contamination bounced back and even gained compared to the pre-event level. The incidents increased the volatility of prices and the increase in volatility was stronger on the dates when the results were announced. Second, different impacts are identified across different markets. Firms traded in overseas stock markets reacted more strongly than those publically traded in China. Third, media coverage and firm attributes affect the event impacts. Companies found not to be contaminated may gain from the media coverage during the course of the event, which provide some insights to safety crisis management among firms. A more experienced firm measured by a

longer time traded in the stock market, and a firm with a greater share of governmental ownership tends to have a smaller adverse impact by the scandal.

One limitation pertaining to the selection of dairy companies is that it excluded the main player, Sanlu, from our analysis. Sanlu plays a critical role in China dairy market, especially in yogurt and milk powder markets. It was first dairy company that was found to be contaminated with melamine and eventually went bankruptcy on December 25th, 2008 (New York Times 2008b). It was a private company whose financial data were not available to the public. Sanlu's core foreign partner Fonterra, a co-operative owned by nearly 11,000 dairy farmers in New Zealand, is mainly focused on New Zealand controlling about 95% of New Zealand's milk business. Because of its absence in the Chinese dairy market and the unavailability of its financial data, Fonterra is not included in the selected companies.

There are several envisions for future researchers. First, it takes time to implement appropriate recovery strategies as well as the market recovery. Chinese government acted quickly in response to the milk scandal by passing new regulations to raise entry barriers to the dairy industry, providing stronger financial support, and specifying stricter supervision of dairy's safety and quality. Individual companies such as Mengniu, Yili and Bright had quick crisis management as well as well as more measures to safeguarding food safety. It is of interest to examine whether and how consumer confidence change in the post-event as specified in this study as well as in the longer time periods. Second, when facing a food scare event, it is quite possible that different consumers may respond differently and different brands may be affected differently a category with differentiated products. One future research is to examine the variation in response to the 2008 milk scandal across the different types of brands in a category and across heterogeneous consumers. Such investigation at the

micro level of individual consumers and brands will help food industry and policy makers implement better crisis management should food scare events occur. In particular, if we find that when facing such events, consumers merely switch between brands in a product category as opposed to stop buying the product category, brand differentiation may help to soften the impact on the industry or speed-up the recovery from such events. An understanding of the profiles between consumers who are more likely to alter their brand choice and consumption patterns and those who are less likely to do so can provide valuable insights to both government agencies and industry managers for managing market response and recovery.

Table 1. Annual Per Capita Consumption of Liquid Milk Worldwide (kilogram)

Region	Country	2000	2001	2002	2003	2004	2005	2006	2007	2008
European	Denmark	133.1	134.0	135.7	136.7	137.2	135.7	139.7	138.0	N/A
	European Union	N/A	90.7	91.7	92.8	92.8	93.2	93.1	89.5	89.3
	France	92.5	92.6	92.5	92.9	91.7	92.0	89.4	89.7	86.8
	Germany	89.9	90.1	91.0	93.9	93.1	92.8	94.4	95.0	94.0
	Ireland	144.2	157.0	157.0	155.7	148.6	135.3	134.0	130.7	N/A
	Italy	63.7	63.1	57.1	56.8	63.1	65.5	65.7	63.4	64.1
	Netherlands	125.8	120.2	120.5	127.7	127.1	126.5	123.6	123.3	119.4
	Norway	123.4	121.9	121.3	115.2	115.6	114.8	116.7	118.0	116.2
	Spain	123.8	129.7	122.1	120.0	119.7	116.9	114.2	112.0	108.6
	Sweden	92.5	101.2	106.3	108.5	110.4	80.7	81.1	79.0	79.9
	United Kingdom	114.8	111.8	111.4	111.6	108.9	103.9	104.8	105.1	N/A
North American	Canada	95.8	94.9	91.8	95.0	95.8	94.7	92.8	92.5	92.1
	Mexico	38.1	36.6	39.1	39.0	39.8	38.3	40.7	N/A	N/A
	United States	87.6	86.3	85.5	84.9	84.2	83.7	83.8	83.0	82.6
Asian-Pacific	Australia	102.3	103.1	104.2	105.5	106.2	113.3	116.8	107.2	107.2
	China	1.0	2.2	3.2	5.1	7.2	8.8	N/A	N/A	N/A
	Japan	37.0	35.6	39.2	38.5	38.0	36.7	35.8	34.9	N/A
	New Zealand	99.0	98.7	97.0	90.0	90.0	90.0	N/A	N/A	N/A
Other regions	Argentina	69.8	70.9	62.2	40.4	42.4	44.2	43.9	43.9	N/A
	Brazil	74.6	74.5	71.2	71.0	72.0	73.2	N/A	N/A	N/A
	South Africa	30.3	29.4	29.4	29.5	26.1	36.8	37.9	39.1	N/A

Source: China Milk Year Book (2009) and International Dairy Federation, Bulletin, 423/2007.

Table 2. Dairy Consumption and Its Decomposition among Urban Residents in China, 1997-2009

	Level (kg / person)			Decomposition (%)		
Year	Liquid milk	Yogurt	Milk powder	Liquid milk	Yogurt	Milk powder
1997	5.07	0.44	2.87	60.50	5.25	34.25
1998	6.18	0.64	3.01	82.87	6.51	30.62
1999	7.88	0.87	3.08	66.61	7.35	26.04
2000	9.94	1.12	3.43	68.60	7.73	23.57
2001	11.90	1.36	3.50	71.00	8.11	20.88
2002	15.68	1.82	3.85	73.44	8.52	18.03
2003	18.62	2.52	3.92	74.27	10.09	15.64
2004	18.83	2.85	3.57	74.57	11.29	14.14
2005	17.92	3.23	3.64	72.29	13.03	14.68
2006	18.32	3.72	3.50	71.71	14.57	13.70
2007	17.75	3.97	3.15	71.37	15.96	12.67
2008	15.19	3.54	3.99	66.86	15.58	17.56
Average	13.61	2.17	3.46	71.17	10.33	20.15

Source: China Milk Year Book (2006-2009) and China Dairy Statistical Report (2009). Milk powder converted to milk equivalent at a rate of 7:1.

Table 3. Quarterly Consumption (Q) and Price (P) of Dairy Products in China, 2008

	Liquid Milk		Yogurt		Milk Powder	
Quarter	Q	P	Q	P	Q	P
1	3.98	6.18	0.75	7.01	0.15	67.20
	(167%)	(34%)	(134%)	(2%)	(249%)	(22%)
2	4.07	6.46	1.02	7.33	0.15	74.80
	(38%)	(34%)	(117%)	(7%)	(275%)	(42%)
3	3.95	6.60	1.15	7.14	0.14	74.07
	(171%)	(40%)	(135%)	(3%)	(324%)	(14%)
4	3.19	7.08	0.62	8.18	0.13	85.00
	(107%)	(50%)	(59%)	(17%)	(225%)	(54%)

Note: Numbers in parentheses are the changes from 2007 to 2008. The unit of Price is Chinese Yuan (CNY) per kilogram and the unit of consumption is kilogram per person.

Table 4. National Average Nominal Price and Real Price of Dairy Products in China, 2004-2008

Nominal Price	2004	2005	2006	2007	2008
Liquid milk	4.58	4.41	4.74	5.19	6.55
Yogurt	6.11	6.32	6.45	6.34	7.35
Milk Powder	37.18	43.73	48.08	55.60	74.95

Real Price	2004	2005	2006	2007	2008
Liquid milk	4.41	4.33	4.67	4.95	6.19
Yogurt	5.88	6.21	6.35	6.05	6.94
Milk Powder	35.78	42.96	47.37	53.05	70.77

Source: China Milk Year Book (2006-2009)

Table 5. Domestic Dairy Production, Imports and Exports

Production	Dairy	Liquid milk	Milk powder
2004	23684	8067	900
2005	28648	9748	900
2006	33025	10330	1100
2007	36334	11960	1300
2008	37600	12658	1200

Imports	Liquid milk		Yogurt		Milk powder	
	Quantity	Expense	Quantity	Expense	Quantity	Expense
2004	3498	4988	492	1146	144931	271138
2005	4279	7221	497	1437	106875	232750
2006	4550	6893	784	1724	134917	289415
2007	4859	8763	731	2100	98186	323840
2008	8220	15398	785	2870	101027	398118

Exports	Liquid milk		Yogurt		Milk powder	
	Quantity	Expense	Quantity	Expense	Quantity	Expense
2004	31422	20775	782	651	9289	20874
2005	34565	23356	1031	738	17764	43924
2006	39702	24681	1060	816	20577	52785
2007	47224	31317	1665	1822	62038	173912
2008	39532	31310	1104	1725	63771	236693

Note: Domestic production for Yogurt is not available. The unit of domestic production is 1,000 ton. The units of “Imports” and “Exports” are ton for quantity and US$1,000 for expenses.

Table 6. Top Ten Dairy Companies in the Liquid Milk Markets

Company name	2004		2005		2006	
	Rank	Market Share	Rank	Market Share	Rank	Market Share
Bright	2	14.92	3	15.52	3	13.93
China Dairy	8	1.44	8	1.8	8	1.86
Haihe	6	2.88	6	2.57	6	2.73
Huishan					9	1.85
Jiabao			10	1.32	10	1.62
Jule	9	1.36				
Mengniu	1	21.89	1	26.06	1	29.01
Sanhuan	10	1.31				
Sanyuan	4	7.99	4	6.19	4	5.99
Shenyang Dairy	5	3.24	7	2.27		
Tianyou			9	1.46	7	2.33
Iigang	7	2.84	5	3.12	5	3.03
Yili	3	12.06	2	16.19	2	17.46

Source: China Milk Year Book (2006-2009)

Table 7. Top Ten Dairy Companies in the Yogurt Markets

Company name	2004		2005		2006	
	Rank	Market Share	Rank	Market Share	Rank	Market Share
Bright	1	19.86	1	19.29	1	17.39
Danone	7	3.54	5	4.88	5	4.72
Huishan	5	4.85	9	2.99	9	2.58
Kangle			10	2.95		
Mengniu	2	9.81	2	17.59	2	16.97
Sanlu	8	3.35	6	3.56	8	2.65
Sanyuan	3	6.1	4	5.78	4	5.39
Tianyou	9	2.3	8	3.4	10	2.44
Iigang	6	3.76	7	3.43	7	2.84
Iiquan					6	3.88
Yili	4	5.06	3	7.34	3	13.34
Youzhiyou	10	1.91				

Source: China Milk Year Book (2006-2009)

Table 8. Top Ten Dairy Companies in the Milk Powder Markets

Company	2004		2005		2006	
name	Rank	Market Share	Rank	Market Share	Rank	Market Share
Abbott*	6	4.26	5	10.45	3	13.97
Anchor*			10	1.88		
Anvent*					7	2.38
Ausnatra*					9	1.75
China Dairy	7	4.23				
Dumex*					2	13.99
Holland**			9	2.13		
Intel*	2	10.27	2	14.36		
Meadjohson*	3	9.33	1	17.66	1	16.41
Nestle *	1	19.62	3	12.63	5	11.07
Newzealand**	8	2.96	7	2.79		
Sanlu	8	3.03	8	2.16	8	2.25
Scient*					10	1.53
Wandashan	10	2.96				
Wyeth*	5	4.82	4	11.81	4	12.78
Yili	4	6.99	6	4.09	6	4.4

Source: China Milk Year Book (2006-2009)

Note: The asterisk, *, indicates foreign dairy companies; and ** indicates that total revenue for all Holland (or New Zealand) dairy companies in China.

Table 9. Domestic Dairy Companies Listed in China's Top 500 Enterprises

		Rank in the China's Top 500 Enterprises			
Company	Province	2008	2007	2006	2005
Bright	Shanghai	95	88	434	359
Yili	Inner Mongolia	248	235	248	289
Mengniu	Inner Mongolia	225	237	287	337
New Hope Group	Sichuan	186	238	187	394
VV Food & Beverage	Jiangsu	437	384	327	294
Sanlu	Hebei	476	427	411	404

Source: China Milk Year Book (2006-2009). Top 500 companies are selected by China Enterprise Confederation (CEC) and China Enterprise Directors Association (CEDA).

Note: Companies that are in bold are those selected for the analysis in this thesis.

Table 10. Large Dairy Companies Based on Their Sales Revenue

Sales Revenue above 5,000,000,000 (CNY)	
Company	Sales Revenue (billion, CNY)
Mengniu	23.87
Yili	21.66
Bright	7.36
Sales Revenue above 1,000,000,000 (CNY)	
Company	Sales Revenue (billion, CNY)
Wondersun (Heilongjiang)	3.05
Synutra (Qingdao)	2.37
Jiabao (Jinan)	1.86
Sanyuan (Beijing)	1.41
American Dairy (Heilongjiang)	1.31
China Dairy (Xi'an)	1.27
New Hope Group	1.24
Junle (Shijiezhuang)	1.06
Shenyang Dairy	1.00

Source: China Dairy Statistical Report (2009)

Note: Companies that are in bold are the selected companies for the analysis in this thesis.

Table 11: Data Sources of the Eight Selected Dairy Companies and Six Food Product Indices

Company	Stock Market	Ticket Name	Date Went to Public	Price Unit	Data Sources
Yili	SHA	600887.SS	1-Jan-2003	CNY	Yahoo finance
Bright	SHA	600597.SS	29-Aug-2002	CNY	Yahoo finance
Sanyuan	SHA	600429.SS	15-Sep-2003	CNY	Yahoo finance
Mengniu	HK	2319	10-Jun-2004	HKD	Yahoo finance
American Dairy	NYSEArca	ADY	20-Nov-2001	USD	Yahoo finance
Synutra	NasdaqGS	SYUT	21-Dec-2004	USD	Yahoo finance
Nestle	SWX	NESN.VX	25-Jun-2001	CHF	Yahoo finance
China Dairy	SGX	T16.SI	1-Nov-2004	SGD	Yahoo finance
Market food indices					
China Food Products Index	China		9-Aug-1993	CNY	DataStream
Hong Kong Food Products Index	Hong Kong		30-Mar-1994	HKD	DataStream
U.S. Food Products Index	United States		2-Jan-1973	USD	DataStream
SWITZ Food Products Index	Switzerland		1-Jan-1973	CHF	DataStream
Singapore Food Products Index	Singapore		1-Jan-1973	SGD	DataStream

Note: CNY, HKD, USD, CHF, and SGD represent Chinese Yuan, Hong Kong Dollar, U.S. Dollar, Swiss Franc, and Singapore Dollar. SGX and SWX indicate Singapore Exchange Limited and Switzerland Exchange, respectively.

Table 12. Revenue of the Eight Selected Publically Traded Companies, 2004 - 2008 (million CNY)

Company	2004	2005	2006	2007	2008
Yili	8735.00	12175.30	16579.70	19359.70	21658.60
Bright	6785.70	6903.90	7443.40	8206.00	7358.50
Sanyuan	1008.60	986.50	1011.50	1102.30	1413.60
Mengniu	7213.80	10825.00	16246.40	21318.10	23865.00
American Dairy	37.40	68.20	115.10	163.90	193.20
Synutra	63.50	132.30	216.60	362.10	312.50
Nestle*	84690.00	91115.00	98458.00	107552.00	109908.00
China Dairy	120.50	165.10	199.40	224.10	270.40

Source: Compiles based on companies' annual reports, income statement, and China milk year books
Note: The Asterisk (*) denotes Nestlé's revenue is not limited to the revenue in the Great China region.

Table 13. Stock Price and Rate of Returns before and after the 2008 Milk Contamination Scandal

		Inception – 8/31/2008[a]		9/1-12/31/2008	
	Inception date	Price	Rate of returns	Price	Rate of returns
China Food Index	8/29/2002	54.55	-0.01	47.63	-0.21
		(23.44)	(1.94)	(4.35)	(3.31)
Yili	1/1/2003	2.28	-0.04	1.33	-0.82
		(1.02)	(3.36)	(0.35)	(4.80)
Bright	8/29/2002	1.11	-0.06	0.64	-0.39
		(0.41)	(3.41)	(0.09)	(4.70)
Sanyuan	9/15/2003	0.60	-0.01	0.55	2.24
		(0.29)	(3.23)	(0.10)	(6.57)
HK Food Index	6/10/2004	30.52	0.08	34.05	-0.30
		(12.42)	(1.66)	(3.99)	(3.06)
Mengniu	6/10/2004	1.81	0.07	1.30	-1.06
		(1.16)	(3.82)	(0.65)	(10.95)
US Food Index	11/20/2001	2497.33	0.02	2410.92	-0.23
		(306.91)	(0.78)	(236.21)	(2.67)
American Dairy	11/20/2001	8.09	0.15	12.36	0.48
		(6.48)	(4.56)	(2.44)	(7.07)
Synutra	12/21/2004	14.72	0.27	17.70	-1.76
		(12.58)	(6.54)	(11.42)	(13.45)
Switz Food Index	6/25/2001	1211.64	0.04	1626.55	-0.15
		(375.88)	(1.29)	(133.43)	(2.84)
Nestle	6/25/2001	15.97	0.12	39.20	-0.14
		(12.98)	(2.02)	(3.28)	(2.99)
Singapore Food Index	11/1/2004	351.02	0.03	211.57	-0.40
		(88.41)	(1.67)	(35.22)	(5.38)
China Dairy	11/1/2004	0.21	-0.04	0.06	-0.68
		(0.09)	(4.96)	(0.02)	(11.53)

Note: [a] several companies may be listed in a particular stock market. To make it comparable, the summary statistics of the market index starts from the earliest date that at least one relevant company started its public trading. Numbers in parentheses are standard deviation.

Table 14. Tests for Non-Stationarity of Data Series

	Null hypothesis for Dickey-Fuller, Phillips-Perron, and Zivot-Andrews tests: containing a unit root (non-stationary)					
data	Dickey Fuller Test		Phillips-Perron test		Zivot-Andrews test [a]	
series	Level	Diff.	Level	Diff.	Level	Diff.
1	-1.39	-30.46**	--1.40	--30.44**	-3.46	-15.16**
2	-1.46	-30.82**	-1.48	--30.82**	-3.82	-14.74**
3	-1.16	-23.95**	-1.55	-24.63**	-5.00*	-11.48**
4	-1.31	-31.15**	-1.34	-31.16**	-2.52	-12.95**
5	-2.12	-29.62**	-2.12	-29.57**	-5.25*	-15.81**
6	-1.68	-26.52**	-1.77	-26.24**	-2.39	-15.22**
7	-1.00	-32.92**	0.94	-33.05**	--3.20	-14.30**
8	-0.92	-36.45**	-0.67	-36.49**	-4.01	-36.75**
	Null hypothesis for KPSS tests: stationary					
Level	L = 0	L = 1	L = 2	L = 3	L = 4	L = 5
1	17.60**	8.81**	5.89**	4.43**	3.56**	2.97**
2	11.80**	5.91**	3.95**	2.97**	2.39**	2.00**
3	6.65**	3.34**	2.24**	1.69**	1.36**	1.14**
4	13.30**	6.69**	3.36**	2.70**	2.25**	1.94**
5	18.00**	9.01**	6.03**	4.54**	3.64**	3.04**
6	5.22**	2.63**	1.77**	1.34**	1.08**	0.91**
7	6.52**	3.29**	2.21**	1.66**	1.34**	1.12**
8	21.70**	10.90**	7.26**	5.45**	4.37**	3.65**
difference	L = 0	L = 1	L = 2	L = 3	L = 4	L = 5
1	0.07	0.07	0.07	0.07	0.07	0.07
2	0.10	0.10	0.10	0.11	0.10	0.10
3	0.09	0.09	0.07	0.07	0.06	0.06
4	0.13	0.13	0.13	0.13	0.13	0.12
5	0.04	0.05	0.04	0.04	0.04	0.05
6	0.08	0.08	0.07	0.07	0.07	0.07
7	0.05	0.05	0.05	0.06	0.06	0.06
8	0.04	0.04	0.04	0.05	0.05	0.05

Note: The asterisks, * and **, indicate 5% and 1% significance level. The critical values at the 5% and 1% significance levels are -2.86 and -3.43 for both Dickey-Fuller tests and Philip-Perron tests; -4.80 and -5.43 for Zivot-Andrews tests; and 0.15 and 0.22 for KPSS tests.

[a] The results of Ziovot-Andrews tests reported pertain to a potential structural break occurring in intercept, which are consistent if allowing for break to occur in trend or both intercept and trend.

Table 15. Actual Rate of Returns in the First Three Weeks after the Event

	Shanghai			HK	Singapore	U.S.		Swiss
date	Yili	Bright	Sanyuan	Mengniu	China Dairy	American Dairy	Synutra	Nestle
9/8	-0.2	-6.23	-7.46	2.06	0.13	4.45	2.82	0.45
9/9	2.42	2.71	1.77	-1.99	-0.15	0.42	-8.12	2.63
9/10	0	1.71	0.3	0.7	-0.3	-1.81	1.89	-2.74
9/11	-0.98	-1.29	-1.63	-7.34	0.15	-2.06	0.06	0.84
912	-0.81	-2.74	-0.14	-4.13	-7.17	-12.99	-1.33	2.95
9/15	Chinese holiday, market closed				-7.33	-12.5	-32.18	-0.92
9/16	-6.31	-8.36	-9.29	-0.46	-0.91	26.15	-78.76	-1.73
9/17	-10.34	-10.4	3.73	-7.84	-8.13	-3.44	-7.33	0.92
9/18	-10.5	-3.58	9.72	stopped	8.58	11	-1.99	-1.36
9/19	Stopped		9.6	stopped	0.29	5.22	13.85	2.74
9/22	1.42	9.65	9.54	stopped	1.31	0.29	24.34	1.67
9/23	-10.22	-10.3	9.81	-84.2	-0.61	-1.25	13.03	-3.5
9/24	-9.68	9.29	9.32	2.38	-0.44	-6.09	-9.14	-2.13
9/25	stopped	9.52	9.62	3.33	-0.01	0.41	-4.93	2.08
9/26	2.44	-0.76	acquisition	-1.76	-0.32	-2.07	0.59	-0.95

Table 16. Average Abnormal Rate of Returns for Each Company during Each Event Window

	Entire Window	Pre-test Window	Post-test Window
	mean (std.)	mean (std.)	mean (std.)
Yili	-3.85***	-2.94	-6.69***
	(4.30)	(2.82)	(4.11)
Bright	-0.85	-4.72**	0.49
	(4.53)	(2.56)	(6.25)
Sanyuan	4.81**	-4.12	8.42***
	(6.50)	(5.46)	(4.25)
Mengniu	-4.47	-3.45***	-24.61
	(17.77)	(0.32)	(39.08)
American Dairy	1.33	-9.38**	6.52*
	(9.66)	(5.38)	(10.05)
Syntrua	-4.89	-11.56	-6.36
	(20.04)	(17.09)	(37.63)
Nestle	-0.16**	0.03	-0.34**
	(0.31)	(0.26)	(0.44)
China Dairy	-1.36	-3.34	0.13
	(9.81)	(5.27)	(2.71)

Note: The asterisks, (*, ** and ***) denote at the 10%, 5% and 1% significance levels respectively. The entire event window was separated between the pre- and post-result windows depending on whether the test results were publically released. Numbers in parentheses are standard deviation.

Table 17. Unpaired T Tests for each two dairy companies in Pre-Test and Post-Test Windows

	Yili	Bright	Sanyuan	Mengniu	ADY	Synutra	Nestle	ChinaDairy
Yili		7.18* (3.35)	15.11*** (2.54)	-17.92 (16.66)	13.21** (4.83)	0.33 (17.07)	6.35*** (1.54)	7.05*** (2.27)
Bright	1.79 (2.69)		7.93** (3.17)	-25.10* (16.89)	6.03 (5.19)	-6.85 (17.17)	-0.83 (2.32)	-0.83 (2.32)
Sanyuan	1.18 (4.34)	-0.61 (4.26)		-33.03** (14.99)	-1.90 (4.45)	-14.78 (15.46)	-8.76*** (1.6)	-8.06*** (2.26)
Mengniu	0.51 (2.01)	-1.28 (1.82)	-0.67 (3.87)		31.13** (15.95)	18.25 (26.91)	24.27* (13.49)	24.97* (16.57)
ADY	6.44 (4.28)	4.66 (4.23)	5.26 (4.93)	5.94 (4.01)		-12.88 (15.90)	-6.86** (3.77)	-6.16 (4.69)
Syntrua	8.62 (12.82)	6.84 (12.81)	7.44 (13.06)	8.12 (12.74)	2.18 (10.34)		6.03 (14.12)	6.72 (17.03)
Nestle	-2.97* (1.5)	-4.75** (1.36)	-4.15 (2.88)	-3.47*** (0.26)	-9.41** (3.11)	-11.59 (9.87)		0.70 (1.12)
ChinaDairy	0.40 (4.20)	-1.39 (4.15)	-0.78 (4.87)	-0.11 (3.93)	-6.04 (4.35)	-8.22 (10.32)	3.37 (3.04)	

Note: The lower left and upper right triangles are for the pre- and post-test windows, respectively. Each cell in the table provides the mean difference of the rate of returns between two companies, the one listed on the first column versus and the other one listed in the first

row, as well as the standard deviations in the parenthesis and the statistical significance indicated by asterisks. , where *, ** and *** denote the 10%, 5% and 1% significance levels, respectively. Numbers in parentheses are standard deviation.

Table 18. Summary Statistics of Variables in the Regression

Market information indicators	Freq.	Percent (%)
U (uncertain)	93	13.21
NC (not contaminated)	241	34.23
C (contaminated)	370	52.56
Stock market	Freq.	Percent (%)
Shanghai	264	37.5
Hong Kong	88	12.5
US	176	25
Swiss	88	12.5
Singapore	88	12.5
Weekly cumulative media coverage in each market		
	freq.	Mean (Std.) Max (Min)
Shanghai	268	49.91 (38.12) 137 (1.00)
Hong Kong	91	1.35 (1.45) 5 0.00
US	176	268.61 (155.39) 634 (57.00)
Swiss	91	92.37 (93.97) 380 0.00
Singapore	100	10.45 (10.84) 51 (1.00)
Firm's characteristics		
years traded in the stock market	704	5.63 (1.25) 7.52 (4.03)
Chinese government-control ownership	704	7.14 (11.66) 35.27 0.00

Note: Three indicators of market information are introduced, where U indicates information uncertainty when the results of the product tests were not released yet; the type of the test results received by each company are districted by NC (Not contaminated) and C (contaminated).

Table 19. Empirical Results of Market Information and Media Coverage

Market information indicator (base = uncertain)	**Model 1**	**Model 2**
NC: not contaminated	7.54***	7.78***
	(0.23)	(0.22)
C: contaminated	-0.47	-0.59***
	(0.30)	(0.19)
Stock markets (base = Shanghai Stock Exchange)		
Hong Kong	-0.79***	-0.15
	(0.21)	(0.20)
US	-3.93***	-3.55***
	(0.34)	(0.22)
Swiss	-0.26	-0.39
	(0.21)	(0.26)
Singapore	-0.18	0.56***
	(0.21)	(0.20)
Interactive terms between market information indicators and stock markets		
not contaminated + U.S.	-3.20***	-3.85***
	(0.42)	(0.22)
not contaminated + Swiss	-8.31***	-8.55***
	(0.26)	(0.24)
not contaminated + Singapore	-7.82***	-8.06***
	(0.23)	(0.22)
contaminated + Hong Kong	0.28	0.40**
	(0.30)	(0.19)
contaminated + US	2.68***	3.21***
	(0.63)	(0.61)
contaminated + Swiss	0.50	0.62**
	(0.36)	(0.26)
Media coverage (cumulative number of news in the corresponding market)		
media coverage + not contaminated	0.00***	0.00***
	(0.00)	(0.00)
media coverage + contaminated	0.00	0.00
	(0.00)	(0.00)
Firm's characteristics		
Years traded in the stock market		0.26***
		(0.05)
Percent of government ownership		0.02***
		(0.00)
no. of observations	595	595
Overall R^2	0.03	0.03

Asterisks, *, ** and ***, indicate the 10%, 5% and 1% significance levels, respectively

Table 20. Impacts of Market Information, Media Coverage, Firm Attributes on Abnormal Rates of Returns

Compare ARRs between different safety indicators (U = uncertain; C = contaminated; NC = not contaminated)			
	C – U	NC -- U	C -- NC
Shanghai	-0.47	7.54***	-8.01***
Hong Kong	-0.19***	7.54***	-7.72***
U.S.	2.21***	4.33***	-2.12***
Swiss	0.03	-0.77***	0.80***
Singapore	-0.47	-0.28***	-0.19
ARRS of firms in different markets but with the same market indicator			
	uncertain	not contaminated	contaminated
Hong Kong	-0.79***	-0.79***	-0.51***
U.S.	-3.93***	-7.13***	-1.25**
Swiss	-0.26	-8.57***	0.24
Singapore	-0.18	-8.00***	-0.18

Asterisks, *, ** and ***, indicate the 10%, 5% and 1% significance levels, respectively

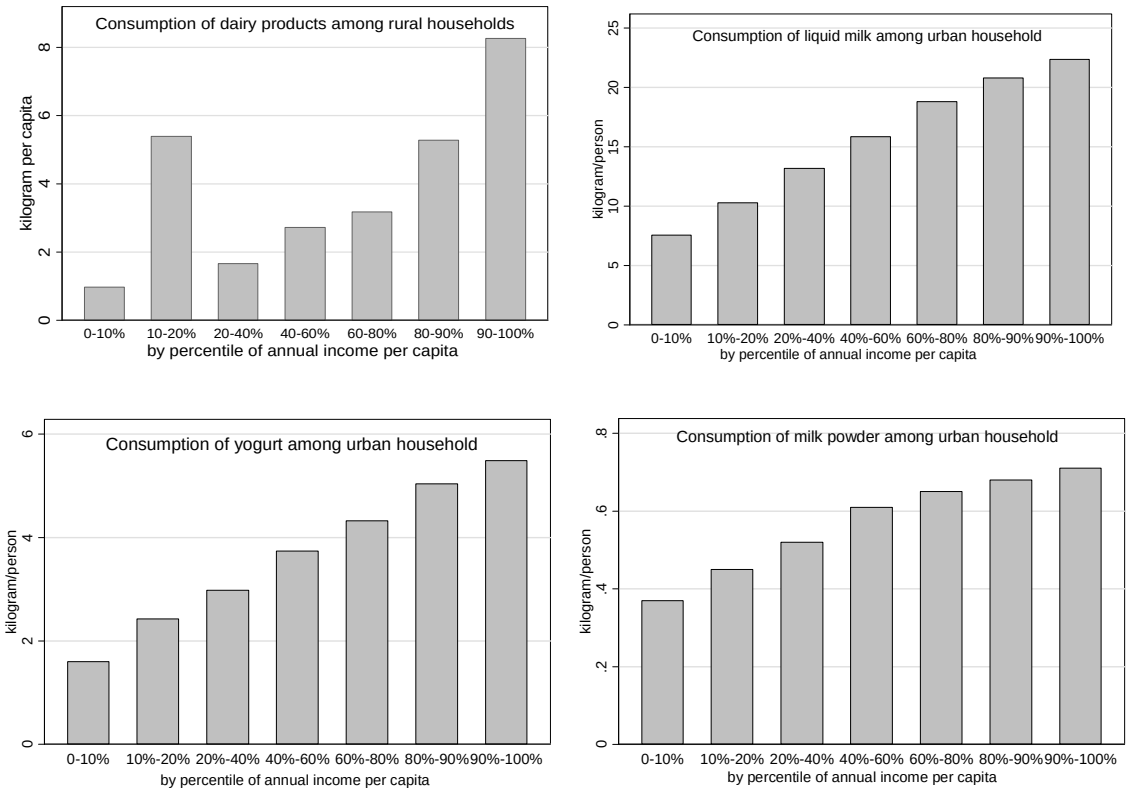


Figure 1. Annual per capita dairy consumption among rural and urban households in China, 2008

Source: Based on the data from China Milk Year Book (2009)

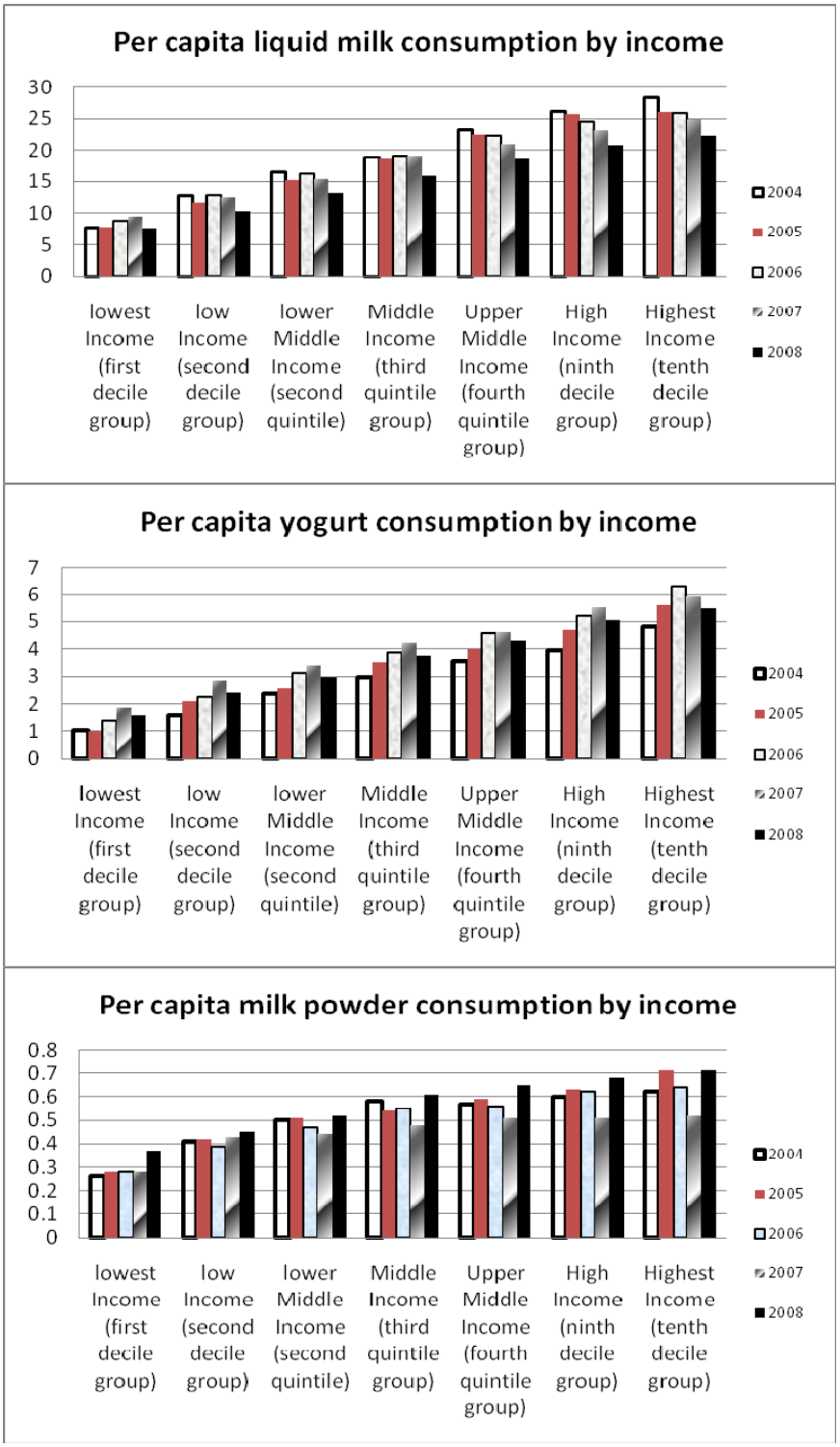
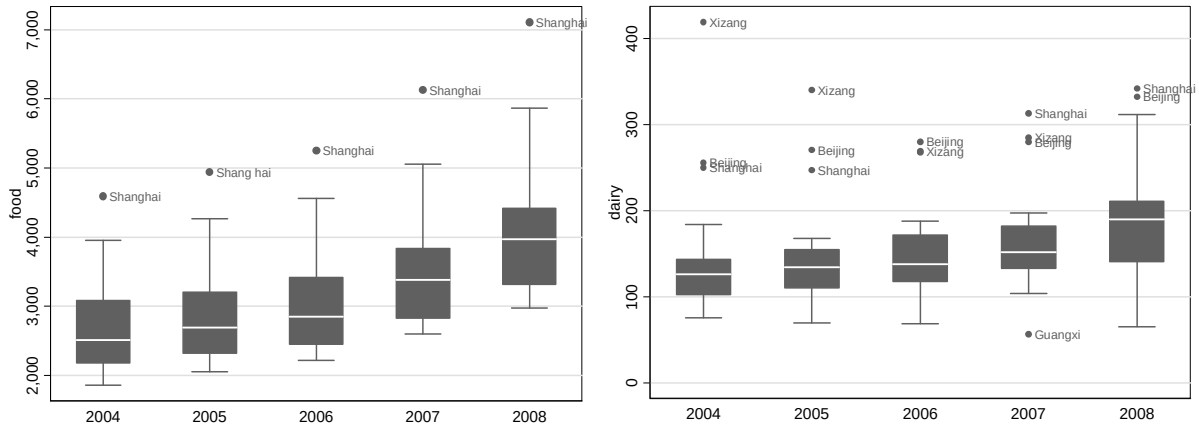
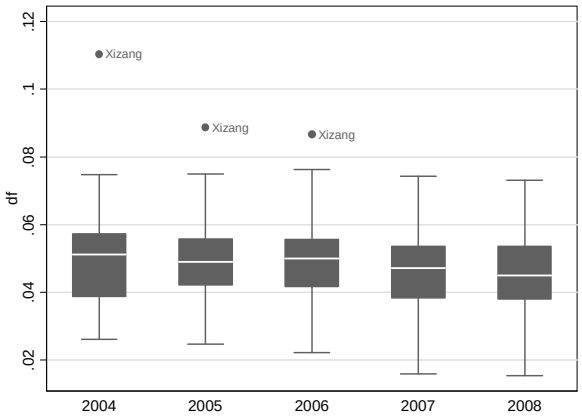


Figure 2. Per capita consumptions (kilogram/person) of three dairy products by level of income among urban households

Source: China Milk Year Book (2006-2009) and China Statistical Yearbook (2004-2009)

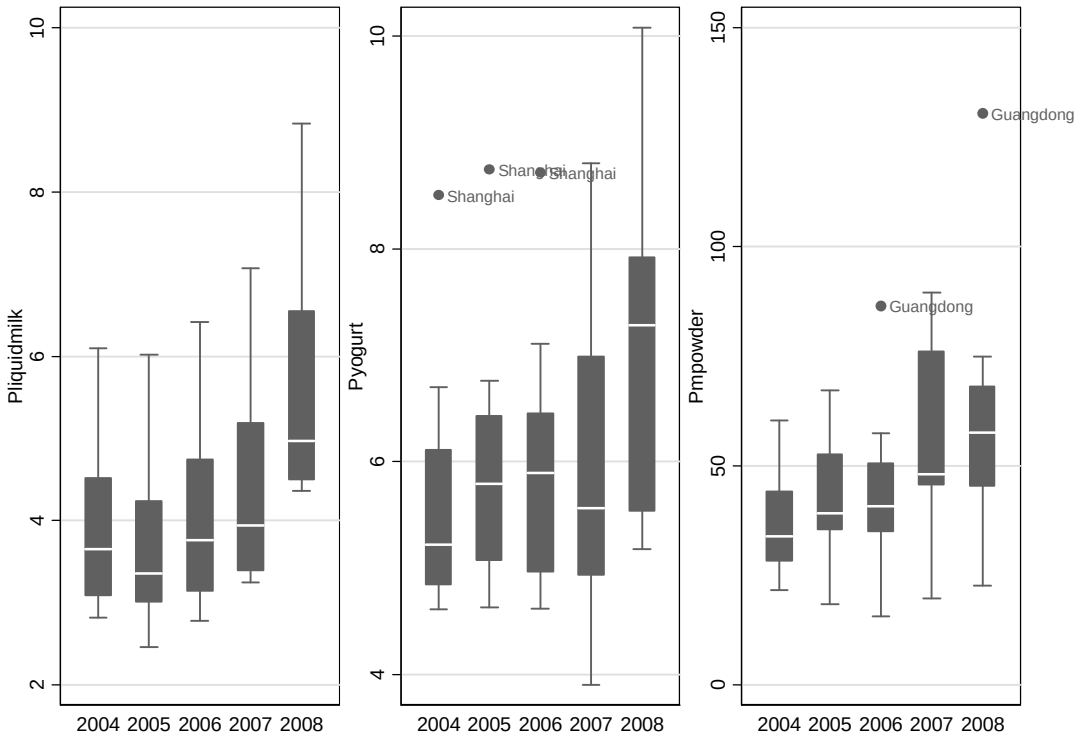


(a) Food expense (b) Dairy expense



(c) Ratio of dairy expense in food expense

Figure 3. Household food expense, dairy expense, and the ratio of dairy expense in total food expense among 31 provinces (including directly governed city regions)



(a) Liquid milk (b) Yogurt (c) Milk powder

Figure 4. Price distribution of liquid milk, yogurt and milk powder in top ten urban areas

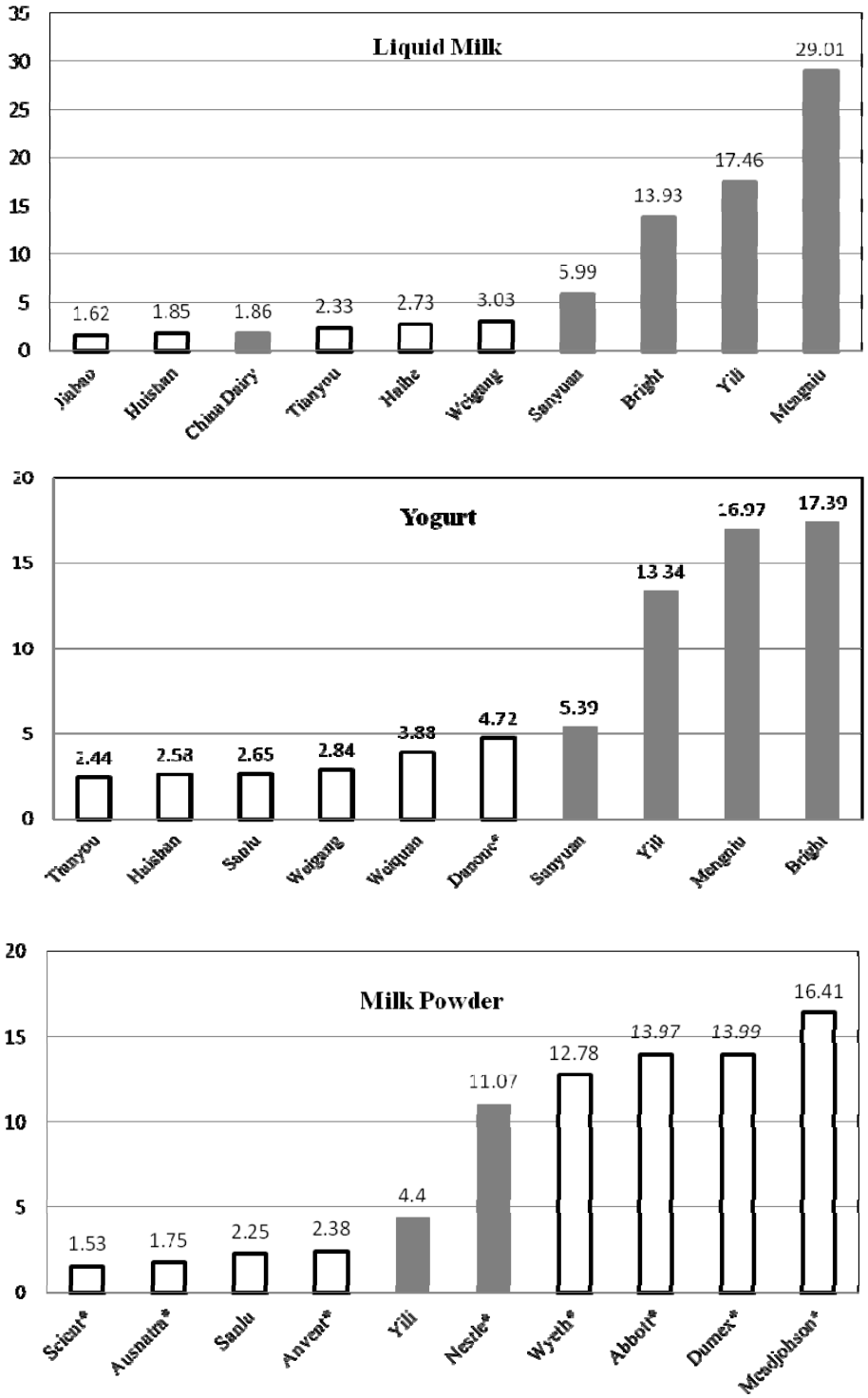


Figure 5. Market share of top ten companies in three main dairy products, 2006

Note: The bar in black represents the company selected in our sample and the asterisk (*) indicates foreign dairy companies.

Source: China Milk Year Book (2007)

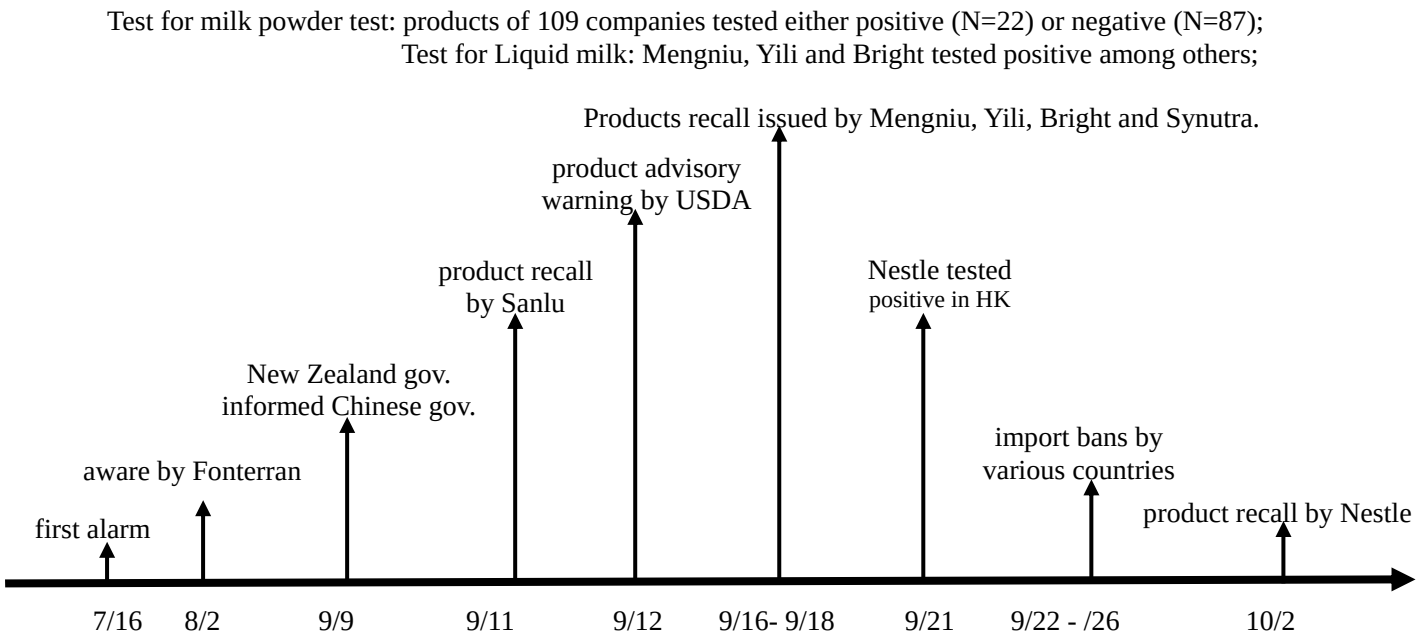


Figure 6. Timeline of the China 2008 milk scandal

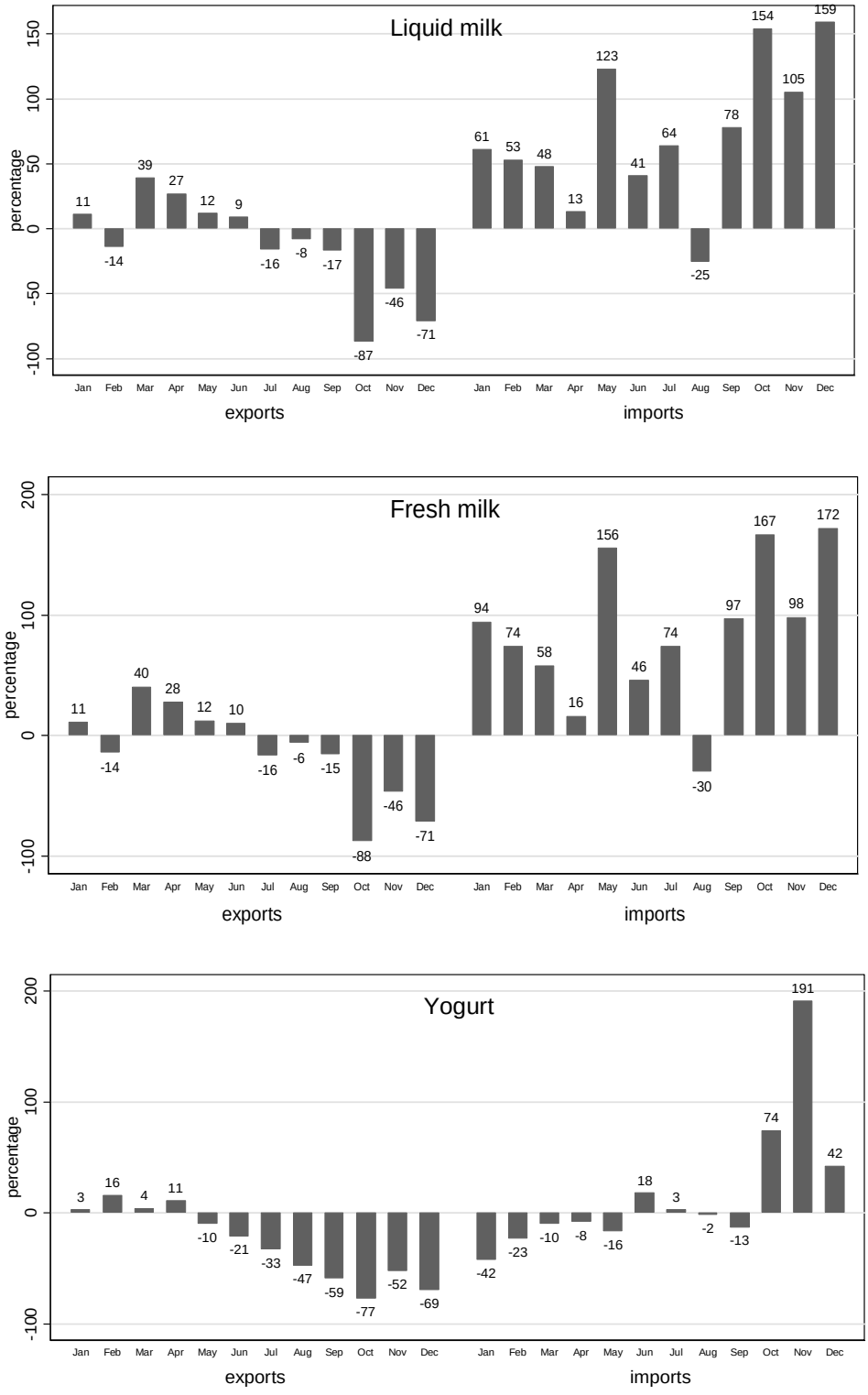


Figure 7. Percentage changes of imports and exports volume of liquid milk, fresh milk and yogurt in the same month between 2007 and 2008

Source: "China Dairy Industry – Start of next growth phase" Fundamental, Industry, Thematic, Thought Leading - FITT Research, Deutsch Bank.

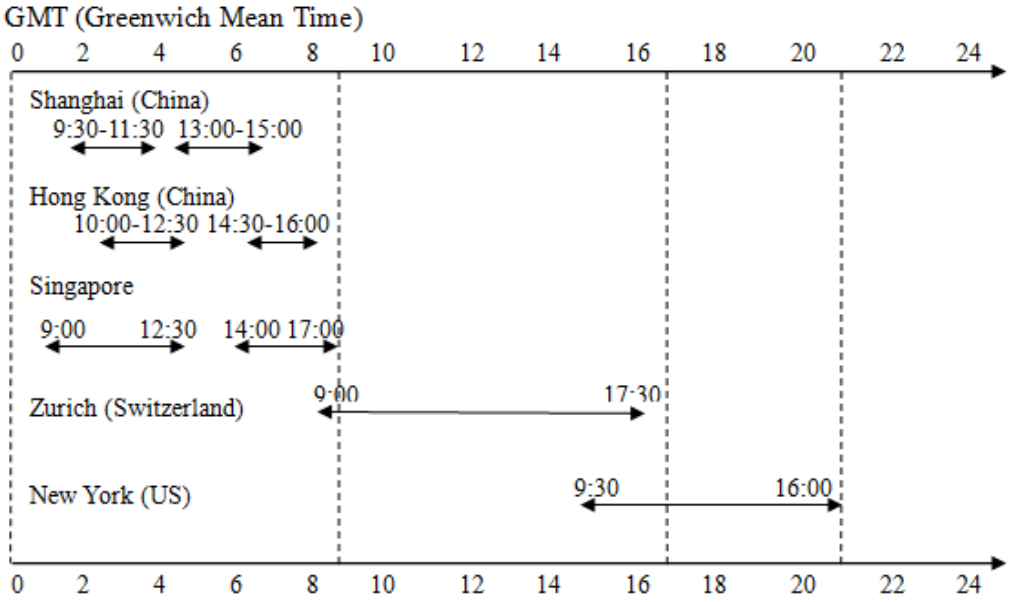


Figure 8. **Trading hours in the five stock markets**

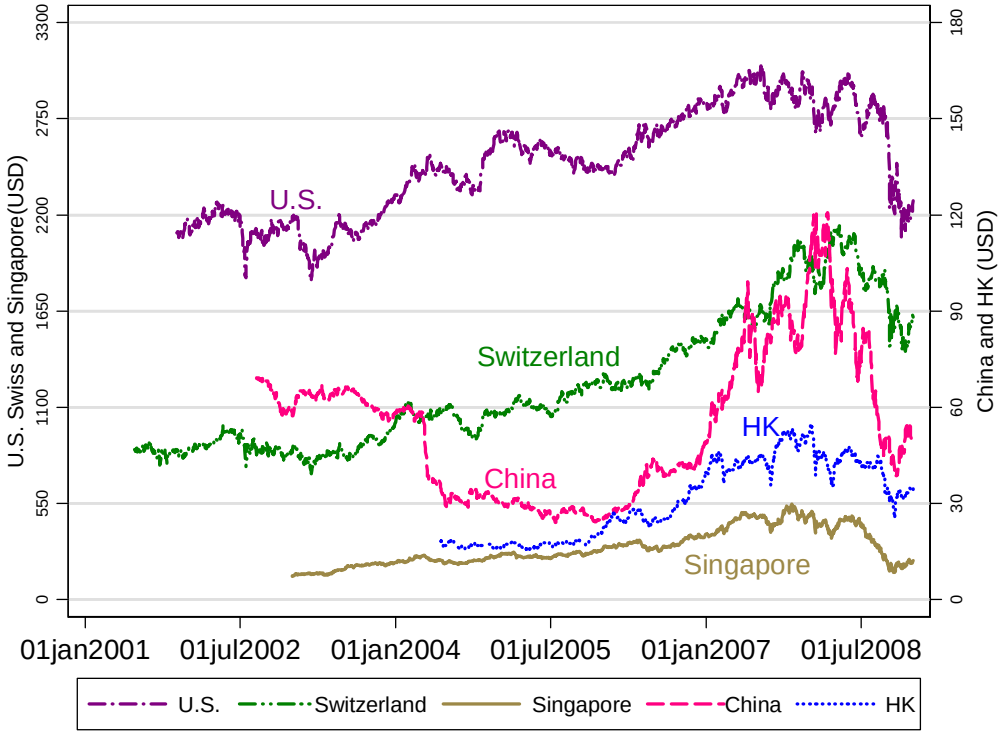


Figure 9. Trends of five market indices

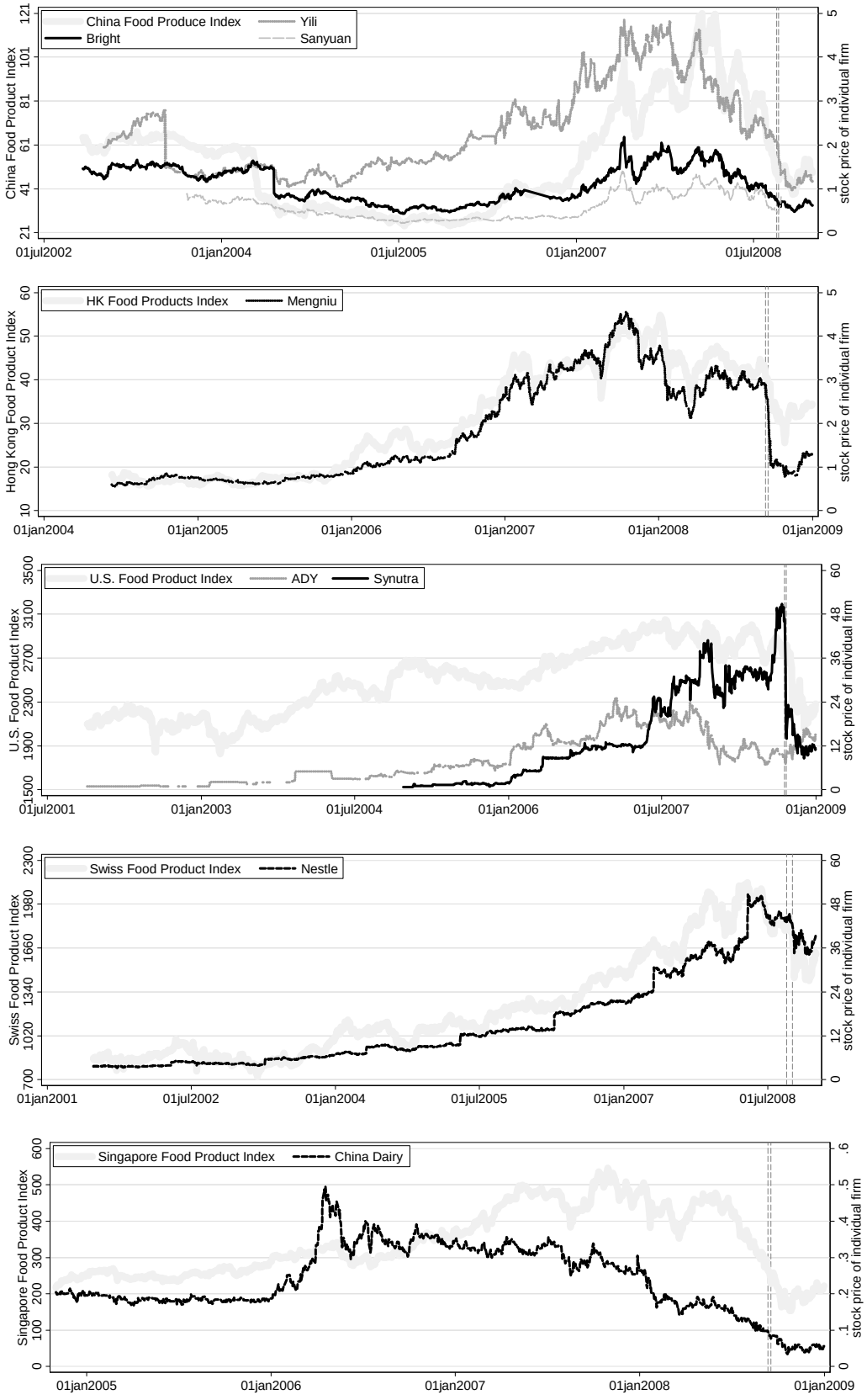


Figure 10. Stock prices of the eight companies and five food market indices

Note: Vertical dashed lines represent event dates for September 11 and for product recalls by each company.

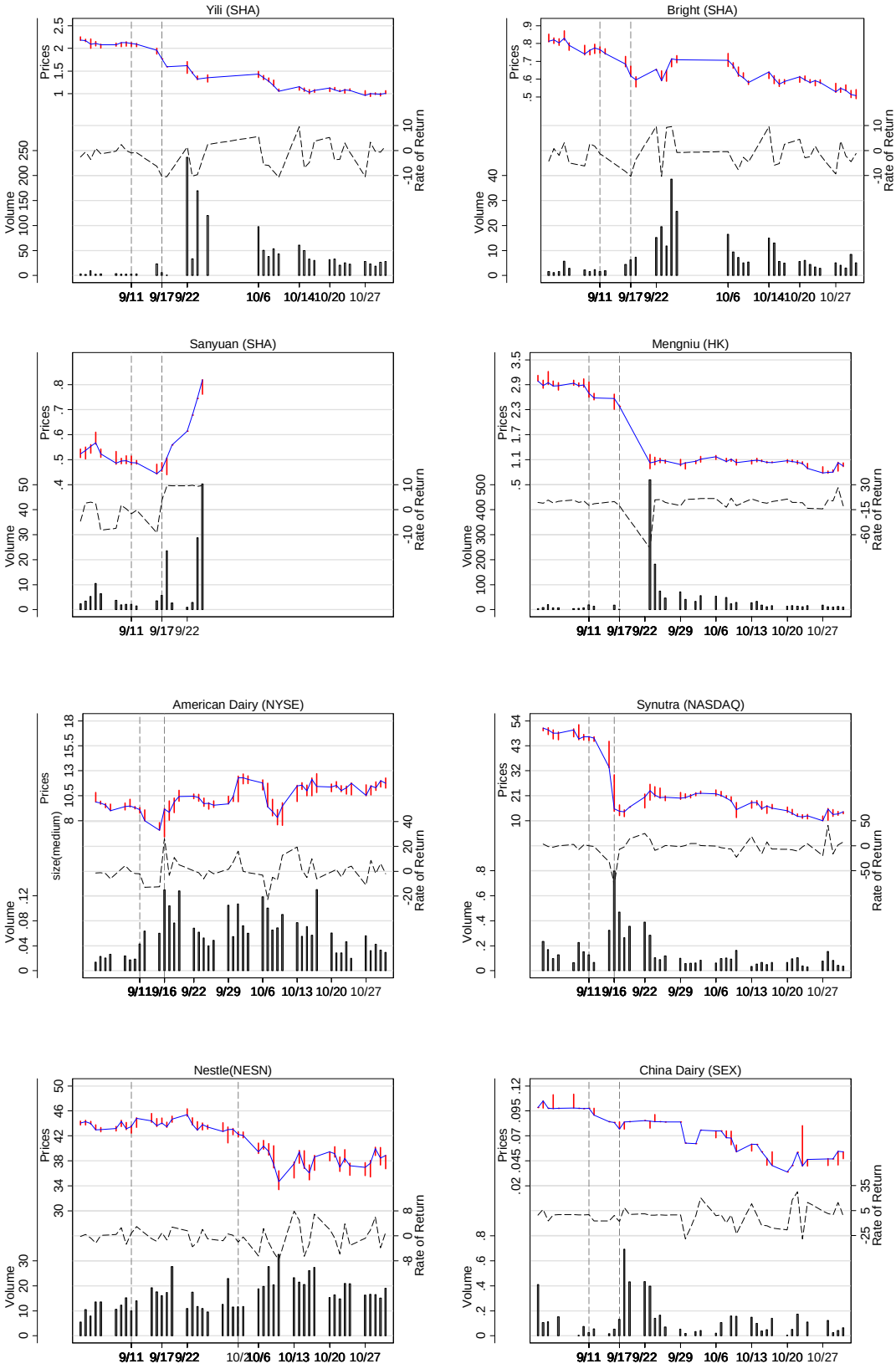


Figure 11. Daily stock prices, rate of returns and trading volumes

Note. Price information consists of daily high and low prices (vertical lines for each trade day); daily closed price (solid lines), daily rate of returns (triangles); and daily

trading volumes (vertical bars). Vertical dashed lines represent event dates, including September 11th when Sanlu recalled its dairy products in China; September 17th when both negative and positive test results of milk powder went public; and October 2nd when Nestle started to recall its dairy products produced in China.

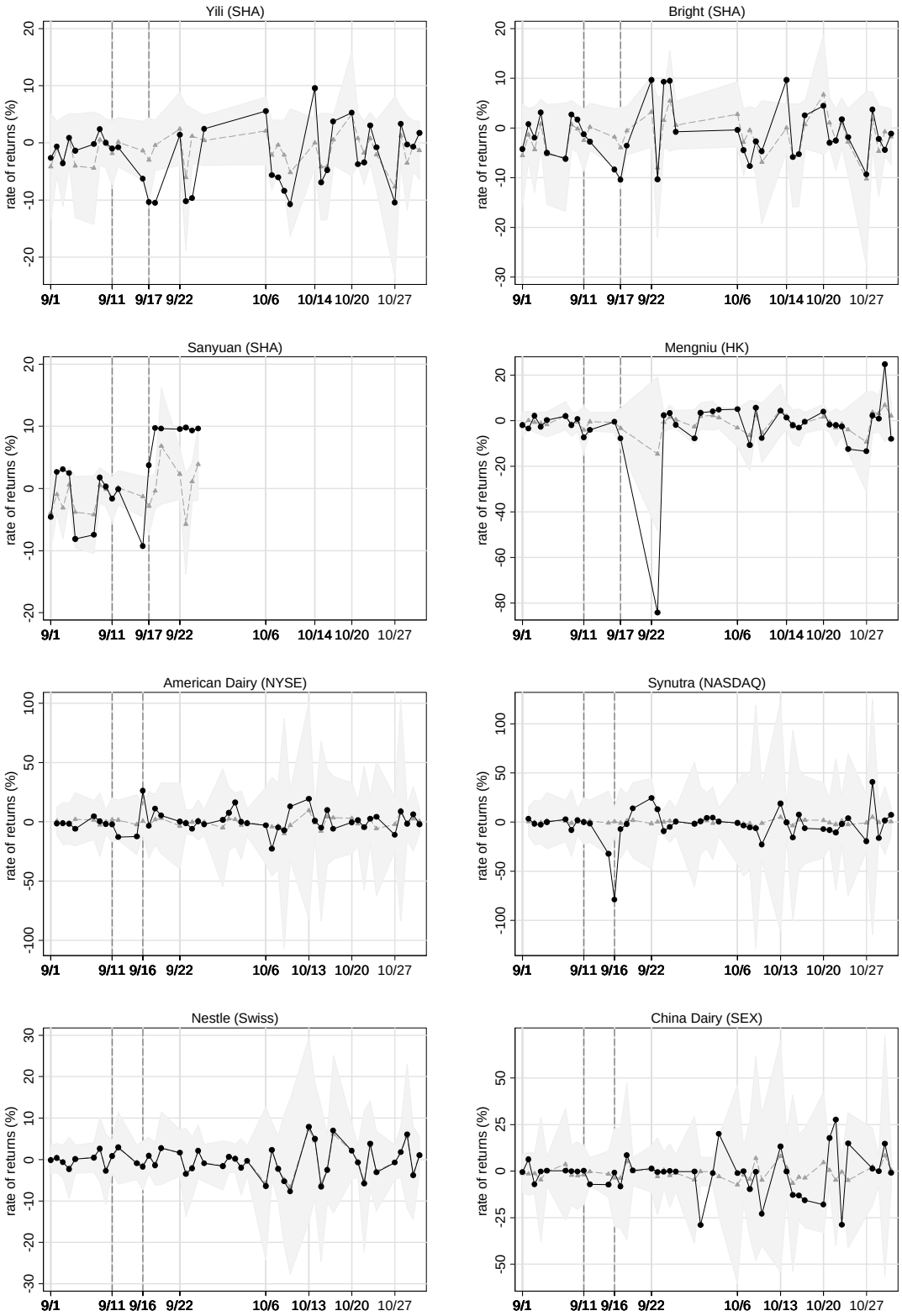


Figure 12. The post-event actual and predicted rate of returns base on the event study analysis

Note: The shaded area represents the confidence interval of the forecasted rate of returns at the 10% significance level. The dashed lines and solid lines indicate the forecasted and actual rate of returns respectively.

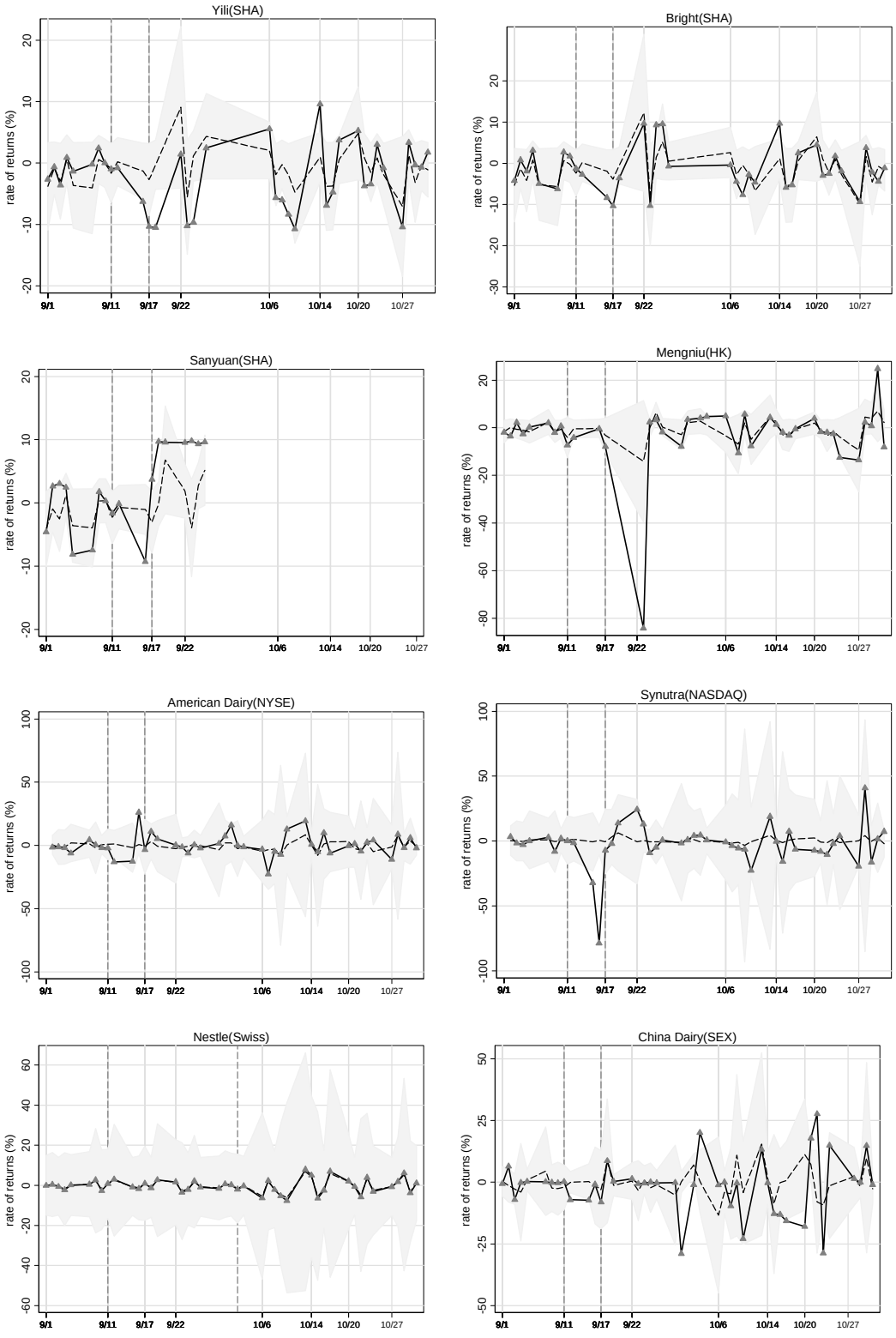


Figure 13. The post-event actual and predicted rate of returns based on GARCH model

Note: The shaded area represents the confidence interval of the forecasted rate of returns at the 10% significance level. The dashed lines and solid lines indicate the forecasted and actual rate of returns respectively.

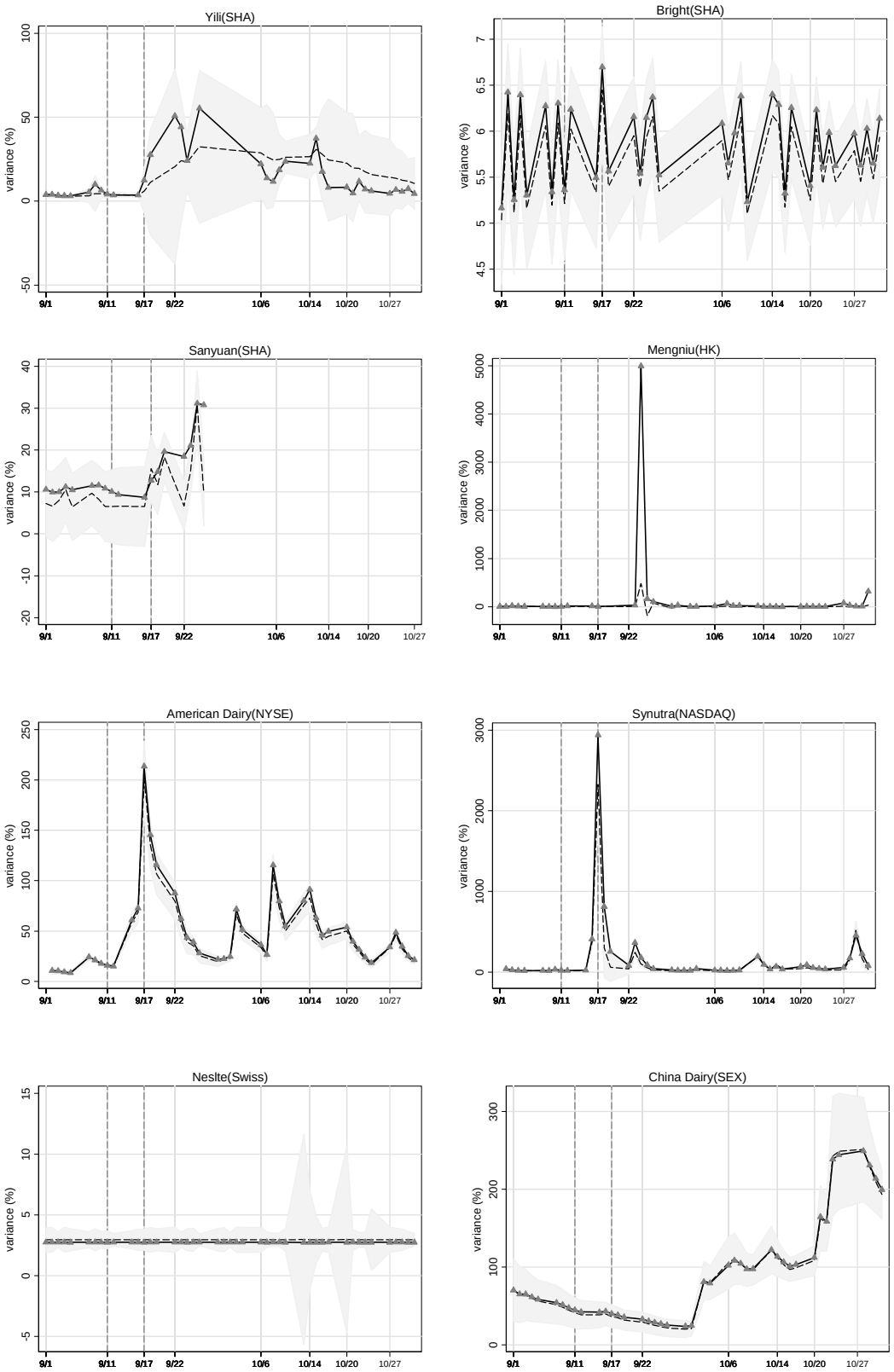


Figure 14. The post-event actual and predicted conditional variance based on GARCH model

Note: The shaded area represents the confidence interval of the variance of forecasted rate of returns at the 10% significance level. The dashed lines and solid lines indicate the forecasted and actual variance respectively.

APPENDIX 1: Timeline of the milk contamination scandal in 2008

July 16: Gansu Province reported to the Chinese Ministry of Heath that local hospitals had identified abnormal increasing incidences of kidney ailments among babies, and that most victims had consumed Sanlu's baby formula.

July 24: The bulletin board of the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) indicated rare occurrences of kidney stones in children -- all causally traced to Sanlu milk formula – was flagged by a urologist in a pediatric hospital.

August 2: Fonterra, a New Zealand partner of Sanlu, became aware of the melamine contamination of milk formula produced by Sanlu.

August 11th: A memo dated on August 11 suggesting Sanlu paying one of the most popular search engines in China called Baidu ¥3 million to censor negative news of milk melamine contamination started circulating on the Internet within days.

September 5th: Fonterra notified the New Zealand government about the milk adulation.

September 9th: New Zealand Government directed its embassy to inform Chinese food safety authorities in Beijing of the milk contamination.

September 10th: Fourteen babies in Gansu province were reported to have became ill (People's Daily 2008a).

September 11th: The Chinese government recalled contaminated milk products sold by Sanlu in China (only in China mainland and Taiwan).

September 11th: World Health Organization was notified of the Chinese milk contamination incidents. One baby died in Gansu Province of China suffering from kidney stones (People's Daily 2008b).

September 12th: The Food and Drug Administration of the U.S. issued a health

information advisory note on infant formula.

September 12th and 13th: The Sanlu administrative team admitted that its milk powder was contaminated with melamine on September 12th. In the following day production was halted at Sanlu and nineteen administrative staffs were arrested.

September 13th: Baidu denied ever accepting ambush negative news of Sanlu relating to the milk contamination incidents.

September 15th: Two baby deaths were confirmed in Beijing relating to the milk contamination incidents. On the same day, the vice president of the Sanlu Group apologized to the public.

September 16th: Milk powder from 22 Chinese companies was tested positive for melamine, and Sanlu tops the rankings. Mengniu, Yili, Bright Dairy and Synutra also involved, but China Dairy was not in the list (AQSIQ 2008a, People's Daily 2008c).

September 17th: The bulletin board of the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) indicated 87 companies with negative melamine test. Sanyuan, American Dairy and China Dairy were in the list (AQSIQ 2008b).

September 17th: MD (Managing Director) of Sanlu was detained on criminal charges. The Mayor of Shijiazhuang City where Sanlu is located, Mr. Ji Chuntang, resigned.

September 17th: The toll of sick children was declared by Health Minister Chen Zhu that more than 6,200 children got ill, and more than 1,300 were still in hospital of whom 158 suffering from acute kidney failure, and most of victims are infants (BBC News 2008c).

September 17th: Mengniu recalled its product, apologized for consumers on its Web site, and asked the Hong Kong stock exchange to "suspend trading in its shares pending the release of an announcement about its milk products" (Bloomberg 2008).

September 17th: Yili and Synutra recalled milk products and issued an apology statement (Bloomberg 2008).

September 18th: Liquid milk test disclosed Mengniu, Yili and Bright Diary. Nestle and Sanyuan were tested with negative melamine. (People's Daily 2008d)

September 18th: Bright Diary recalled products and stated an apology for customers (Bloomberg 2008).

September 18th: Chinese top dairy companies are revoked "Inspection-Free" right by government.

September 18th – 22nd: Stock trading of Mengniu was halted from 18th to 22nd (20th and 21st were weekend) and resumed September 23rd. (Caijing Magazine 2008a).

September 19th: Stock trading of Mengniu, Yili and Bright Dairy were all suspended (Caijing Magazine 2008b).

September 21st: Hong Kong victim diagnosed as milk scandal spread.

September 21st: The Hong Kong government announced that Chinese-made Nestlé pure milk contaminated. But Nestle denied it and insisted that all products are safety (China Daily 2008b).

September 22nd : Toll of ill babies increased to 53,000, and at least four babies died; the State Council publishes inquest concluded that Li Changjiang, the minister in charge of the AQSIQ (Administration of Quality Supervision, Inspection and Quarantine), was responsible for the "negligence in supervision", then he was forced to submit a demission; Wu Xianguo also resigned his position as Local Party Secretary (BBC 2008e).

September 22nd: Chinese milk products were banned by Taiwan.

September 22nd: Other countries started to test Chinese dairy products or remove them from shelves.

September 22nd: Malaysia and Singapore banned Chinese milk candies, chocolate.

September 23rd: Tanzania suspends milk imports from China.

September 23rd: Two additional HK children diagnosed; scare spread to cake and sweets.

September 23rd: Number of ill babies is 54,000, 4 dead.

September 24th: 3 more new victims in HK and Macau got ill.

September 24th: Indonesia bans Chinese milk imports.

September 24th: Tesco withdraws White Rabbit Creamy Candies.

September 25th: Suffering three days limited down (JRJ.com 2008), trading in Yili stopped today under the influence of the milk contamination scandal (Nanfang Daily 2008).

September 25th: South Korea bans Chinese food.

September 25th: First suspected victim in Taiwan is a two-year-old.

September 25th: Vietnam bans milk imported from China.

September 25th: The EU bans Chinese baby food with milk traces.

September 25th: Sales of White Rabbit Creamy Candy are halted after tests detect melamine.

September 26th: Chile withdraws Chinese dairy products.

September 26th: India bans Chinese dairy products for 3 months.

September 26th: 5 new melamine victims were reported in Taiwan.

September 26th: Taiwan Health minister dismissed over melamine tolerance levels.

September 27th: Hong Kong finds traces of melamine in HJ Heinz baby food; Indonesia finds melamine in M&Ms (Mars Inc) and Oreos (Nabisco).

September 29th: Cadbury (which is a confectionery and beverage company with its headquarters in London, United Kingdom) recalls products in Asia after tests find

traces of melamine. 22 people suspected of inducting melamine into the supply chain have been arrested in Hebei province.

September 30th: 31 milk batches were tested with positive melamine by AQSIQ (Administration of Quality Supervision, Inspection and Quarantine).

September 30th: Koala's March Cookies with melamine found in Netherlands.

September 30th: Lipton milk tea powder recalled in Hong Kong.

October 2nd: Taiwan announced milk contamination by Nestle. Nestle recalled milk products produced in China (New York Times 2008a).

October 2nd: Parents of victims lodge an appeal against Sanlu in China.

October 4th: The Korea Food and Drug Administration (KFDA) claimed that Kit Kat bars of Nestle ordered from China were detected melamine in. Nestle admitted that, after its own test, a single batch out of eight confectionery food was positive with melamine (Reuters 2008).

October 8th: The China government claimed no longer to update figures since “it is not an infectious disease"; Reuters reported that the toll mount to nearly 94,000 at the end of September.

October 10th: Three girls diagnosed with kidney stones in Macau.

October 10th: Slovakia finds melamine in chocolate snacks.

October 13th: Trading in Yili and Bright stopped on 13th (China News 2008).

October 14th: China ordered to withdraw all milk produced more than a month ago.

October 15th: The toll of kidney stone case is seventh in Hong Kong.

October 16th: Eighth kidney stone case diagnosed in Hong Kong.

October 16th: Italy seizes smuggled Chinese milk.

October 16th: Malaysia discovers impure ammonium bicarbonate responsible for biscuits contamination.

October 18th: Melamine was found in egg powder in Japan.

October 19th: 469 tons of baking ammonia imported from China was detected with melamine in Taiwan.

October 21st: About 1,500 raccoon dogs in China die of kidney failure because of feed tainted with melamine.

October 22nd: Levels of melamine in a brand of mainland eggs were in excess in Hong Kong.

October 22nd: Melamine was found in Chinese egg powder in South Korea.

October 23rd: Six more people are arrested who are relative to the tainted milk scandal.

October 26th: Eggs produced by Dalian Hanwei Group's eggs contain melamine were discovered in Hong Kong.

October 29th: Melamine was found in two more egg brands from Shanxi and Hubei provinces.

October 31st: State media admit that Chinese animal feed may contain melamine routinely.

October 31st: Lawsuits against Sanlu were hold by officials.

November 2nd: A Chinese official insists the egg scandal is isolated with milk case, and clamps down on illegal producers of feed.

December 1st: Ministry of Health reported toll of victims more than 290,000, 51,900 still in hospital; 3 deaths officially confirmed (out of 11 deaths reported from provinces).

December 10th: Ministry of Health announced that since September 22 million children examined for kidney problems; Ministry of Health also gave a statement of compensation plan for victims under review (China View 2008).

December 25th: Shijiazhuang court accepted a creditor's bankruptcy petition against Sanlu.

December 26th: Six people in connection with melamine adulteration were charged by Shijiazhuang court, two of them were convicted by" endangering public security".

December 29th:1,500 boxes of melamine-contaminated Silang House of Steamed Potato Crackers.

December 31st: Tian, Wenhua, former general manager of Sanlu, and three other company executives charged with producing and selling milk contaminated with melamine, appeared in court in Shijiazhuang.

REFERENCES

Allbusiness. 2000. “Global Dairy Consumption: a World Market in Review (State of the Industry: Global Report).” Available at http://www.allbusiness.com/print/268646-1-22eeq.html. Last accessed August 17, 2009.

Antweiler, W. and M. Z. Frank. 2004. “Is All That Talk Just Noise? The Information Content of Internet Stock Message Boards.” *The Journal of Finance* 59(3): 1259-1294.

Armitage, S. (1995). "Event Study Methods and Evidence on Their Performance." *Journal of Economic Survey* 8 (4).

Bai, J., T. Wahl, and J. McCluskey. 2008. “Fluid Milk Consumption in Urban Qingdao, China.” *The Australian Journal of Agricultural and Resource Economics* 52: 133-147.

Bartholdy, J., D. Olson and P. Peare. 2007. “Conducting Event Studies on a Small Stock Exchange.” *The European Journal of Finance* 13 (3): 227-252.

Beghin, J. 2006. “Evolving Dairy Markets in Asia: Recent Findings and Implications.” *Food policy* 31, 195-200.

Bessler, A.D., J. W. Kolari, and T. A. Maung. 2009. “Dynamic Linkages among Equity Markets: Local versus Basket Currencies.” *Applied Economics* 10:1-17.

Billger, S. M. 2007. “The Heterogeneous Effect of the Passage of the Occupational Safety and Health Act on Stock Returns.” *Journal of Labor Research* 28:536-551.

Binder, J. J. 1998. "The Event Study Methodology since 1969." *Review of Quantitative Finance and Accounting* 11: 111-137.

Blayney, D., M. Gehlhar, C. H. Bolling, K. Jones, S. Langley, M. A. Normile, and A. Somwaru. 2006. *U.S. Dairy at a Global Crossroads*. Washington DC: U.S. Department of Agriculture, Economic Research Report Number 28, November.

Bloomberg. 2008. “China Revokes `Inspection-Free' Right Amid Milk Scare.” Available at http://www.bloomberg.com/apps/news?pid=20601080&sid=a1rfKvOp3xwc&refer=asia. Last accessed February 5, 2009.

Boeher, E., Musumeci, J., and Poulsen, A.B. 1991. "Event Study Methodology under Conditions of Event Induced Variance." *Journal of Financial Economics* 30: 253-272.

Bowman, R. G. 1983. "Understanding and Conducting Event Studies." *Journal of Business Finance and Accounting* 10 (4): 561-584.

Bowen R.M., A.K. Davis and D.A. Matsumoto. 2005. “Emphasis on Pro Forma versus GAAP Earnings in Quarterly Press Releases: Determinants, SEC Intervention, and Market Reactions.” *The Accounting Review* 80(4):1011-1038.

Bowman, R.G. 1983. "Understanding and Conducting Event Studies." *Journal of Business Finance and Accounting* 10 (4): 561-584.

British Broadcasting Corporation (BBC) News. 2004a. “China ‘Fake Milk’ Scandal Deepens.” Available at http://news.bbc.co.uk/2/hi/asia-pacific/3648583.stm. Last accessed January 28, 2009.

British Broadcasting Corporation (BBC) News. 2008b. “Timeline: China milk scandal.” Available at http://news.bbc.co.uk/2/hi/asia-pacific/7720404.stm. Last accessed January 29, 2009.

British Broadcasting Corporation (BBC) News. September 17, 2008c. “Chinese to tighten dairy testing.” Available at http://news.bbc.co.uk/2/hi/asia-pacific/7621651.stm. Last accessed February 8, 2009.

British Broadcasting Corporation (BBC) News. September 17, 2008d. “China quality chief resigns over milk.” Available at http://news.bbc.co.uk/2/hi/asia-pacific/7629130.stm. Last accessed February 8, 2009.

British Broadcasting Corporation (BBC) News. September 25, 2008e. “EU limits imported Chinese food.” Available at http://news.bbc.co.uk/2/hi/europe/7635594.stm. Last accessed February 8, 2009.

Brockett, P. L., H. M. Chen and J. R. Garven. 1994. "A New Stochastically Flexible Event Methodology with Application to Proposition 103.” Insurance: *Mathematics and Economics* 25: 197-217.

Brown, K. C., L. J. Lockwood, and S. L. Lummer. 1985. “An Examination of Event Dependency and Structural Change in Security Pricing Models.” *Journal of Financial and Quantitative Analysis* 20: 315-334.

Brown, S. J., Warner, J. B. 1985. "Using Daily Stock Returns: the case of event studies." *Journal of Financial Economics* 14: 3-31.

Brown, S. J., Warner, J. B. 1980. "Measuring Security Price Performance." Journal of Financial Economics 8: 205-258.

Burton, M., T. Young, and R. Cromb. 1999. “Meat Consumers’ Long-Term Response to Preceived Risks Associated with BSE in Great Britain.” *Cahiers d’economie et sociologie rurals* 50: 8-19.

Caijing Magazine. September 26, 2008a. “Yili, Mengniu Get Government Dairy Aid.” Available at http://english.caijing.com.cn/2008-09-26/110029952.html. Last accessed March 16, 2009.

Caijing Magazine. September 19, 2008b. “Milk Companies Have Trading Suspended.” Available at http://english.caijing.com.cn/2008-09-19/110014110.html. Last accessed March 16, 2009.

Campbell, J. Y., A. W. Lo, and A. C. MacKinlay. 1997. "Event-Study Analysis", Chapter 4 in *The Econometrics of Financial Markets.* Princeton University Press ISBN 0-691-04301-9, pp149-180.

China Commodity Net. May 24, 2006. “International Dairy Companies are back to Chinese Market.” Available at http://ccn.mofcom.gov.cn/swxw/show.php?eid=15360. Last accessed March 1, 2011.

China Daily. November 21, 2001. Hu, Yan. “School milk programme under way.” Available at http://www.chinadaily.com.cn/en/doc/2001-11/21/content_94552.htm. Last access November 8, 2009.

China Daily. March 31, 2005. “Red Dye a 'Food for Thought' for Chinese.” Available at http://www.chinadaily.com.cn/english/doc/2005-03/31/content_429921.htm. Last accessed January 28, 2009.

China Agricultural Products Trade.”Shenyang Longdi Grain Products Company.”

Available at http://english.cnapt.com/product-5172. Last accessed September 11, 2009.

China Daily. 2007. “Safe Food for All Should be the Recipe.” Available at http://www.chinadaily.com.cn/china/2007-03/15/content_828060.htm. Last accessed February 3, 2009.

China Daily. September 17, 2008a. “Most Companies' Baby Milk Powder Safe - State Council.” Available at http://www.chinadaily.com.cn/china/2008-09/17/content_7032984.htm. Last accessed January 29, 2009.

China Daily. September 21, 2008b. “Nestle Milk Found to Contain Melamine in Hong Kong.” Available at http://www.chinadaily.com.cn/china/2008-09/21/content_7045016.htm. Last accessed February 5, 2009.

China Daily. October 30, 2008c. “Melamine Scandal Costs Major Dairy Maker Millions.” Available at http://www.chinadaily.com.cn/bizchina/2008-10/30/content_7159706.htm. Last accessed March 6, 2011.

China Daily. October 31, 2008d. “Inner Mongolia Yili Q3 Loss Widens.” Available at http://www.chinadaily.com.cn/bizchina/2008-10/31/content_7163205.htm. Last accessed March 1, 2011.

China Daily. December 24, 2008e. “Mengniu Expects $131m Loss due to Melamine.” Available at http://www.chinadaily.com.cn/bizchina/2008-12/24/content_7336782.htm. Last accessed March 1, 2011.

China Daily. December 24, 2008f. “Sanlu Confirms Bankruptcy Filing.” Available at http://www.chinadaily.com.cn/bizchina/2008-12/24/content_7337935.htm. Last accessed March 1, 2011.

China Dialogue. September 14, 2006. "China's Food Fears, Part 1." Available at http://www.chinadialogue.net/article/show/single/en/374-China-s-food-fears-part-one-. Last accessed January 28, 2009.

China Digital Times. September 13, 2008. “Milk Powder Contamination Discovered in August But Made Public Now?” Available at http://chinadigitaltimes.net/2008/09/contamination-discovered-in-aug-but-made-public-now. Last accessed February 16, 2009.

China News. October 14, 2008. “《对话》说走嘴致股票停牌 伊利光明发澄清公告.” Available at http://www.chinanews.com.cn/cj/ssgs/news/2008/10-14/1412004.shtml. Last accessed March 16, 2009.

China Statistical Yearbook 2004-2008. China Statistics Press. Available at http://www.stats.gov.cn/tjsj/ndsj/2008/indexeh.htm. Last accessed November 15, 2009.

China Trade Remedy Information. September 28, 2008. “International Reaction to the 2008 Chinese Milk Scandal.” Available at http://www.cacs.gov.cn/cacs/news/xiangguanshow.aspx?articleId=45565. Last accessed February 17, 2009.

China View. December 10, 2008. “China Plans Compensation after Tainted Milk Scandal.” Available at http://news.xinhuanet.com/english/2008-12/10/content_10486056.htm. Last accessed February 7, 2009.

ChinaDairy.net. “Jiangxi Bright Dairy Company.” Available at http://www.chinadairy.net/Dongli/company/index.asp?id=3615. Last access April 6, 2011.

ChinaQuality.org. “Nestle (China).” Available at http://www.chinaquality.org.cn/2009315hd/qy_detail.asp?id=398. Last access April 6, 2011.

CNN. April 24, 2008. “How to End the Global Food Shortage.” Available at http://www.time.com/time/magazine/article/0,9171,1734834,00.html. Last accessed May 13, 2010.

CNN Fortune. 2009. “Our Annual Ranking of the World's Largest Corporations.” Available at http://money.cnn.com/magazines/fortune/global500/2009/snapshots/6126.html. Last accessed August, 2009.

Corrado, C. J. and T. L. Zivney. 1992. “The Specification and Power of the Sign Test in Event Study Hypothesis Tests Using Daily Stock Returns.” *The Journal of Financial and Quantitative Analysis* 27 (3): 465-478.

Cowan, A. R. and A. M.A. Sergeant. 1996a. Forthcoming. "Trading Frequency and Event Study Test Specification." Journal of Banking & Finance.

Dairysite. 2007. “”People’s Republic of China Dairy and Products Annual Report 2007.” Available at http://www.thedairysite.com/articles/1232/peoples-republic-of-china-dairy-and-products-annual-report-2007. Last accessed November 16, 2009.

Dairysite. 2009. “Mirror on Melamine as China's Dairy Exports Drop.” Available at http://www.thedairysite.com/news/26188/mirror-on-melamine-as-chinas-dairy-exports-drop. Last accessed March 6, 2011.

Dann, L. Y. and W. H. Mikkelson. 2002. “Convertible Debt Issuance, Capital Structure Change and Financing-Related Information.” *Journal of Financial Economics* 13: 157-186.

Dasgupta, S., B. Laplante, and N. Mamingi. 2001. “Pollution and Capital Markets in Developing Countries.” *Journal of Environmental Economics and Management* 42: 310-335.

DeJong, F. 2007. “Event Studies Methodology.” Lecture notes written for the course Empirical Finance and Investment Cases. Unpublished, Tilburg University.

Diebold, F. X. and G. D. Rudebusch. 1990. "On the Power of Dickey-Fuller Tests Against Fractional Alternatives," *Finance and Economics Discussion Series 119*, Board of Governors of the Federal Reserve System (U.S.).

Dodd, P. and R. Leftwich. 1980. “The Market for Corporate Charters: Unhealthy Competition versus Federal Regulation.” *Journal of Business* 53 (3): 259-283.

Dohlman, E., T. Hall and A. Somwaru. 2002. “Regulatory Events and Biotech Firm Share Prices.” *Review of Agricultural Economics* 24(1): 108-122.

Dombrow, Jonathan, Mauricio Rodriguez, and C. F. Sirmans, "A Complete Non-parametric Event Study Approach", under review at Review of Quantitative Finance and Accounting.

Dong, F. 2005. "The Outlook for Asian Dairy Markets: The Role of Demographic, Income and Prices." *Food Policy* 31, 260-271.

Eades, K M., P. J. Hess, and E. H. Kim. 1985. "Market Rationality and Dividend Announcements." *Journal of Financial Economics* 14: 581-604.

Economist. 2008. "An Old Chinese Myth." Available at http://www.economist.com/node/10429271?story_id=10429271. Last accessed January 30th, 2011.

Eun, C. and S. Shim 1989. "International Transmission of Equity Market Movements." *Journal of Financial and Quantitative Analysis* 24: 241-256.

EUROPA – Gateway to the European Union. September 15, 2008. "Midday Express: Commission takes measures to protect European citizens from products with melamine-contaminated milk from China." Available at http://europa.eu/rapid/pressReleasesAction.do?reference=MEX/08/0926&format=HTML&aged=0&language=EN&guiLanguage=en . Last accessed May 26, 2010.

European Food Information Resource Network (EuroFIR 2004). "Composition of Dairy." Available at http://www.eurofir.net/printpage.asp?id=6196. Last accessed August 26, 2009.

Fang L. and Peress J. 2009. "Media Coverage and the Cross-Section of Stock Returns." *Journal of Finance* 64(5):2023-52.

Farka, M. 2008. "The Volatility Impact of Policy Actions on Stocks and Treasuries: Analysis from Intraday Data." *Review of Financial Studies* 15, 751-782.

Food and Agriculture Organization of the United Nations (FAO). 2003. "School Milk Programme – The Economic Dimension: A study of the economic impact of China School Milk Programme (CSMP)." Available at http://www.fao.org/es/esc/common/ecg/188/en/The_Economic_Dimension_of_the_China_School_Milk_Progr.pdf. Last access November 6, 2009.

Fonterra homepage. "Why Fonterra?" Available at http://www.fonterra.com/wps/wcm/connect/fonterracom/fonterra.com/Our+Business/Supplying+Fonterra/Why+Fonterra/. Last accessed October 30, 2009.

Forbes. September 23, 2008. "Investors Finding China Mengniu Dairy Curdled." Available at http://www.forbes.com/2008/09/23/mengniu-dairy-scandal-markets-equity-cx_vk_0923markets03.html. Last accessed March 16, 2009.

Fuller, F., J. Beghin, and S. Rozelle. 2004a. "China' Dairy Market: Consumer Demand Survey and Supply Characteristics." Center for Agricultural Development, Iowa State University, Staff paper No. 04-ST 99, September.

Fuller, F., J. Beghin, and S. Rozelle. 2004b. "Urban Demand for Dairy Products in China: Evidence from New Survey Data." Or "Consumption of Dairy products in Urban China: Results from Beijing, Shanghai and Guangzhou/" *The Australian Journal of Agricultural and Resource Economics* 51, 459-474.

Fuller, F., J. Huang, H. Ma, and S. Rozelle. 2006. "Got Milk? The Rapid Rise of China's

Dairy Sector and Its Future Prospects." *Food Policy* 31, 201-215.

General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China. (GAQSQ). Available at http://english.aqsiq.gov.cn/. Last accessed October 27, 2009.

Grand, M. C. and V. V. D´Elia. 2005. "Environmental News and Stock Markets Performance: Further Evidence for Argentina." CEMA Working Paper.

Guide to China's Dairy Industry. 2002. 1st ed. China Agricultural Press.

Hamilton, J. T. 1995. "Pollution as News: Media and Stock Market Reactions to the Toxics Release Inventory Data." *Journal of Environmental Economics and Management* 28: 98-113.

Henderson, G. V. 1989. "Problems and Solutions in Conducting Event Studies." *The Journal of Risk and Insurance*: 282-306.

Hendry, D. F. and M. Massmann. 2007. "Co-Breaking: Recent Advances and a Synopsis of the Literature." *Journal of Business & Economic Statistics*, 25, 33-51.

Hillebrandt, P. M. 2000. *Economic Theory and Construction Industry*, 3rd. ed. Palgrave Macmillan.

Halpern, P. 1983. "Corporate Acquisitions: A Theory of Special Cases? A Review of Event Studies Applied to Acquisitions." *The Journal of Finance*. VOL. XXXVIII.

International Dairy Foods Association (IDFA). Available at http://www.idfa.org/facts/index.cfm. Last accessed August 26, 2009.

International Institute for Applied Systems Analysis (IIASA) . 2004. "Science for Global Insight." Available at http://www.iiasa.ac.at/Research/FAW/index.html. Last access January 30th, 2011.

Jin, Y. H., G. J. Power, and L. Elbakidze. 2008. "The Impact of North American BSE Events on Live Cattle Futures Prices." American Journal of Agricultural Economics 90: 1279-1286.

Jin, H. J. and J. Kim. 2008. "The Effects of the BSE Outbreak on the Security Values of US Agribusiness and Food Processing Firms." *Applied Economics* 40:357-372.

JRJ.com. September 26, 2008. "三元停牌议并购，伊利股份宣布销售逐步回升." Available at http://stock.jrj.com.cn/2008/09/2601472168168.shtml. Last accessed March 16, 2009.

Knips, V. "Developing Countries and the Global Dairy Sector Part I: Global Overview." A Living from Livestock. Pro-Poor Livestock Policy Initiative. Available at http://www.fao.org/ag/againfo/programmes/en/pplpi/docarc/execsumm_wp30.pdf. Last accessed August 26, 2009.

Kolari, J., and Pynnonen, S. 2005. "Event-Study Methodology: Correction for Cross-Sectional Correlation in Standardized Abnormal Return Tests." No 23768, PPLPI Working Papers from Food and Agriculture Organization of the United Nations, Pro-Poor Livestock Policy Initiative.

Kothari, S. P., and Warner, J.B. 2004. "Econometrics of Event Studies." Handbook of *Corporate Finance: Empirical Corporate Finance* (Elsevier/North-Holland)

Kwiatkowski, Denis, Peter C. B. Phillips, Peter Schmidt, and Yongcheol Shin. 1992. "Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root:

How Sure Are We that Economic Time Series Have a Unit Root?" Journal of Econometrics, vol. 54 (October-December 1992), pp.159–78.

Laplante, B. and P. Lanoie. 2001. "The Market Response to Environmental Incidents in Canada: A Theoretical and Empirical Analysis." Market Response to Environmental Incidents: 657-672.

Lee, S. H. and O. Varela. 1997. "An Investigation of Event Study Methodologies with Clustered Events and Event Day Uncertainty." Review of Quantitative Finance and Accounting, 8: 211-228.

Lewbel, A. 2006. Engel Curves: Entry for the New Palgrave Dictionary of Economics. 2nd ed. Boston College.

Lintner, J. 1965. "The Valuation of Risky Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets." *The Review of Economics and Statistics* 47 (1): 13-37.

Mabel Wong. 2009. "China Dairy Industry - Start of Next Growth Phases." Fundamental, Industry, Thematic, Thought Leading Research, Deutsche Bank.

MacKinlay, A. C. 1997. "Event Studies in Economics and Finance." J*ournal of Economic Literature* XXXV: 13-39.

Marsh, T. L., T. C. Schroeder, and J. Mintert. 2004. "Impacts of Meat Product Recalls on Consumer Demand in the USA." *Applied Economics* 36 (2004):897-909.

Masulis, R. W. 1980. "The Effects of Capital Structure Change on Security Prices – A Study of Exchange Offers." *Journal of Financial Economics* 8 (1980): 139-178.

Maynard, L. J., E. Goddard, and J. Conley. 2008. "Impact of BSSE on Beef Purchases in Alberta and Ontario Quick-Serve Restaurants." *Canadian Journal of Agricultural Economics* 56 (2008): 337-351.

Mazzocchi, M. 2006. "No news is good news: Stochastic parameters versus media-coverage indices in demand models after food scares". *American Journal of Agricultural Economics* 88:727–741.

Mazzocchi, M., M. Ragona, and M. Fritz. 2009. "Stock Market Response to Food Safety Regulations." *European Review of Agricultural Economics* 36 (4): 571-595.

McWilliams, A., and Siegel, D. 1997. "Event Studies in Management Research: Theoretical and Empirical Issues." *The Academy of Management Journal* 40 (3): 626-657.

Mengniu.com. September 17th, 2008. "Official Apology Statement." Available at http://www.mengniu.com.cn/newsfile/200891710373823551.asp. Last accessed March 16, 2009.

Meschke, F., 2004. CEO interviews on CNBC. University of Minnesota Working Paper.

Mikkelson, W. H. 1981. "Convertible Calls and Security Returns." *Journal of Financial Economics* 9: 237-264.

Mikkelson, W. H. and M. M. Partch. 1985. "Stock Price Effects and Costs of Secondary Distributions." *Journal of Financial Economics* 14:165-194.

Mikkelson, W. H. and M. M. Partch. 1986. "Valuation Effects of Security Offerings and the Issuance Process." *Journal of Financial Economics* 15: 31-60.

Milk Year Book. 2006-2008. China Agricultural Press.

Ministry of Health of the People's Republic of China (MOH). 2008."New Release Conference on December 10th, 2008." Available at http://www.moh.gov.cn/publicfiles/business/htmlfiles/mohbgt/s3582/200812/38473.htm. Last accessed May 26, 2010.

Mitchell, M. L. and J. H. Mulherin. 1994. “The Impact of Public Information on the Stock Market.” *The Journal of Finance* 49 (3): 923-950.

Moore, N. H., D. R. Peterson, and P. P. Peterson. 1986. "Shelf Registrations and Shareholder Wealth: A Comparison of Shelf and Traditional Equity Offerings." *Journal of Finance* 41 (2): 197-208.

Nanfang Daily. September 26, 2008. “四虎拦路伊利股份盈利遭击.” Available at http://www.nanfangdaily.com.cn/gs/200809260081.asp. Last accessed March 16, 2009.

New York Times. The Associated Press, Reuters. October 2, 2008a. “Taiwan recalls Nestlé milk products.” Available at http://www.iht.com/articles/2008/10/02/asia/milk.php. Last accessed February 5, 2009.

New York Times. December 24, 2008b. "Company at Core of China’s Milk Scandal Is Declared Bankrupt" Available at http://www.nytimes.com/2008/12/25/world/asia/25milk.html. Last accessed February 6, 2009.

Patell, J. M. 1976. "Corporate Forecasts of Earnings per Share and Stock Price Behavior: Empirical Tests." *Journal of Accounting Research* 14: 246-276.

Pearce, D. K. and V. V. Roley. 1985. "Stock Prices and Economic News" *The Journal of Business* 58 (1): 49-67.

People’s Daily. September 17, 2006. “China's schools urged to improve sanitation after food poisoning cases.” Available at http://english.people.com.cn/200609/07/eng20060907_300590.html. Last accessed January 29, 2009.

People’s Daily. September 10, 2008a. “14 babies suffer from kidney stones, fake milk powder suspected.” Available at http://english.people.com.cn/90001/90776/90882/6497062.html. Last accessed February 7, 2009.

People’s daily. September 11, 2008b. “Baby dies of kidney stones in NW China, fake milk powder suspected.” Available at http://english.people.com.cn/90001/90776/90882/6497948.html. Last accessed February 8, 2009.

People’s Daily. September 17, 2008c. “China seizes 22 companies with contaminated baby milk powder.” Available at http://english.people.com.cn/90001/90776/90882/6500599.html. Last accessed February 5, 2009.”

People’s Daily. September 19, 2008d. “Most liquid milk in China does not contain melamine.” Available at http://english.people.com.cn/90001/90782/90880/6502509.html. Last access February 5, 2009.

People.com. September 17, 2008. “Apology Statement of Synutra Corporate.” Available at http://health.people.com.cn/GB/8063228.html. Last accessed May 26, 2010.

People's Daily. May 16, 2004. "Guangdong launches inspection on bulk liquor following four toxic alcohol deaths." Available at http://english.people.com.cn/200405/16/print20040516_143420.html. Last accessed January 28, 2009.

People’s Daily. August 22, 2006a. “Snail meningitis patients to claim for group compensation.” Available at http://english.people.com.cn/200608/22/eng20060822_295665.html. Last accessed January 29, 2009.

People’s Daily. September 17, 2006b. “China's schools urged to improve sanitation after food poisoning cases.” Available at http://english.people.com.cn/200609/07/eng20060907_300590.html. Last accessed January 29, 2009.

People’s Daily. September 10, 2008a. “14 babies suffer from kidney stones, fake milk powder suspected.” Available at http://english.people.com.cn/90001/90776/90882/6497062.html. Last accessed February 7, 2009.

People’s daily. September 11, 2008b. “Baby dies of kidney stones in NW China, fake milk powder suspected.” Available at http://english.people.com.cn/90001/90776/90882/6497948.html. Last accessed February 8, 2009.

People’s Daily. September 17, 2008c. “China seizes 22 companies with contaminated baby milk powder.” Available at http://english.people.com.cn/90001/90776/90882/6500599.html. Last accessed February 5, 2009.”

People’s Daily. September 19, 2008d. “Most liquid milk in China does not contain melamine.” Available at http://english.people.com.cn/90001/90782/90880/6502509.html. Last access February 5, 2009.

Peterson, P. P. (1989). "Event Studies: A Review of Issues and Methodology." *Quarterly Journal of Business and Economics* 28: 36-66.

Prabhala, N. R. 1997. "Conditional Methods in Event-Studies and an Equilibrium Justification for Standard Event-Study Procedures." *Review of Financial Studies* 10 (1):1-38.

Reuters. October 4, 2008. “UPDATE 1-S.Korea Finds Melamine in China-made Snickers, Kit Kat.” Available at http://www.reuters.com/article/rbssConsumerGoodsAndRetailNews/idUSL42706220081004. Last access March 12, 2009.

Ross, S. A. 1976. “The Arbitrage Theory of Capital Asset Pricing.” *Journal of Economic Theory* 13: 341-360.

Salinger, Michael. 1992a. "Standard Errors in Event Studies." *Journal of Financial and Quantitative Analysis* 27 (1): 39-53.

Salinger, Michael. 1992b. "Value Event Studies." *The Review of Economics and Statistics*

74 (4): 671-677.

Salin, V. and N. H. Hooker. 2001. “Stock Market Reaction to Food Recalls.” *Review of Agricultural Economics* 23(1): 33-46.

Shanghai Daily. December 7, 2006. “Cancer-scare Noodles still on the Market.” Available at http://english.cri.cn/2946/2006/12/07/48@171620.htm. Last accessed January 28, 2009.

Sharpe, W. F. 1963. “A Simplified Model for portfolio Analysis.” *Management Science* 9 (2): 277-293.

Sharpe, W. F. 1964. “Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk.” *The Journal of Finance* 19 (3): 425-442.

Smith M.R., E.O. van Ravenswaay, and S.R. Thompson. “Sales Loss Determination in Food Contamination Incidents: An Application to Milk Bans in Hawaii.”

SAQSIQA. 2008a. “The List of Products and Companies Which Were Tested Positive for Melamine.” Available at http://www.aqsiq.gov.cn/zjxw/dfzjxw/dfftpxw/200809/t20080917_89994.htm. Last accessed August 5, 2009.

SAQSIQA. 2008b. “The List of 87 Companies Which Were Tested Negative for Melamine.” Available at http://www.aqsiq.gov.cn/zjxw/dfzjxw/dfftpxw/200809/t20080918_90221.htm. Last access August 5, 2009.

SAQSIQA. 2008c. “The Outcome of Test for Liquid Milk.” Available at http://www.aqsiq.gov.cn/zjxw/zjxw/zjftpxw/200809/t20080919_90325.htm. Last access August 5, 2009.

SAQSIQ. 2008c. “Joint Statement on the extension of the Memorandum of Understanding on administrative co-operation arrangement between DG SANCO and AQSIQ.” Available at http://ec.europa.eu/delegations/china/eu_china/food_safety_and_consumer_protection/food_safety/index_en.htm. Last access February 2011.

Tsay, R. S. 2005. *Analysis of Financial Time Series.* Second Edition. A JOHN WILEY & SONS, INC., PUBLICATION.

Thomsen, M. R. and A. M. McKenzie. 2001. “Market Incentives for Safe Foods” An Examination of Shareholder Losses from Meat and Poultry Recalls.” *American Journal Agricultural Economics* 82(3): 526-538.

United States Department of Agriculture (USDAa). Updated July 09, 2008. Food and Nutrition Information Center. “USDA Food Guide Pyramid Resources. – Dietary Guidelines for American 2005. Chapter 5 Food Groups To Encourage” Available at http://www.health.gov/dietaryguidelines/dga2005/document/html/chapter5.htm. Last accessed October 23, 2009.

United States Department of Agriculture (USDAb). Updated April 2009. Food and Nutrition Service. “About WIC.” Available at http://www.fns.usda.gov/wic/aboutwic/mission.htm. Last accessed October 23, 2009.

United States Department of Agriculture (USDAc). Updated October 2009. Food and Nutrition Service. “Special Milk Program.” Available at http://www.fns.usda.gov/cnd/Milk. Last accessed August 26, 2009.

United States Department of Agriculture (USDAd). 2009. Foreign Agricultural Service. "China: FAIRS Subject Report Food Safety Law Implementation Regulation." Available at http://www.usdachina.org/info_details1.asp?id=2261 and http://www.fas.usda.gov/gainfiles/200905/146347786.pdf. Last access February 11, 2011.

U.S. Commercial Service. 2003. "China Commercial Brief - March 14, 2003". Available at http://www.buyusa.gov/china/en/ccb030314.html. Last accessed February 3, 2009.

U.S. Food and Drug Administration (U.S. FDA). September 12, 2008. "FDA Issues Health Information Advisory on Infant Formula." Available at http://www.fda.gov/bbs/topics/NEWS/2008/NEW01883.html. Last accessed February 16, 2009.

Vega C. 2006. "Stock Price Reaction to Public and Private Information." *Journal of Financial Economics* 82: 103-133.

Vilella-Vila, M. and J. Costa-Font. 2008. "Press Media Reporting Effects on Risk Perceptions and Attitudes towards Genetically Modified (GM) Food." *The Journal of Socio-Economics* 37: 2095-2106.

VOA. September 26, 2008. "China's Melamine Milk Crisis Creates Crisis Of Confidence." Available at http://www.voanews.com/english/archive/2008-09/2008-09-26 voa45.cfm?CFID=105194268&CFTOKEN=38098097&jsessionid=6630a4cc332744b6216258186e28212f6572. Last accessed January 29, 2009.

Wang, Z., V. Salin, N. H. Hooker and D. Leatham. 2002. "Stock Market Reaction to Food Recalls: a GARCH Application." *Applied Economics Letters* 9: 979-987.

Wang, Z., Y. Mao, and F. Gale. 2008. "Chinese Consumer Demand for Food Safety Attributes in Milk Products." *Food Policy* 33, 27-36.

Washington Times. October 2, 2008. "Taiwan: Melamine Found in Nestle." Available at http://www.washingtontimes.com/news/2008/oct/02/taiwan-melamine-found-nestle-milk-powders/?page=2. Last accessed May 26, 2010.

World Health Organization (WHO). September 26, 2008. "Vigilance Needed to Ensure Safe Infant Food." Available at http://www.who.int/mediacentre/news/releases/2008/pr35/en/index.html. Last accessed May 19, 2010.

WORLD SCHOOL MILK DAY (WSMD). 2009. "Milk Celebrations around the Globe." Available at http://www.milk.org/worldschoolmilk/AllAbout-Around%20the%20World.htm. Last accessed November 6, 2009.

World Socialist Web Site (WSWS). December 2007. "Severe Food Shortages, Price Spikes Threaten World Population." Available at http://www.wsws.org/articles/2007/dec2007/food-d22.shtml. Last accessed May 13, 2010.

Xiao, J, L. Yu., X. Chen, and B. Huang. 2004. "Characteristics, Use and Outlook for HACCP." Chinese Journal of Animal Quarantine 21(7): 2-4.

Xinhua News (2008a). September 18, 2008. "Bright Dairy's Apology Statement to

Consumers." Available at http://news.xinhuanet.com/newscenter/2008-09/19/content_10080754.htm. Last accessed May 26, 2010.

Xinhua News (2008b). State Council "Regulation of Dairy Quality and Safety Supervision ([2008] No. 536)" Available at http://news.xinhuanet.com/newscenter/2008-10/10/content_10172487.htm. Last accessed April 16, 2010.

Xinhua News (2008c). General Office of the State Council "Outline of Dairy Industry Rectification and Plan." Available at http://news.xinhuanet.com/newscenter/2008-11/19/content_10382526.htm. Last accessed April 16, 2010.

Xinhua News (2008d). "New Liquid Milk in Line with Melamine Limits: AQSIQ.". Available at http://www.china.org.cn/government/central_government/2008-10/12/content_16599136.htm. Last access February 11, 2011.

Yang, J., M. S. Haigh, and D. J. Leatham. 2001. "Agricultural Liberalization Policy and Commodity Price Volatility: A GARCH Application." *Applied Economics Letters*, 8(9), 593-98.

Yang, S., J. Ding., J. Zheng., B. Hu., J. Li., H. Chen., Z. Zhou., and X. Qiao. 2009. "Detection of Melamine in Milk Products by Surface Desorption Atmospheric Pressure Chemical Ionization Mass Spectrometry." *Analytical Chemistry* 81: 2426-2436.

Yili.com. September 17th, 2008. "Yili Group to Dear Moms – Apology Statement." Available at http://www.yili.com/ylnews/82811847f84c4f149a469ab2d72ecb59.shtml. Last accessed May 26, 2008.

Zhou, Z., W. Tian, and J. Zhou. 2002. "The Emerging Dairy Economy in China: Production, Consumption and Trade Prospects." *Agribusiness Review* 10, 8.

Zivot, E. and D. W. K. Andrews. 1992, "Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis", Journal of Business & Economic Statistics, Vol. 10, No. 3, pp. 251-270.