ABSTRACT

LEE, DAEMYUNG. Three Essays on Policy Impacts on Labor and Health Outcomes and Food Recalls. (Under the direction of Xiaoyong Zheng and Kathryn Boys).

These three essays study the effect of a health-related policy change on labor supply and health outcomes and food safety issues. In the first chapter, I examine the effect of an introduction of State Children's Health Insurance Program (SCHIP) premiums on labor supply. Health insurance has played a key role in determining an individual's job choice, retirement plan, and health care utilization. This paper examines the effect of introducing premiums in the Arizona State Children's Health Insurance Program (SCHIP) in 2004 on the labor supply of adults with children. The results of a difference-in-differences approach indicated that, among Arizona residents with children, men were six percentage points more likely to work and worked 4.5-5.2 more weeks per year after the policy implementation. Also, single women were 13 percentage points more likely to work and worked, on average, an additional 7.2-8.1 weeks per year. On the contrary, married women were 5.2 percentage points less likely to work and worked, on average, 8-9.6 weeks less per year after the policy change as their husbands worked more.

Next, the second chapter evaluates the impact of food recalls on stock price returns for companies issuing the recall. Food-borne diseases cause 48 million people, one-sixth of the U.S. population, to become sick, 128,000 people to be hospitalized, and 3,000 people to die each year (CDC, 2016). The probability of these incidents can be reduced by food recalls regulated by government agencies. This paper analyzes the effects of food recalls by FDA on the stock returns of firms using the event study method. Cumulative average abnormal returns (CAAR) are estimated for industries and recall classes. Each industry shows a variety of different patterns. The CAAR of Food Manufacturing industry such as ConAgra slightly decreased and recovered its original state. However, the CAAR of Food and Beverage Retailers industry such as Kroger

experienced a continual decrease in CAAR over 90 days. Next, class I recalls have a larger impact than do Class II recalls on firms' valuation.

The third chapter examines the effect of an introduction of SCHIP premiums on children's medical utilization, medical expenses, and health outcomes in Arizona. Many Americans in the U.S. cannot afford preventive health services due to economic circumstances (CDC, 2010). The situation is even worse in low-income households. Medicaid and the State Children's Health Insurance Program (SCHIP) can help millions of low-income people have preventive health care services in order to promote prevention (Medicaid, 2015). I study the effect of an introduction of SCHIP premiums in Arizona on children's medical utilization, medical expenses, and health outcomes using the triple difference estimation method. The results show that children became less healthy, and they were less likely to receive preventive care services compared to before the policy change. In addition, policy implementation decreased the probability of making any appointments for health care at a doctor's office or clinic. The implementation is also associated with a decrease in hospital outpatient visits. Lastly, the percent of out-of-pocket costs that a patient has to pay increased.

Three Essays on Policy Impacts on Labor and Health Outcomes and Food Recalls

by
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DEDICATION

This dissertation is dedicated to my parents, Bog Seong Lee and Myung Ai Choi, and my sister, Joon Moon Lee, for their endless love, encouragement, and support.

BIOGRAPHY

Daemyung Lee was born in Seoul and grew up in Incheon, South Korea. He pursued a Bachelor's degree in economics from SoongSil University where he graduated with honors. He earned a Master's degree in Economics from Korea University, a doctoral certificate in Economics from Korea University, and an en-route Master’s degree in Economics during the Ph.D. Program from North Carolina State University. He completed his doctoral dissertation under the direction of Dr. Xiaoyong Zheng and Dr. Kathryn Boys.

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CHAPTER 1

How does an introduction of premiums into the State Children's Health Insurance Program (SCHIP) affect labor supply? Evidence from Arizona

1.1. Introduction

Economists have long been interested in labor supply issues and associated societal aspects. For example, labor income accounts for approximately 60% of the total economic output in the U.S. (Giandrea and Sprague, 2017) and a one percent increase in labor supply increases the total economic output by around three percent on average in U.S. industries (Akay and Dogan, 2013). At the individual level, weekly paid working hours may have negative effects on quality of life for both men and women, though the effect on women may be stronger (Knabe and Ratzel, 2010).

Labor supply also affects income which may have impacts on public welfare programs. For instance, when individuals quit working, it would result in a reduction of income. As a result, the costs of other welfare programs such as the Supplemental Nutrition Assistance Program (SNAP – formerly known as food stamps) would increase (Kenney et al., 2012; Deshpande, 2016). One such example of this was the 2008 Medicaid expansion in Oregon which led to a decrease in employment by about 3 percent, and a subsequent increase in SNAP enrollment by 2.5 percent (Baicker et al., 2014).

Medicaid is the most common public health insurance program for low-income Americans. Introduced under Title XIX of the Social Security Act of 1965, Medicaid provides affordable health care coverage to low-income, elderly, and disabled individuals. Although many low-income individuals and their children receive Medicaid coverage, it is difficult for those whose incomes are only slightly above the Medicaid threshold to afford private health insurance.

The State Children's Health Insurance Program (SCHIP) was created under Title XXI of the Balanced Budget Act of 1997 to expand health care coverage for children in low-income households. The program is jointly financed by the federal and state governments, but many states, including Arizona, run their own programs and can set their own SCHIP policies. The income requirements for SCHIP are slightly higher than those for Medicaid; households are eligible to enroll in the SCHIP by meeting some requirements shown in Table 1.1 and Table 1.2. Since its inception, SCHIP has played a key role in supporting individuals with relatively low incomes who may be above the threshold for Medicaid coverage through the provision of low-cost health insurance for their children.

Insurance premiums are a type of cost-sharing for which the insured has to pay periodically to get insurance coverage. The premium introduction could be a burden in that it might result in loss of health insurance coverage for some children. By 2008, 34 states had implemented copayments and premium cost-sharing (Ross, Horn, and Marks, 2008).

Although many states have introduced premiums into their SCHIP programs, it is worth studying the 2004 SCHIP policy change in Arizona because the amount of premium introduced was relatively large for low-income people. As shown in Figure 1.1, there was a sizable decrease in Arizona's state expenditure for SCHIP in 2004 and 2005.[1] This decrease is likely attributed to the introduction of SCHIP premiums in Arizona in July 2004, which resulted in larger disenrollment and smaller reenrollment compared with other years (Kenney et al., 2007).

[1] All dollar values are converted as constant 2008 dollars inflated using the Consumer Price Index for All Urban Consumers (CPI-U) from the Bureau of Labor Statistics following Busch, Golberstein, and Meara (2014).

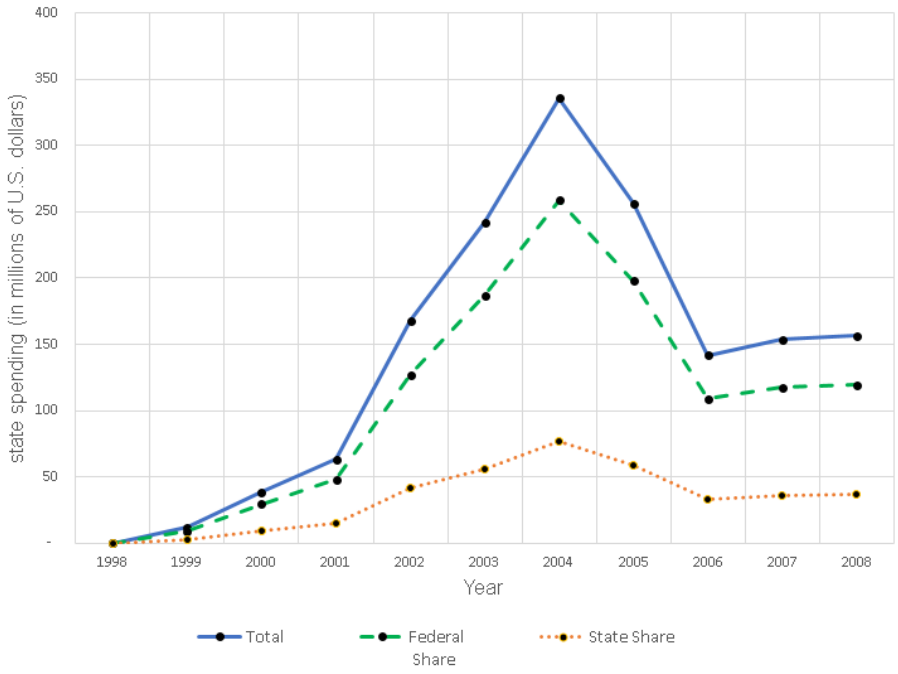

Figure 1.1 Trend of SCHIP Expenditure in Arizona
Source: Financial Management Report between 1998 and 2008 from Medicaid.gov.

This policy introduced a monthly premium of $10 for one child and $15 for more than one child for households whose incomes are between 101% and 150% of the federal poverty line (FPL). For households earning 150%-175% of the FPL, the monthly premium was raised from $10 to $20 for the first child and $15 to $30 for two or more children. For the highest-earning category, households at 176%-200% of the FPL, the monthly premium increased from $10 to $25 for the first child and from $20 to $30 for more than one child, respectively. By contrast, for example, Michigan increased the monthly SCHIP premium from $5 to $10 for households with incomes greater than 150% but less than or equal to 200% of the FPL on March 8, 2007 regardless of the number of children. There was no monthly premium for families earning between 101% and 150% of the FPL, before and after the policy change. In addition, there was evidence that people were significantly influenced by this policy change. As a result of this policy change, the rate of

disenrollment in the Arizona SCHIP increased and the rate of reenrollment in the Arizona SCHIP decreased (Kenney et al., 2007).

Previous studies have shown that the introduction, expansion, or contraction of Medicaid changes the labor supply (Winkler, 1991; Lee and Tomohara, 2008; Strumpf, 2011; Garthwaite, Gross, and Notowidigdo, 2014; Boyle and Lahey, 2016). However, little is known about the effects of policy changes in the State Children's Health Insurance Program (SCHIP) on labor supply. Thus, the purpose of this study was to examine the effects of the 2004 Arizona SCHIP premium policy changes on individuals' labor supply. The difference-in-differences (DD) and synthetic control methods were used to analyze these effects both at the extensive margin (whether to work) and at the intensive margin (how many weeks to work in a year).

This paper contributes to the existing literature as the first to study the effect of SCHIP policy change in a particular state. Additionally, while previous studies have focused on the effects of such policy changes on women (Winkler, 1991), single women (Strumpf, 2011), married women (Lee and Tomohara, 2008), pregnant women (Dave et al., 2015), and veterans (Boyle and Lahey, 2010) and their wives (Boyle and Lahey, 2016), this analysis includes both men and women. The labor supply of one member of a household can affect the labor supply decisions of other members making it important to study the effects of policy changes on men in addition to women.

I found that men with children in Arizona were six percentage points more likely to work and worked 4.5-5.2 more weeks per year after the policy change. For women with children in Arizona as a whole, the policy change did not have an impact on their probability of working but a negative impact on their numbers of work weeks per year. I then examined the policy effects on single women and married women separately. I found single women were 13 percentage points more likely to work and on average they worked an additional 7.2-8.1 weeks per year after the

policy change. By contrast, married women were 5.2 percentage points less likely to work and on average they worked 8-9.6 weeks less per year after the policy change as their husbands worked more. These results are in line with previous studies, especially from Boyle and Lahey (2010, 2016), representing that men were more likely to work after losing premium benefits of public health insurance. By contrast, wives were less likely to work after their husbands began to work. This outcome is supported by findings that single women or divorced women, who do not have husbands, increased both the intensive and extensive margin of labor supply.

The rest of the paper is organized as follows. Section 1.2 reviews previous literature. Section 1.3 introduces the major public health insurance programs for low-income people in the U.S. and SCHIP in particular as backgrounds for identification strategies. Section 1.4 discusses the data and the empirical strategy used. Results are presented and discussed in Section 1.5. The final section concludes.

1.2. Literature Review

This study is closely related to previous literature studying the impact of Medicaid on the U.S. labor supply. Winkler (1991) studied the impact of Medicaid on labor supply with a focus on females and found that Medicaid had a significant negative effect on a female head-of-household's decision to work. More specifically, a 10 percent increase in Medicaid expenditure decreased a female head-of-household's probability of working by between 0.9 and 1.3 percentage points. Although Winkler (1991) hypothesized that an increase in Medicaid expenditures would have a negative impact on hours worked; assuming leisure is a normal good, it was thought that this additional "income" (in the form of a government transfer), which may be increasing the attractiveness of being a nonworker. Results of this study that Medicaid expansion reduced a

head's probability of working. However, it had an insignificant effect on the number of hours worked. The author conjectured a possible omitted variable bias, specifically a measure of initial health status, as the reason Medicaid had differential impacts on these two decisions. Medicaid benefits likely improved participants' health and therefore enabled workers to increase their hours. Similarly, Dave et al. (2015) examined the effects of Medicaid expansion in the late 1980s and early 1990s on the labor supply of pregnant women. They found that an increase in Medicaid eligibility between 1985 and 1996 significantly decreased the probability of pregnant women working.

Strumpf (2011) examined the effect of Medicaid introduction on labor supply for single women using Current Population Survey (CPS) data from 1963 to 1975. In contrast to the findings of Winkler (1991) and Dave et al. (2015), the author did not find evidence that women who qualified for Medicaid decreased their labor supply compared to ineligible women as one might expect as a result of the income effect. This finding could be due to the potential for Medicaid to increase children's health care utilization (Currie and Gruber, 1996a; 1996b). As a result, children's health would be improved and single women would be able to increase hours worked, offsetting the income effect.

Scholars have also studied the effects of Medicaid or SCHIP policy changes on labor supply in certain U.S. states. Garthwaite, Gross, and Notowidigdo (2014) studied the effect of TennCare (Tennessee's version of Medicaid) disenrollment on the labor supply of childless adults using CPS data. They found that employment rates increased by 2.5 percentage points after disenrollment. They argued that some employees might delay their retirement to maintain employer-provided coverage after the disenrollment.

Lee and Tomohara (2008) examined the effect of SCHIP implementation on labor supply of married women. They found that SCHIP affected only certain groups of married women such as non-white women. The introduction of SCHIP lowered the probability of working for non-white women, women with pre-school aged children, and those with less than high school education.

Looking at another type of public health insurance program, Boyle and Lahey (2016) studied the effects of veteran's health insurance the labor supply of married couples. They found that veterans were less likely to work after receiving VA health benefits. On the other hand, veterans' wives were more likely to work after their husbands began to receive VA health benefits. They observed two main effects of a husband's work status on a wife's work status. First, wives tended to retire with their husbands. Second, wives tended to increase their work hours after their husbands retired, likely due to financial need. The authors concluded that the second effect likely dominated the first effect as wives' probability of working increased by 1-2 percentage points once their husbands received VA health benefits.

As evidenced by the review of the existing literature, there is a gap regarding the effect of policy changes in the SCHIP on the labor supply for both men and women. This paper aims to fill that gap by studying how the labor supply was affected by the introduction of SCHIP premiums in Arizona.

1.3. Public Health Insurance Programs

Before describing the SCHIP program, Medicaid, which is the main public health insurance program for low-income people, will be briefly introduced in this section. The private health insurance market has not been able to provide affordable health insurance plans for low-income and disabled people. Therefore, Medicaid and SCHIP were developed. Medicaid is a joint federal

and state program to support families with the lowest incomes. SCHIP offers essential coverage to children in families with slightly higher incomes that are not eligible for Medicaid.

1.3.1. Medicaid

Medicaid is the state and federal program that provides health coverage for low-income or disabled people.[2] The Medicaid program was created as Title XIX in the Social Security Amendments of 1965, which are amendments to the Social Security Act of 1935. The number of Medicaid enrollees was about 71 million in 2014. People are eligible for Medicaid benefits when they meet certain income criteria as shown in Table 1.1.

Although eligibility varies from state to state, Title XIX of The Social Security Act specifies mandatory eligibility groups and optional eligibility groups. If states want to qualify for Federal funds, they must provide Medicaid coverage not only for individuals receiving public income maintenance payments (PIM) such as Temporary Assistance for Needy Families (TANF, formerly known as AFDC), but also for related groups who do not get cash payments. Column 2 in Table 1.1 displays the mandatory Medicaid eligibility groups.

States also have the option of offering Medicaid coverage for certain other related groups of people. These optional groups have similar characteristics as those of the mandatory groups, but states can set their own eligibility criteria. These optional groups include people in column 3 in Table 1.1.

[2] Disabled people who have been approved for Social Security disability insurance (SSDI) benefits get Medicare, and those who have been approved for Supplemental Security Income (SSI) receive Medicaid.

Table 1.1 Medicaid Mandatory and Optional Eligibility before Affordable Healthcare Act (ACA)

Eligibility Category	Mandatory Coverage	Optional Coverage
Infants under 1	≤133% FPL	≤l85% FPL
Children 1-5	≤133% FPL	*
Children 6-19	≤100% FPL	*
Pregnant women	≤133% FPL	≤185% FPL
Parents	Below state's 1996 Aid to Families with Dependent Children (AFDC) limit	*
Parents in welfare-to-work families	≤185% FPL	*
Elderly and disabled Supplemental Security Income (SSI) beneficiaries	SSI limits	Above SSI limits, but below 100% FPL
Certain Working disabled		Variable, SSI level to 250% FPL
Elderly - Medicare assistance only (payment for Medicare cost-sharing requirements)	Variable, up to 175% FPL	Variable up to l75% FPL
Nursing home residents		Above SSI limits, but below 300% SSI
Medically needy		"Spend down" medical expenses to state set income level

Note: * This table shows the federal policy. * means that there is no federal optional threshold for the category and states decide on the threshold.

Sources: Teitelbaum and Wilensky (2016) and Schneider et al., (2002),

Medicaid is essential for seniors and disabled people since poverty is related to both old age and disability status. Medicare covers most seniors, but the program costs are high even though many elderly people have low incomes and limited savings. It is difficult for disabled people to enroll in private health insurance if they cannot work at all or can only work part-time. Moreover, private insurance generally does not provide enough benefits to cover services for them to live an independent life society. For example, Medicaid is the main payer for long-term services and supports (LTSS) which help people with disabilities and older adults with self-care and other household tasks such as bathing, dressing, fixing meals, and managing a home.

SSI recipients may be automatically approved for Medicaid benefits in most states. However, some states including Illinois and Virginia do not obey this rule because they adopted section 209(b) of the 1972 amendments to the Social Security Act. This section allows states to have their own Medicaid eligibility criteria for the elderly and people with disabilities.

Many people receive both SSI and Social Security benefits. Medicaid is tied to the receipt of SSI benefits in most states, whereas Medicare is tied to Social Security benefits. It is possible to receive both Medicare and Medicaid. States pay the Medicare premiums for SSI beneficiaries if they also qualify for Medicaid. They would also be eligible for Extra Help with Medicare Part D without filing a separate application if they get both SSI and Medicare.

Some people have income exceeding the Medicaid eligibility threshold. This amount of surplus income is called excess income. If they spend this excess income on medical expenses, they may be eligible for Medicaid. This policy is called the Spenddown program. These Spenddown benefits are only for people who are children under 21 years old, adults over 65 years old, the blind, the disabled, or living in families with at least one parent absent, dead, disabled or unemployed. For example, suppose an individual over 65 cannot enroll in Medicaid because his or her monthly income is $30 more than the Medicaid income threshold. If he or she incurs a $30 per month medical expenditure, Medicaid will cover the rest of medical bills. In this case, the Spenddown is the $30 of medical bills.

States have the option to impose premiums and cost-sharing (out-of-pocket costs) for Medicaid enrollees. Deductibles, copayments, and coinsurance are all part of the cost-sharing. States can impose charges on people with slightly higher income more although the maximum out of pocket costs are usually restricted. Certain groups that need protection including children and pregnant women are exempt from most cost-sharing.

For instance, in 2018, most people in Arizona who are covered by the Arizona Health Care Cost Containment System (AHCCCS) do not need to pay a monthly premium. However, if they incur medical costs, they have to make payments for medical care that they use. Specifically, for people who are 19 years old or older, they need to pay copayments ranging from $2.30 to $3.40 per visit for certain medical services under AHCCCS. Certain vulnerable groups of people do not have to make copayments. These include children less than 19 years old, pregnant women, or people in hospice care.

1.3.2. SCHIP

The Social Security Act was amended by Section 4901 of the Balanced Budget Act of 1997 (BBA) by adding SCHIP as Title XXI. Title XXI offers funds to states in order to finance the SCHIP programs. John Kasich, who at that time was the chairman of the U.S. House Budget Committee, introduced the Balanced Budget Act of 1997. The bill was passed by both the House and the Senate on June 25, 1997. President Bill Clinton signed this bill into law on August 5, 1997.

SCHIP is the partnership program between the federal and state governments based on income and family size. All 50 states participate in the SCHIP program even though it is an optional program. It provides health coverage to uninsured children under the age of 19 whose families earn a higher income than the Medicaid threshold but cannot afford private coverage. In other words, the lower-income limit for SCHIP is the Medicaid threshold. Each state has different upper-income limits as shown in Table 1.2. In 2016, the number of SCHIP enrollees was about 8.9 million, compared with 37 million children enrolled in Medicaid.

Table 1.2 SCHIP Income Eligibility Upper Limits as a Percent of the Federal Poverty Level on January 1, 2017

State	Upper Limit	State	Upper Limit	State	Upper Limit
Alabama	317%	Kentucky	218%	North Dakota	175%
Alaska	208%	Louisiana	255%	Ohio	211%
Arizona	205%	Maine	213%	Oklahoma	210%
Arkansas	216%	Maryland	322%	Oregon	305%
California	266%	Massachusetts	305%	Pennsylvania	319%
Colorado	265%	Michigan	217%	Rhode Island	266%
Connecticut	323%	Minnesota	288%	South Carolina	213%
Delaware	217%	Mississippi	214%	South Dakota	209%
D.C.	324%	Missouri	305%	Tennessee	255%
Florida	215%	Montana	266%	Texas	206%
Georgia	252%	Nebraska	218%	Utah	205%
Hawaii	313%	Nevada	205%	Vermont	317%
Idaho	190%	New Hampshire	323%	Virginia	205%
Illinois	318%	New Jersey	355%	Washington	317%
Indiana	262%	New Mexico	305%	West Virginia	305%
Iowa	307%	New York	405%	Wisconsin	306%
Kansas	244%	North Carolina	216%	Wyoming	205%

Source: Medicaid and CHIP Eligibility, Enrollment, Renewal, and Cost Sharing Policies as of January 2017: Findings from a 50-State Survey, Kaiser Family Foundation, January 2017. Based on a national survey conducted by the Kaiser Commission on Medicaid and the Uninsured with the Georgetown University Center for Children and Families, 2017.

A state has to submit a Title XXI SCHIP policy plan to receive federal funds. Each state can create its children's health insurance program (CHIP) in the following three ways. First, a state can follow federal Medicaid rules, which is called Medicaid expansion CHIP (MSCHIP). Second, a state can design separate CHIP program (S-SCHIP). Third, a state can combine both M-SCHIP and S-SCHIP (COMBO). According to Lee and Tomohara (2008), 15 states used S-SCHIP, 19 states used M-SCHIP and 17 states used COMBO as of March 2000. In 2015, 29 States, 8 States plus 5 territories and D.C. and 11 states, used COMBO, M-SCHIP and S-SCHIP, respectively, because the Affordable Healthcare Act (ACA) expanded Medicaid to families earning up to 133% of FPL in 2014 and 11 states followed this rule. Premiums for the SCHIP programs vary by state. Table 1.3 lists the SCHIP premiums for two children in a three-member family in Arizona and some other states as of January 2007.

Table 1.3 Premium Payments for Two Children in A Family of Three at Selected Income Levels in Arizona and candidates of control states in January 2007 (Unit: dollars, $)

State	Frequency of payment	Income Level at which State begins Requiring Premiums (FPL)	Amount at 101% of the Federal Poverty Line	Amount at 151% of the Federal Poverty Line	Amount at 200% of the Federal Poverty Line
Arizona	Monthly	101	15	30	35
Arkansas	None	None	-	-	-
Colorado	Annually	151	0	35	35
Delaware	Monthly	101	10	15	25
Iowa	Monthly	151	0	20	20
Louisiana	None	None	-	-	-
Mississippi	None	None	-	-	-
Montana	None	None	-	-	-
Nebraska	None	None	-	-	-
New Mexico	None	None	-	-	-
New York	Monthly	160	0	0	18*
North Carolina	Annually	151	0	100	100
North Dakota	None	None	-	-	-
Ohio	None	None	-	-	-
Oklahoma	None	None	-	-	-
Oregon	None	None	-	-	-
South Carolina	None	None	-	-	-
South Dakota	None	None	-	-	-
Virginia	None	None	-	-	-
Wyoming	None	None	-	-	-

Note: * Eligibility for maximum poverty level in New York is higher than 200%, therefore, $18 shows the amount at 201% of the Federal Poverty Line.

Source: Ross, D. C., A. Horn, and C. Marks (2008) " Health Coverage for Children and Families in Medicaid and SCHIP: State Efforts Face New Hurdles: A 50-State Update on Eligibility Rules, Enrollment and Renewal Procedures, and Cost-Sharing Practices in Medicaid and SCHIP in 2008," The Henry J. Kaiser Family Foundation

1.4. Methodology and Data

1.4.1. Data

The data are based on the Annual Social and Economic Supplement (ASEC) of the CPS. CPS data have been collected on a monthly basis since 1940. A supplemental survey, the ASEC, is also conducted in March of each year. While the monthly CPS is designed to collect basic demographic and labor force data, the March supplement includes more in-depth information including work experience, income, noncash benefits, migration, SSI, and health status. In addition to the differences in information gathered, there are also differences in the selection criteria for the two surveys. For example, there were 74,008 respondents for the March 2006 CPS monthly survey compared to 94,097 respondents for the March 2006 ASEC supplemental survey. This difference is due to the variations in the selection criteria as well as additional respondents were drawn from CPS respondent pools in adjacent months and Hispanics were oversampled because they make up a small share of the population. Researchers can correct this through weighting.

The respondents to the supplement mainly come from respondents to the basic CPS survey in March, but some of them are respondents to the basic CPS survey in adjacent months. Also, not all respondents to the basic CPS survey in March will receive the supplement questionnaire because the supplement has different selection criteria.

For this study, sampling was restricted to 2001-2007, with the exception of 2004. This sample frame was selected because SCHIP was unstable before 2001 in terms of policy changes and there was a financial crisis that did not equally affect all states in the U.S. Additionally, the observation year 2004 was dropped because Arizona introduced SCHIP premiums in July of that year. The total number of observations included in this sample frame was 1,263,731 individual respondents (99,707 households) for six years. Next, only heads/householders and spouses remain

in order to leave only one person per household by gender. As a result, the number of observations was reduced to 706,639. The sample was further narrowed to include only households eligible for the SCHIP. Starting with those with children under the age of 18, the number of observations was reduced to 315,127. The final step was to apply the SCHIP income criteria in Arizona detailed in Table 1.4 and ones in control states group in Table 1.5 to the sample, resulting in a total of 8,213 observations.

Table 1.4 Medicaid and SCHIP Income Thresholds by Age in Arizona

Children's age	Medicaid Income Threshold (as percentages of FPL)	SCHIP Income Threshold (as percentages of FPL)
<1	1-140%	141-200%
1-5	1-133%	134-200%
6-18	1-100%	101-200%

Source: Ross, D. C., A. Horn, and C. Marks (2008)

Table 1.5 SCHIP Income Thresholds by Children's Age in Eight States for the Control Group

	SCHIP Income Threshold (as percentages of FPL)			
Children's age	Arkansas	Iowa	Nebraska	New Mexico
<1	0-200%	134-200%	0-185%	0-235%
1-5	0-200%	134-200%	0-185%	0-235%
6-18	0-200%	134-200%	0-185%	0-235%
	SCHIP Income Threshold (as percentages of FPL)			
Children's age	North Dakota	Ohio	Oklahoma	South Carolina
<1	134-140%	0-200%	101-185%	0-185%
1-5	134-140%	0-200%	101-185%	0-150%
6-18	101-140%	0-200%	101-185%	0-150%

Source: Ross, D. C., A. Horn, and C. Marks (2008)

1.4.2. Empirical Methods

Difference-in-differences (DD) estimation with the synthetic control method is used to analyze the effect of the 2004 SCHIP policy change in Arizona. As the policy change happened in 2004, the years 2001 to 2003 are defined as the control period and the years 2005-2007 are done as the

treatment period for work status. On the other hand, another dependent variable, weeks worked last year, is recorded as lags of the actual values. For example, if a respondent worked for 30 weeks in 2001, 30 weeks were recorded in the data in 2002. Therefore, the years between 2002 and 2004 are to be considered as a control period while 2005-2008 are to be as a treatment period. In addition, some time-varying variables such as age and the number of children under age 18 are also adjusted by subtracting one year old. Next, the treatment and control groups are to be discussed in more detail in the following subsection.

1.4.2.1. Identification Assumptions and the Treatment and Control Groups

Boyle and Lahey (2016) pointed out that several identification assumptions need to be satisfied to use the DD method. First, individuals in the treatment group should be influenced by the policy change while individuals in the control groups should not. Second, there should no other contemporaneous shocks that affect the two groups differently other than the policy change being considered. Third, individuals in the treatment and control groups should be similar. Fourth, the treatment and control groups should have parallel trends, that is, the treatment group would have followed the same trend as the control group if there was no policy change. The treatment and control groups were constructed such that these assumptions were likely to hold.

As required by the first identification assumption discussed above, it was first necessary to distinguish people who were eligible for the SCHIP in order to define the treatment group. Table 1.4 shows the Medicaid and SCHIP income thresholds in Arizona). Income thresholds are based on Federal Poverty Guidelines (FPL) which are issued by the Department of Health and Human Services (HHS) annually. Medicaid and SCHIP income thresholds vary by age. First, for children under the age of 1, Medicaid covers children from families whose incomes are up to 140 percent

of the FPL while SCHIP covers children from families whose incomes are between 141 and 200 percent of the FPL. For children between the ages of 1 and 5, Medicaid covers those with families whose incomes are up to 133 percent of the FPL, whereas SCHIP covers children with families whose incomes are between 134 and 200 percent of the FPL. For children between 6 and 18, Medicaid covers those from families whose incomes are up to the 100% FPL while SCHIP covers children from families whose incomes are between 101 and 200 percent of the FPL. Based on this information, the treatment group was defined as adults in Arizona with children under age 1 and whose family incomes are between 141-200% of the FPL, with children between the ages of 1 and 5 and whose family incomes are between 134-200% FPL, or with children between 6 and 18 and whose family incomes are between 101-200% of the FPL.

The following steps present how the control group was constructed. The control group should consist of SCHIP recipients in those states where SCHIP policies did not change between 2001 and 2007 in order to satisfy the first identification assumption discussed above. Many states have introduced or increased SCHIP premiums due to budget shortfalls. As a result, premiums had changed in all but 19 states during this period. Those 19 states were: Arkansas, Colorado, Delaware, Iowa, Louisiana, Mississippi, Montana, Nebraska, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Virginia, and Wyoming.

Among these 19 states, Colorado, Delaware, Louisiana, Montana, New York, North Carolina, Oregon, South Dakota, Virginia, and Wyoming changed state income thresholds for SCHIP during the period of interest. For example, in January 2003, Oregon increased its SCHIP income threshold from 170% of the FPL to 185% of the FPL. After eliminating these states, the following nine states remained: Arkansas, Iowa, Mississippi, Nebraska, New Mexico, North Dakota, Ohio, Oklahoma, and South Carolina. Of these remaining states, it was found that

Mississippi changed SCHIP copayments in 2005, raising the copayment for prescriptions from $1 to $3 per generic drug prescription. Therefore, Mississippi was removed, leaving eight states as candidates for the control group. With these final eight candidate states, a control group was built following their own income criteria, detailed in Table 1.5.

The fourth identification assumption discussed above is that the treatment group and the control group should have parallel trends if there was no policy change. One way to make this assumption more likely to hold is to construct a synthetic control group, which is a weighted combination group from the original control group. By doing this, the constructed synthetic control group has similar trends as the treatment group during the control period (Abadie and Gardeazabal, 2013; Abadie, Diamond, and Hainmueller, 2011). Obtaining synthetic control units as a control group, DD estimation can be applied instead of the original control group. Following Fitzpatrick (2008), Courtemanche and Zapata (2014), and Dillender, Heinrich, and Houseman (2016), the weights from the synthetic control method were multiplied by the CPS weights. This enabled the application of the synthetic control strategy to individual-level data and optimized the CPS sample design.

1.4.2.2. Synthetic Control Method with Eight Candidate States

Let J denote the number of available candidate states, that is, $J = 8$. In essence, the synthetic control method is to find $W = (w_1, ..., w_J)'$, a $J \times 1$ vector of nonnegative weights with $w_1 + w_2 + ... + w_J = 1$ so that the outcomes for the treatment state (Arizona) are very similar to the weighted average outcomes for the control states when W is used as the vector of weights during the control period. More specifically, let X_1 denote the $(K \times 1)$ vector of K independent variables for Arizona and X_0 do the $(K \times J)$ matrix containing the values for the same variables for the J

candidate states. Then, the optimal weighting vector W^* is chosen by minimizing the following distance function,

$$\|X_1 - X_0 W\| V = \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)} \quad [1.1]$$

,where V is a $(K \times K)$ diagonal matrix reflecting the relative importance of the variables in X_0 and X_1. V is selected by minimizing the mean squared prediction error (MSPE) of the outcome variable over the control period. Specifically, let Z_1 be the $(T_p \times 1)$ vector of the outcome variable (work status or weeks worked last year) for Arizona during the control period and Z_0 be the $(T_p \times J)$ analogous matrix for the control states, where T_p is the number of years in the control period. Then V is selected by minimizing the following function,

$$V^* = \arg\min_{V \in \Upsilon} (Z_1 - Z_0 W^*(V))'(Z_1 - Z_0 W^*(V)) \quad [1.2]$$

,where Υ is the set of all positive definite and diagonal matrices.

Figure 1.2 through Figure 1.5 show the time series plots of the outcome variable, work status for all women with children, all men with them, married women with children, or single women with the ones, in Arizona and the synthetic control group constructed using the method described above. Figures 1.6 through 1.9 depict the similar plots for the other outcome variable, weeks worked last year, for the four groups. The dotted vertical line represents a boundary one indicating the control period, one year before the policy implementation. The outcome variables for the treatment group and the synthetic control group largely follow a similar trend during the control period, justifying the use of DD methods based on these two groups.

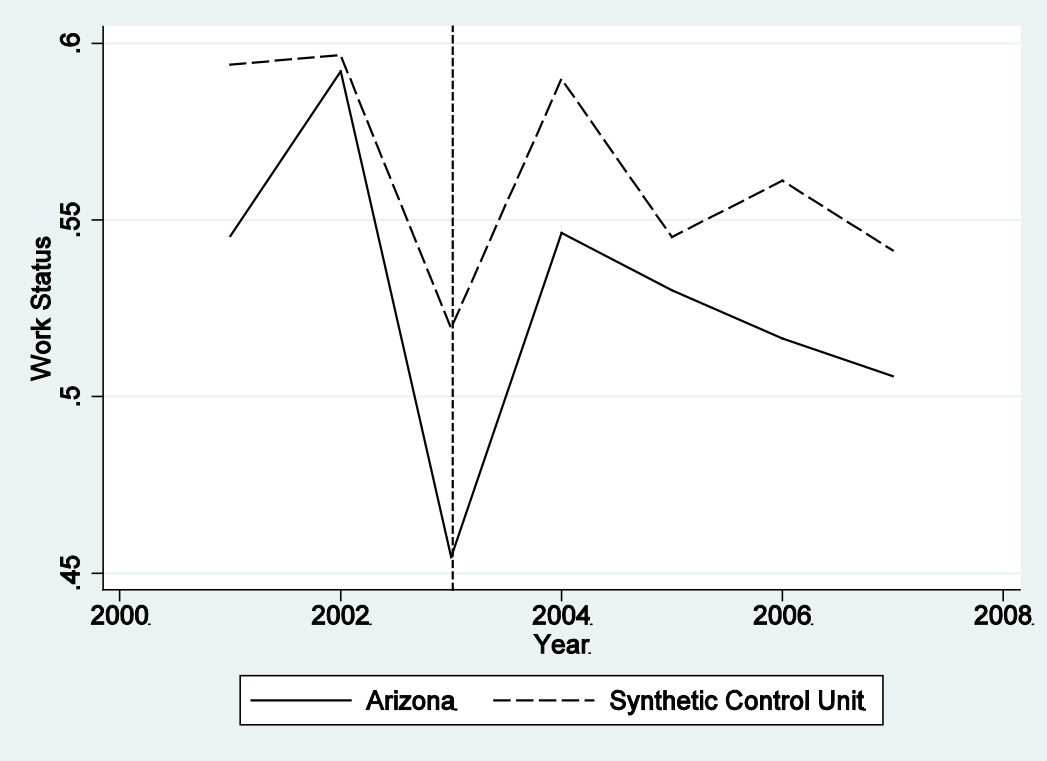

Figure 1.2 Trends of work status for all women in Arizona and synthetic control group

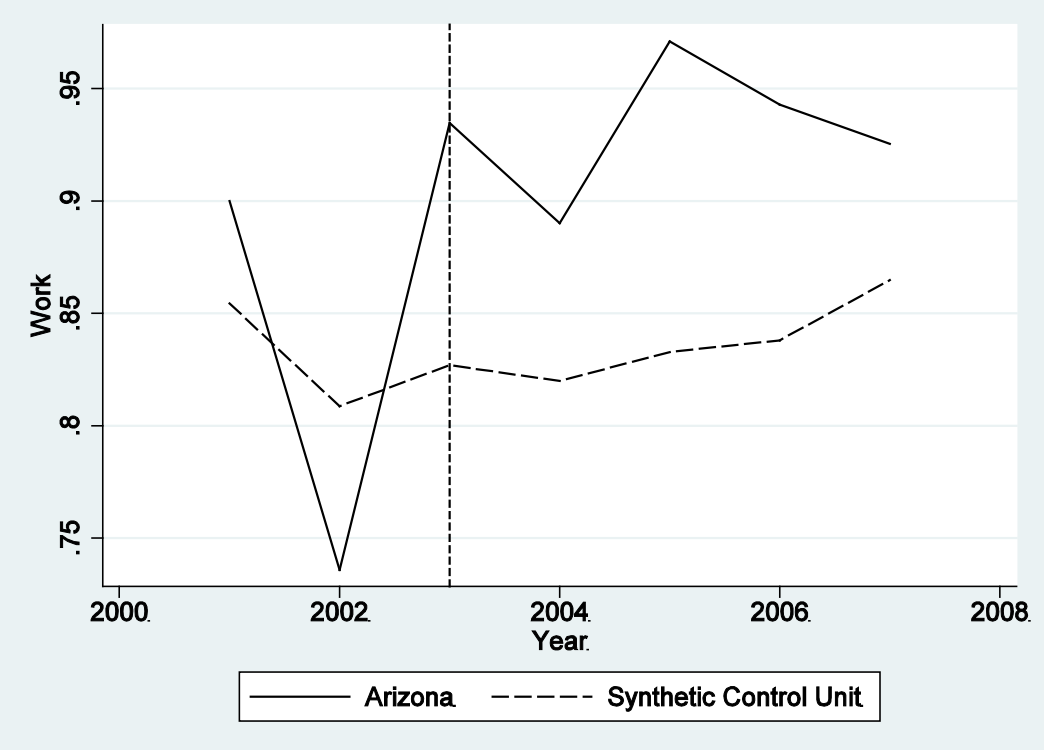

Figure 1.3 Trends of work status for all men in Arizona and synthetic control group

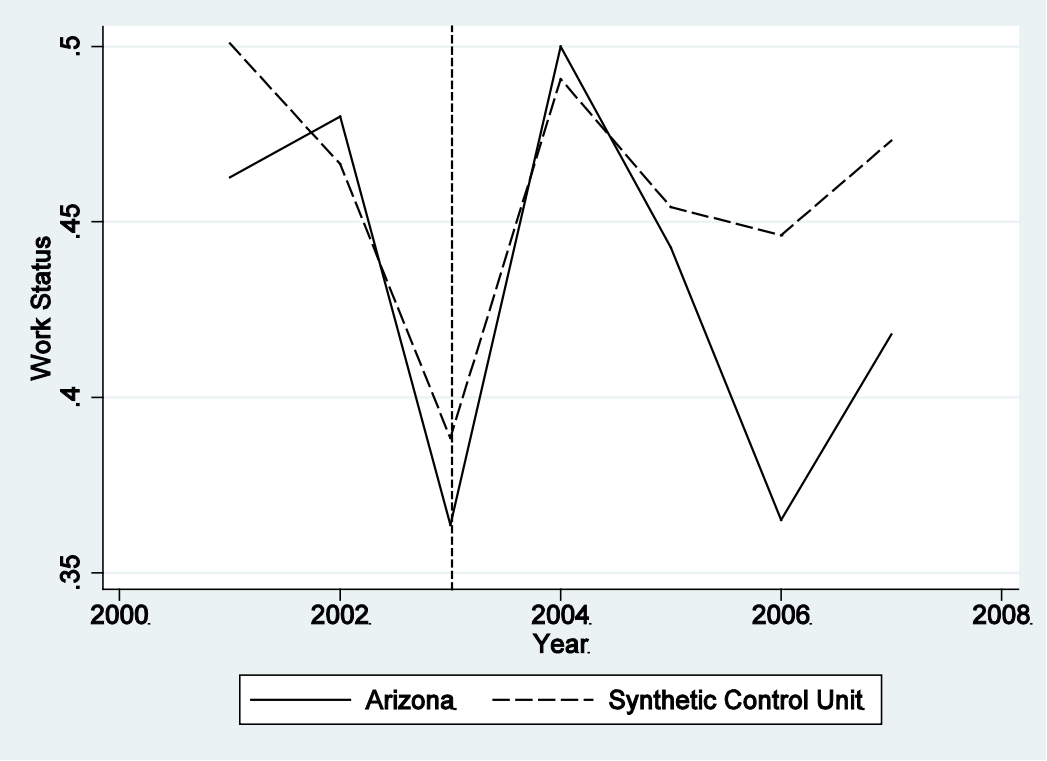

Figure 1.4 Trends of work status for married women in Arizona and synthetic control group

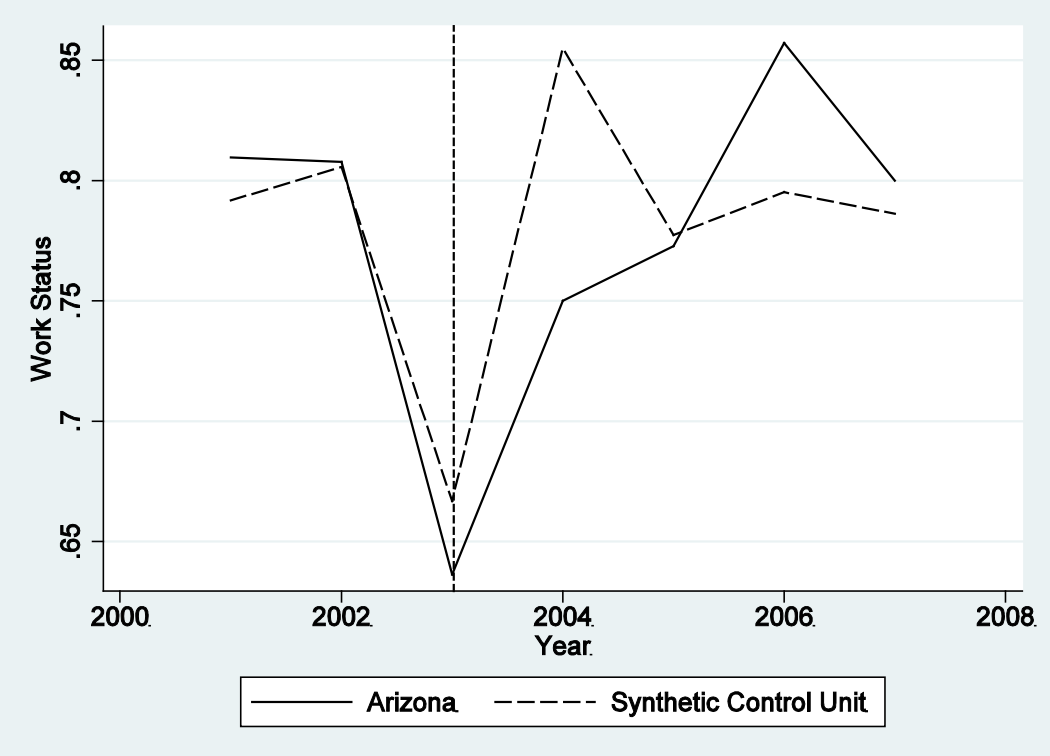

Figure 1.5 Trends of work status for single women in Arizona and synthetic control group

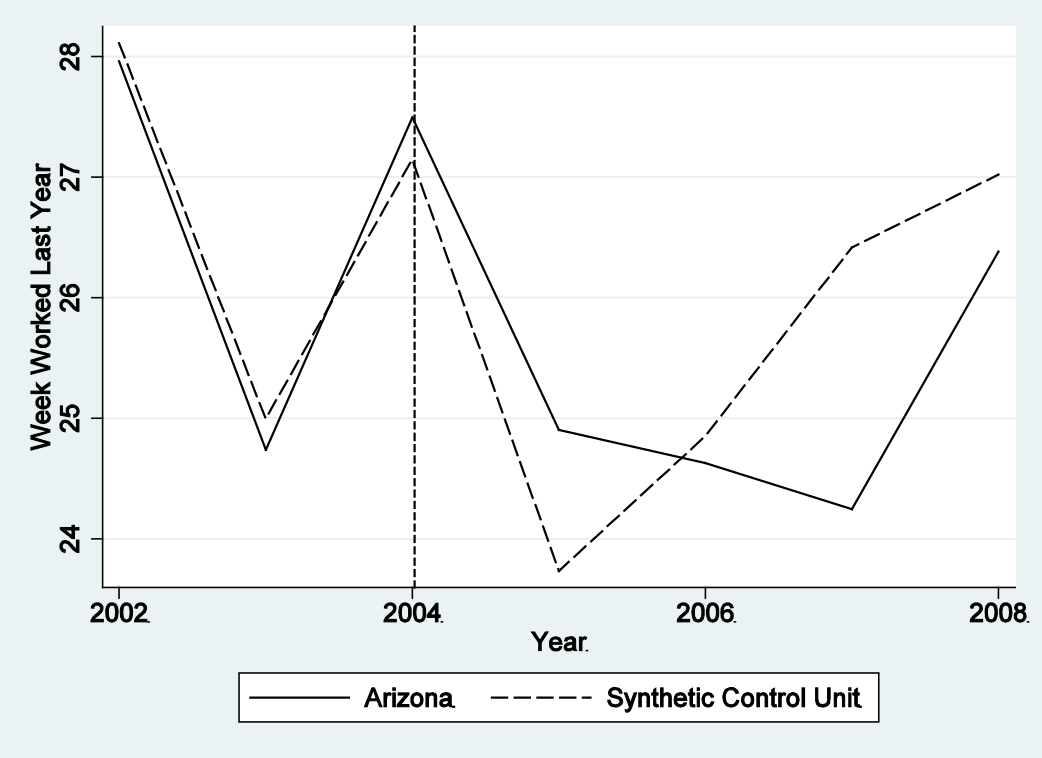

Figure 1.6 Trends of week worked last year for all women in Arizona and synthetic control group

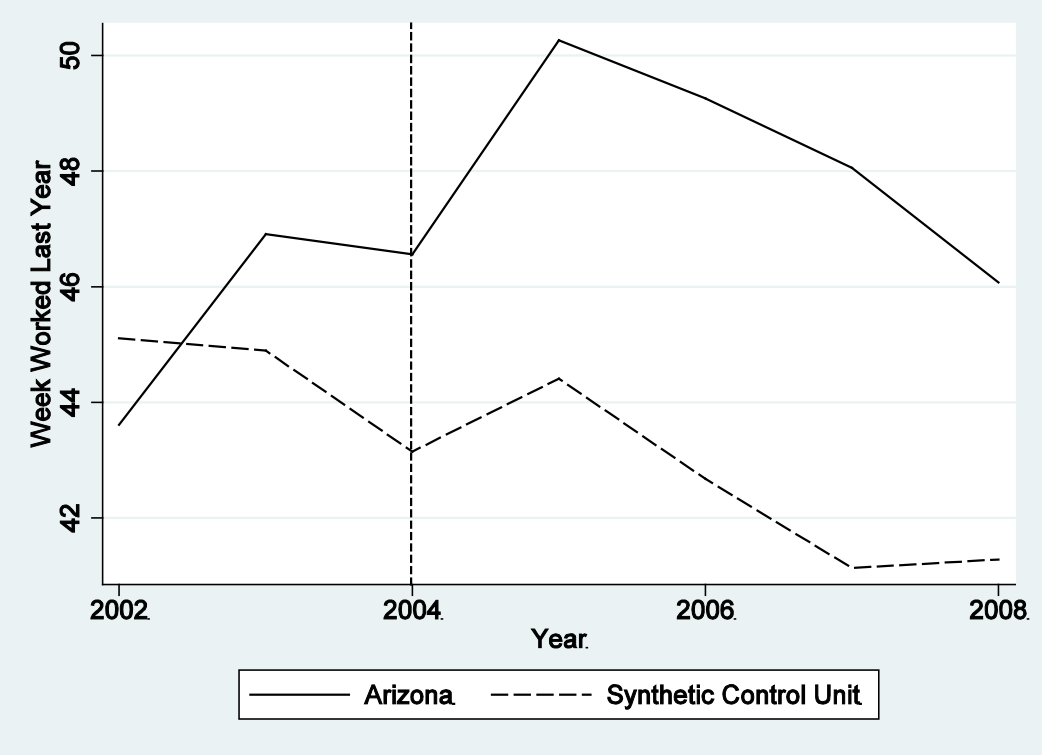

Figure 1.7 Trends of week worked last year for all men in Arizona and synthetic control group

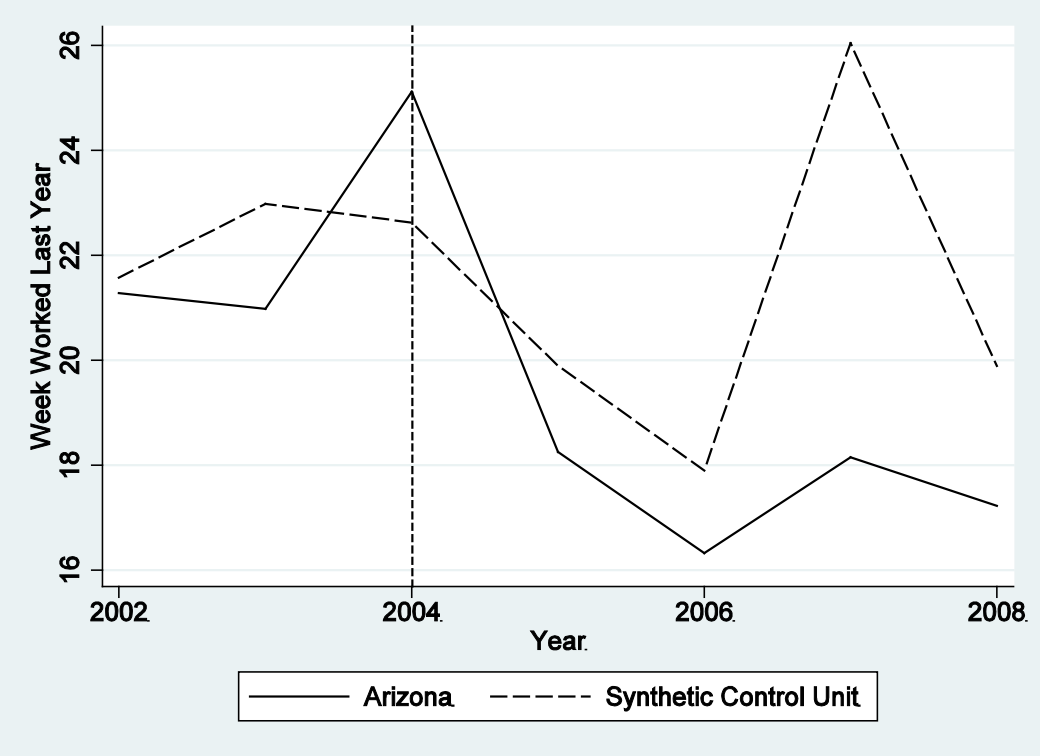

Figure 1.8 Trends of week worked last year for married women in Arizona and synthetic control group

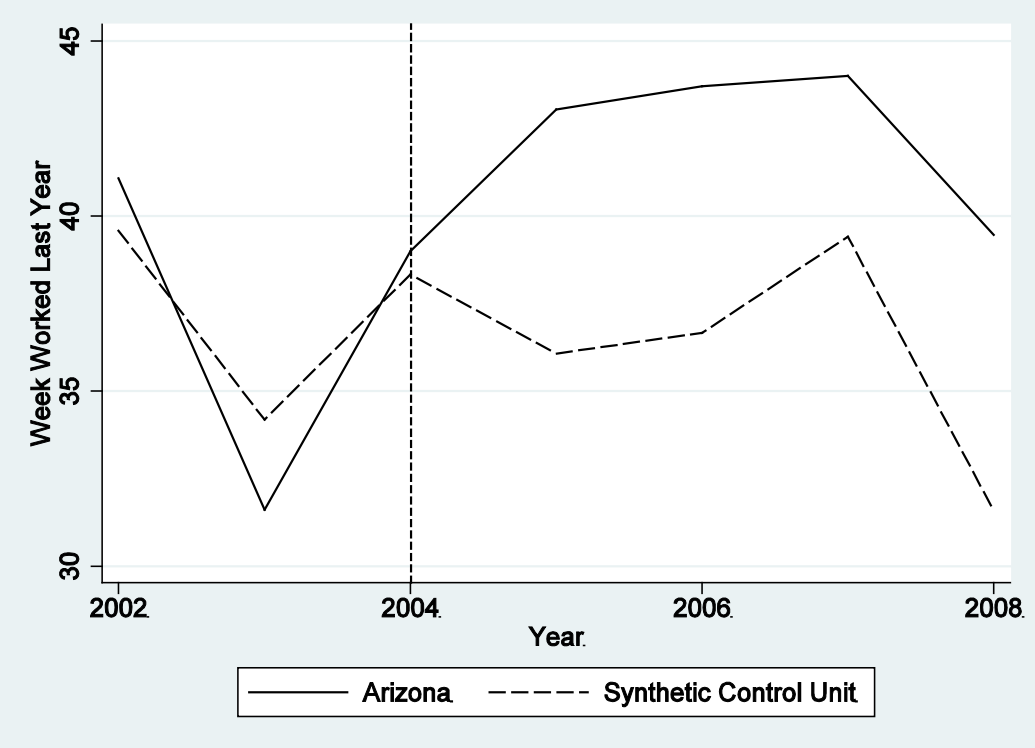

Figure 1.9 Trends of week worked last year for single women in Arizona and synthetic control group

The third identification assumption above requires that individuals in the treatment group are similar to the ones in the control group during the control period. Tables 1.6 through 1.9 report descriptive statistics for both the dependent and explanatory variables for individuals in the treatment group and the synthetic control group by gender and the dependent variable. With a few exceptions, the differences are small, lending support to the third identification assumption.

Table 1.6 Descriptive Statistics for work status of all women

Variable	**Treated**	**Synthetic**
Work Status	0.53	0.57
Age	34.43	34.47
<High School	0.39	0.19
High School	0.26	0.45
More than College	0.35	0.36
Excellent	0.34	0.27
Very good	0.29	0.31
Good	0.27	0.27
Fair or Poor	0.09	0.14
Married	0.70	0.65
Separated, Divorced, or Widowed	0.18	0.23
Never married/single	0.13	0.12
White (Non-Hispanic)	0.35	0.60
White (Hispanic)	0.55	0.15
Black	0.05	0.16
Others	0.05	0.08
# of children age <=5	0.74	0.73
# of children age<=18	2.29	2.19
Dummy whether living in a city	0.83	0.53

Table 1.7 Descriptive Statistics for work status of all men

Variable	Treated	Synthetic
Work Status	0.86	0.83
Age	36.31	37.68
<High School	0.43	0.22
High School	0.28	0.42
More than College	0.29	0.35
Excellent	0.38	0.28
Very good	0.27	0.36
Good	0.27	0.27
Fair or Poor	0.09	0.10
Married	0.88	0.90
Separated, Divorced, or Widowed	0.04	0.05
Never married/single	0.08	0.04
White (Non-Hispanic)	0.31	0.77
White (Hispanic)	0.65	0.18
Black	0.03	0.03
Others	0.01	0.02
# of children age <=5	0.84	0.86
# of children age<=18	2.34	2.51
Dummy whether living in a city	0.86	0.33

Table 1.8 Descriptive Statistics for weeks worked last year of all women

Variable	Treated	Synthetic
Weeks worked last year	26.73	26.75
(Age-1)	33.75	33.73
<High School	0.39	0.22
High School	0.28	0.44
More than College	0.33	0.35
Excellent	0.34	0.24
Very good	0.30	0.31
Good	0.27	0.27
Fair or Poor	0.10	0.18
Married	0.71	0.59
Separated, Divorced, or Widowed	0.17	0.24
Never married/single	0.12	0.18
White (Non-Hispanic)	0.34	0.63
White (Hispanic)	0.57	0.08
Black	0.03	0.22
Others	0.06	0.08
# of children age <=6	0.85	0.80
# of children age<=19	2.25	2.23
Dummy whether living in a city	0.84	0.62

Table 1.9 Descriptive Statistics for weeks worked last year of all men

Variable	Treated	Synthetic
Weeks worked last year	45.69	44.38
(Age-1)	35.71	36.33
<High School	0.42	0.24
High School	0.25	0.44
More than College	0.33	0.32
Excellent	0.37	0.31
Very good	0.31	0.33
Good	0.22	0.26
Fair or Poor	0.10	0.10
Married	0.87	0.88
Separated, Divorced, or Widowed	0.04	0.08
Never married/single	0.09	0.04
White (Non-Hispanic)	0.32	0.64
White (Hispanic)	0.64	0.22
Black	0.03	0.04
Others	0.01	0.11
# of children age <=6	1.00	0.86
# of children age<=19	2.30	2.27
Dummy whether living in a city	0.87	0.49

The second identification assumption discussed above is that there are no other contemporaneous shocks differently affect both the treatment and control groups. For this, I reviewed each state's policies for low-income people belonging to the treatment and control groups such as state income tax. There had not been significant changes in these states during the sample period.

1.4.2.3. Econometric Models

For the outcome variable, work status, the following probit difference-in-difference model is estimated:

$$Work^{*}_{ist} = \alpha_0 + \alpha_1(Treat_s \times Post_t) + \alpha_2 Year_t + \alpha_3 State_s + X'_{ist}\beta + \varepsilon_{ist} \quad [1.3]$$

The dependent variable is $Work_{ist}$, which denotes observed work status. $Work^{*}_{ist}$ is a latent variable for an individual i in state s and in year t, where $Work_{ist} = 1$ if $Work^{*}_{ist} \geq 0$, $Work_{ist} = 0$

otherwise. $Post_t$ is a dummy variable indicating the treatment period from 2005 to 2007, and zero for the control period from 2001 to 2003. $Treat_s$ is a dummy variable which is one if a respondent belongs to the treatment group defined above and 0 otherwise. $Treat_s \times Post_t$ is an interaction term between treatment period and group indicators, and the coefficient of it, α_1, can be interpreted as the policy effect. To control for other heterogeneity across different individuals, a vector of characteristics X_{ist} is added. X_{ist} includes age, age squared, race, health status, education, marital status for all men or all women, the number of children under the age of 5 or 18, and citizen. ε_{it} is an error term.

Based on this information, we can process the following procedures for the Probit estimation.

$$P(Work_{ist} = 1 \mid \mathbb{X}) = G(\alpha_0 + \alpha_1(Treat_s \times Post_t) + \alpha_2 Year_t + \alpha_3 State_s + X_{ist}^{'}\beta) \quad [1.4]$$

, where $\mathbb{X}$ is a vector of independent variables and $G(\cdot)$ is a function, which takes on values such that $0 < G(z) < 1$, for all real numbers z. In this probit model, $G(\cdot)$ is the standard normal cumulative distribution function, which can be denoted as $G(z) = \Phi(z) = \int_{-\infty}^{z} \phi(v)dv$, where $\phi(z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}z^2}$. [3]

We can obtain the following response probability for y in order to examine the effects of the SCHIP premiums on the response probability, $P(Work_{ist} = 1 \mid \mathbb{X})$.

[3] The biggest different thing between the Probit model and the logit model, in the logit model, $G(\cdot)$ is the logistic function such as the cumulative distribution function, $G(z) = \frac{e^z}{1+e^z}$, for a standard logistic random variable. In this paper, only Probit model are used.

$$P(Work_{ist}=1\,|\,\mathbb{X}) = P(Work^{*}_{ist}>0\,|\,\mathbb{X})$$

$$= P\left[\varepsilon_{ist} > -(\alpha_0+\alpha_1(Treat_s\times Post_t)+\alpha_2 Year_t+\alpha_3 State_s+X'_{ist}\beta)\,|\,\mathbb{X}\right]$$

$$= 1-G\left[-(\alpha_0+\alpha_1(Treat_s\times Post_t)+\alpha_2 Year_t+\alpha_3 State_s+X'_{ist}\beta)\right]$$

$$= G\left[(\alpha_0+\alpha_1(Treat_s\times Post_t)+\alpha_2 Year_t+\alpha_3 State_s+X'_{ist}\beta\right] \quad [1.5]$$

Next, the log-likelihood function is considered with the following density of $Work_{ist}$ given $\mathbb{X}$

$$\log\left[f(Work_{ist}\,|\,\mathbb{X};\mathbb{B})\right] = Work_{ist}\log\left[G(\alpha_0+\alpha_1(Treat_s\times Post_t)+\alpha_2 Year_t+\alpha_3 State_s+X'_{ist}\beta)\right]$$

$$+(1-Work_{ist})\log\left[G(\alpha_0+\alpha_1(Treat_s\times Post_t)+\alpha_2 Year_t+\alpha_3 State_s+X'_{ist}\beta)\right] \quad [1.6]$$

, where $\mathbb{B}$ is a set of parameters. The log-likelihood, $\mathcal{L}(\mathbb{B})=\sum_{i=1}^{n}\log\left[f(Work_{ist}\,|\,\mathbb{X};\mathbb{B})\right]_i$ with a sample size i, can be calculated by adding the log-likelihood function. The maximum likelihood estimation (MLE) of $\mathbb{B}$, especially α_1, maximizes this log-likelihood.

For the other outcome variable, "weeks worked last year," the Tobit model is used because the number of weeks worked in a year ranges from 0 to 52 and is censored from sides. The specific form of two-limit Tobit is as follows,

$$y^{*}_{ist-1} = \gamma_0+\gamma_1(Treat_s\times Post_{t-1})+\gamma_2 Year_{t-1}+\gamma_3 State_s+X'_{ist-1}\delta+\nu_{ist-1} \quad [1.7]$$

, where $y_{ist-1}=\begin{cases} y^{*}_{ist-1}, & if\ \ 0<y^{*}_{ist-1}<52 \\ 0, & if\ \ y^{*}_{ist-1}\le 0 \\ 52, & if\ \ 52\le y^{*}_{ist-1}\end{cases}$ and $\nu_{ist-1}\,|\,\mathbb{X}\sim Normal\left(0,\sigma^2\right)$.

Since the dependent variable, weeks worked last year, consist of the lagged (past period) values, y^{*}_{ist-1} is used for a latent variable assuming a normal and homoscedastic distribution with a linear conditional mean. We observe y_{ist-1}, which is bounded between 0 and 52.

It is worth noting that the analysis of the total number of weeks worked last year is a type

of count variable, which can be estimated by count regression models. Poisson or negative binomial regression can be used depending on whether or not over-dispersion exists. In this study, the negative binomial regression is to be exploited because the distribution of medical utilization shows over-dispersion for count model. The following equation [1.8] shows Poisson regression model.

$$y_{ist-1} \sim Poisson(\lambda_{ist-1}) \quad [1.8]$$

, where $\lambda_{ist-1} = \exp(\mu_0 + \mu_1(Treat_s \times Post_{t-1}) + \mu_2 Year_{t-1} + \mu_3 State_s + X'_{ist-1}\theta + \text{offset}_{ist-1})$ [4]

Based on Poisson regression, we can consider the negative binomial regression in expression [1.9] if it has over-dispersion problem, and there is omitted variable ω_{ist-1}, such that $e^{\omega_{ist-1}} \sim Gamma(1/\alpha, \alpha)$ with mean 1 $(=1/\alpha \times \alpha)$ and variance α $(=1/\alpha \times \alpha^2)$, where α is the over-dispersion parameter.

$$y_{ist-1} \sim Poisson(\lambda^*_{ist-1}) \quad [1.9]$$

, where $\lambda^*_{ist-1} = \exp(\mu_0 + \mu_1(Treat_s \times Post_{t-1}) + \mu_2 Year_{t-1} + \mu_3 State_s + X'_{ist}\theta + \text{exposure}_{ist-1} + \omega_{ist-1})$

The larger α is, the greater variance the dependent variable has. If α=0, Poisson regression is the same as negative binomial regression.

1.5. Results and Discussion

It is important to examine the impact of the 2004 SCHIP premium change in Arizona at both the extensive and the intensive margin, to understand women and men's labor supply behavior. In labor economics, extensive margin refers to whether to work, and intensive margin means how much to work. Also, about 90% of the men with children were married in both Arizona and control

[4] The offset is set to be zero because this paper is based on CPS panel data, and individual-level data are to be used. For regional data, population are normally used for exposure.

states in the sample period, whereas only 60-70% of women with children were married in those states during the same time period. As a result, men were analyzed as a whole, but married and single women separately.

1.5.1. Work Status

Estimation results for the probit regressions are reported in Table 1.10 which highlights the effects of SCHIP premiums on all men, all women, married women, and single women. All values reported in the tables are marginal effects at means.

The policy had a positive effect on men. Specifically, the introduction of SCHIP premium in Arizona increased men's probability of working by 6 percent points. This result can be interpreted by men's need to cover the additional expenses and moving to an employer-provided health insurance plan. First, men who did not work would need to find a job to cover the additional expenses as the expenses for SCHIP increased due to the policy change. The change in policy probably prompted some men to find a job for health insurance coverage, so that the family no longer needs SCHIP. According to Kenney et al. (2007), the new premiums in Arizona increased the rate of disenrollment and decreased the rate of re-enrollment. The rate of disenrollment increased by 38 percent and children in Arizona were less likely to re-enroll after the policy change. It is possible that individuals who disenrolled from SCHIP found another health insurance provider.

In contrast, Column (2) in Table 1.10 shows that the SCHIP premium introduction did not affect women's labor supply when all women were analyzed as a single group. More interesting results are found when married and single women were analyzed separately in Column (3) and Column (4) in Table 1.10. Column (3) in Table 1.10 shows that SCHIP premium introduction negatively affected married women's probability of working by 5 percentage points. Married

women have husbands. As men are found to increase their chance of working, some women may quit the job to better take care of the children. Then the next natural question is why the policy change triggered men to increase the probability of working and their wives to decrease the probability of working. This can be explained by the wage difference between men and women. If a husband earns more money, then it is desirable for the husband to work in order to maximize the benefit of the family under the constraint of having to take care of the children at the same time. Likewise, if the wife makes more money per hour than her husband, then it is more efficient for the wife to work and for the husband to care for a child.

To examine the plausibility of this explanation, I looked at the actual average income earned by men and women in Arizona. Married women earned, on average, $6,900 annually between 2001 and 2007, whereas the average earnings for married men were $18,200 during the same period. Excluding zero incomes, married men earned $19,300 and those married women made $9,800 over that period. Therefore, it is clear that the husband working while the wife contributes to their household such as taking care of the children maximizes the benefits of the family.

On the other hand, Column (4) in Table 1.10 also shows that the policy change triggered single women to increase their probability of working. Like men, some single women who did not work chose to find a job so that they could afford the additional expenses or replace SCHIP with an employer-provided health plan.

Table 1.10 The Effect of SCHIP Premiums on Work Status for All Women, All Men, Married Women, and Single Women

VARIABLES	(1) All Men	(2) All Women	(3) Married Women	(4) Single Women
$Treat_s \times Post_t$	0.060***	0.010	-0.050*	0.129***
Age	0.007	0.033***	0.016***	0.051***
Age squared	-0.000**	-0.000***	-0.000***	-0.001***
High School	-0.007	0.177***	0.166***	0.166*
College or above	0.021	0.192***	0.144***	0.146
Health Status (Good)	0.151***	0.325***	0.218***	0.242***
Health Status (Very Good)	0.152***	0.360***	0.230***	0.311***
Health Status (Excellent)	0.182***	0.274***	0.138**	0.370***
Separated, Divorced, or Widowed	-0.044***	0.319***		
Never married/Single	-0.007	0.280***		
White (Hispanic)	0.015	0.145***	0.128***	0.205***
Black	-0.027	0.068***	0.018	0.023
Others	0.019	0.132**	0.111	0.086
# of children age <=5	-0.011	-0.031	-0.029	-0.115*
# of children age<=18	0.017**	-0.017	-0.002	0.047
Dummy whether living in a city	-0.006	0.060***	0.071***	-0.067
Observations	1,275	2,344	1,469	726
Year FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES

Note: Cluster-robust standard errors in parentheses. The dependent variable is work status. Each column shows marginal effects of Probit model. All predictors are at their mean value. *** p<0.01, ** p<0.05, * p<0.1

There are some other results in Column (1) and Column (2) in Table 1.10 that are worth discussing. First, the probability of working increases as women get older, holding all other independent variables constant. However, age and educational variables did not significantly affect men's probability of working. For women, the higher the level of education, the higher the probability of participation in the labor market. Second, both men and women are more likely to work when they have better health conditions. Third, women of non-white races including white Hispanic are more likely to work than white women. Fourth, women living in urban areas are more likely to work than those who in rural areas. Fifth, men are more likely to work if they have children under the age of 18.

In Column (3) and (4) in Table 1.10, the results for married and single women separately regarding the control variables are similar to those for women as a whole in Column (1) and

Column (2) except races, the age of children and the place of residence. Being of black and other races is no longer found to affect the probability of their working. Whether living in a city is found to have an influence on married women only. Finally, single women are found to be less likely to work if they have children under the age of 5.

1.5.2. Weeks Worked Last Year

Tobit regression and negative binomial results for the other outcome variable, that is, the number of weeks worked last year, are reported in Tables 1.11 and 1.12. Again, the values in the tables are marginal effects. The main results are that men worked 4.5 more weeks, married women worked 8 weeks less, and single women worked 7 more weeks per year in the tobit model due to the introduction of SCHIP premiums in Arizona. These patterns are similar to those of work status in Table 1.10. The results from the count model are similar to the ones from the tobit model, but those from negative binomial estimation are larger than those from the tobit model.

The signs of regression coefficients for other explanatory variables are similar to those from the probit model except for several variables. First, education for men is not significant in probit model in Table 1.10 and in the count model in Table 1.11, and therefore it does not affect men's probability of working, whereas education has a negative effect on the number of weeks worked per year by men from tobit estimation, as shown in Table 1.11. Second, single men with children worked more weeks compared to married men with children even though marital status does not affect their probability of working, as shown in Table 1.10. Third, white-Hispanic men worked about 3.2-4.5 more weeks per year than Non-Hispanic whites. Fourth, Table 1.12 shows that black married women worked 1.5-3 more weeks than married women in other races, whereas there is no such effect for black single women with the tobit model and the negative effect for them

with the negative binomial model. Fifth, women having children less than 5 years old, both married and single, tended to reduce their labor supply. One possible reason is that they should spend more time taking care of children under the age of five. The values of the coefficients for weeks worked last year may be considered large because it can be thought that single women in Arizona who had already worked in 2001-2003 worked seven weeks more in 2005-2007. In this case, the coefficient (8-9.6 weeks) would be large.

However, the results should be interpreted differently because it includes people who did not work at all in 2001-2003. For example, if an adult who did not work (0 weeks) in 2003 worked for 30 weeks in 2005 after the policy change, the average looks larger. That is, single women who did not work before the policy will increase the mean largely. There are two reasons why I did not divide the sample into two groups: people who had already worked and those who had not worked. First, I mainly study the effect of SCHIP premiums on not only the people who worked in the control period but also the ones who did not work. In other words, I examine the effect of the policy change on whole adults with children in Arizona. Second, the number of the samples is small, and therefore it is difficult to divide the sample more because I have already divided the small sample into four groups (men, women, single women, and married women).

I perform placebo tests by replicating the original regressions by setting a period between 1998 and 2000 as a pre-policy period and that between 2001 and 2003 as a post-policy one. I obtain different results from baseline regressions in Table-S1.13 through Table-S1.15. Most of them are not significant or have different signs from the original ones. These results provide more evidence that an introduction of the SCHIP premiums would affect labor supply.

It is known that a lot of pre-intervention periods are needed to use the synthetic control method because the credibility of a synthetic control relies on how well unit's characteristics and

outcomes are tracked (Abadie, Diamond, Hainmueller, 2015). To carry out this analysis, I extended the pre-policy period to 1998 as part of the robustness tests in Table-S1.16-18. It shows consistent results with the baseline regression ones. Nevertheless, the 2001-2003 pre-policy period is required as a control group. This is because there is an assumption that there was no change in SCHIP policy other than SCHIP premiums in 2004 for a state in the control group and treatment group, However, many states changed their policy before 2001. Even Arizona set up 200% FPL (Federal poverty level) eligibility for SCHIP on October 1, 1999.

Table 1.11 The Effect of SCHIP Premiums on Work Weeks for Men and Women

VARIABLES	(1) tobit All Men	(2) NBReg All Men	(3) tobit All Women	(4) NBReg All Women
$Treat_s \times Post_t$	4.452***	5.235***	-3.555***	-5.723***
Age-1	0.394	0.918	1.274***	1.572***
(Age-1) squared	-0.006*	-0.015	-0.019***	-0.022***
High School	-0.801	0.346	7.820***	9.751***
College or above	-0.609**	0.508	7.333***	8.743***
Health Status (Good)	7.425***	17.123***	9.624***	10.484***
Health Status (Very Good)	10.181***	19.491***	11.432***	11.789***
Health Status (Excellent)	10.963***	20.630***	9.635***	10.341***
Separated, Divorced, or Widowed	-1.995***	-4.332***	14.213***	12.758***
Never married/Single	8.002***	4.578***	12.390***	12.528***
White (Hispanic)	3.264***	4.502***	3.508***	4.160***
Black	-1.481	-1.632	-0.563	0.163
Others	-1.894	-3.492	2.016	1.234
# of children age <=6	-0.823	-0.991**	-3.131***	-3.194***
# of children age<=19	1.110***	1.110***	0.627	0.430
Dummy whether living in a city	1.524	2.142	2.597***	3.382***
Observations	1,633	1,633	3,079	3,079
Year FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES

Note: Cluster-robust standard errors in parentheses. The dependent variable is weeks worked last year. Each column shows marginal effects of tobit or or negative binomial (NBReg) model. All predictors are at their mean value.
*** p<0.01, ** p<0.05, * p<0.1

Table 1.12 The Effect of SCHIP Premiums on Work Weeks for Married and Single Women

VARIABLES	(1) tobit Married Women	(2) NBReg Married Women	(2) tobit Single Women	(4) NBReg Single Women
$Treat_s \times Post_t$	-7.981***	-9.638***	7.171***	8.108***
Age-1	0.478**	0.792***	1.947***	3.546**
d(Age-1) squared	-0.009***	-0.013***	-0.029***	-0.051**
High School	9.374***	10.727***	2.688**	3.674***
College or above	7.379***	8.377***	0.471	4.595***
Health Status (Good)	7.395***	7.748***	6.702	12.529
Health Status (Very Good)	7.782***	8.474***	13.269***	16.696***
Health Status (Excellent)	6.483***	7.567***	8.387**	13.641**
White (Hispanic)	5.059**	6.079***	2.961**	2.480**
Black	1.490***	3.028***	-2.932	-3.786*
Others	0.217	0.131	2.937	-0.293
# of children age <=6	-2.881***	-2.998***	-3.526***	-2.890**
# of children age<=19	0.612	0.528	2.475	2.015***
Dummy whether living in a city	6.010***	5.769***	-2.122	-2.285
Observations	1,386	1,386	609	609
Year FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES

Note: Cluster-robust standard errors in parentheses. The dependent variable is weeks worked last year. Each column shows marginal effects of tobit or or negative binomial (NBReg) model. All predictors are at their mean value.
*** p<0.01, ** p<0.05, * p<0.1

1.6. Conclusion

The introduction of policies such as SCHIP premiums has caused spill-over effects across the country such as a change in labor supply, medical utilization, and health outcomes. Policy changes for public insurance not only affect health outcomes and health care utilization but also the labor market. These policies may stimulate or discourage incentives to work depending on various demographic characteristics such as age, gender, and race. A substantial decrease in Arizona's expenditure for SCHIP in 2004 and 2005 resulted from the introduction of SCHIP premiums in July 2004. In turn, there were many dis-enrollees and less re-enrollees in the SCHIP. These individuals likely found another way to obtain health insurance, and there was a remarkable change in the labor supply of Arizona.

In order to examine this phenomenon, the DD with the synthetic control method was employed. There were various effects related to the introduction of the SCHIP premiums in

Arizona in 2004 on parents' labor supply. Men and single women were more likely to work and worked more weeks per year to find ways to make up for the loss of their public insurance while married women reduced their labor supply both at the extensive and intensive margin so that they could take care of their children when their husband worked more.

Making the SCHIP more expensive through the introduction of premiums may cause some families to drop insurance for their children, which would certainly impact children's access to health care and health outcomes. Therefore, the effect of this policy change on children's health care utilization and health outcomes is also of interest and will be explored in future studies.

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Supplemental Tables

Table-S1.13 Placebo Test for Work Status for All Women, All Men, Married Women, and Single Women

VARIABLES	(1) All Men	(2) All Women	(3) Married Women	(4) Single Women
$Treat_s \times Post_t$	-0.082***	-0.048***	0.028	-0.179***
	(0.018)	(0.007)	(0.024)	(0.019)
Age	0.004	0.024**	0.032**	0.046***
	(0.004)	(0.012)	(0.014)	(0.003)
Age squared	-0.000***	-0.000**	-0.000**	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
High School	-0.009	0.149***	0.134***	0.203***
	(0.049)	(0.004)	(0.025)	(0.049)
College or above	-0.018	0.188***	0.187***	0.135***
	(0.041)	(0.024)	(0.037)	(0.022)
Health Status (Good)	0.233***	0.219***	0.140*	0.146***
	(0.021)	(0.010)	(0.081)	(0.046)
Health Status (Very Good)	0.312***	0.261***	0.133*	0.220***
	(0.036)	(0.022)	(0.068)	(0.022)
Health Status (Excellent)	0.356***	0.212***	0.073	0.271***
	(0.040)	(0.027)	(0.080)	(0.029)
Separated, Divorced, or Widowed	-0.052**	0.209***		
	(0.024)	(0.065)		
Never married/Single	-0.192***	0.210***		
	(0.025)	(0.062)		
White (Hispanic)	-0.020	0.030***	0.080***	-0.026***
	(0.022)	(0.010)	(0.011)	(0.004)
Black	-0.037**	-0.016	0.120***	-0.090***
	(0.016)	(0.016)	(0.029)	(0.014)
Others	-0.037	-0.151***	-0.082	-0.343***
	(0.026)	(0.053)	(0.078)	(0.035)
# of children age <=5	-0.006**	-0.081***	-0.053	-0.079***
	(0.002)	(0.023)	(0.037)	(0.011)
# of children age<=18	0.002	-0.001	0.008***	0.056***
	(0.004)	(0.005)	(0.001)	(0.010)
Dummy whether living in a city	-0.018**	0.075***	0.094**	0.010
	(0.008)	(0.011)	(0.048)	(0.042)
Observations	1,346	2,192	1,294	891
Year FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES

Note: Cluster-robust standard errors in parentheses. The dependent variable is work status. Each column shows marginal effects of Probit model. All predictors are at their mean value. *** p<0.01, ** p<0.05, * p<0.1
Pre-period: 1998-2000, Post-period: 2001-2003

Table-S1.14 Placebo Test for Work Weeks for Men and Women

VARIABLES	(1) tobit All Men	(2) NBReg All Men	(3) tobit All Women	(4) NBReg All Women
$Treat_s \times Post_t$	0.434	2.222	1.370***	-0.249
	(2.460)	(2.544)	(0.206)	(1.084)
Age-1	0.374	1.357*	1.570***	2.116***
	(0.240)	(0.788)	(0.008)	(0.341)
(Age-1) squared	-0.007**	-0.023**	-0.023***	-0.030***
	(0.003)	(0.011)	(0.001)	(0.006)
High School	0.435	1.186	5.738***	6.499***
	(0.899)	(1.294)	(0.120)	(1.062)
College or above	-0.525	-0.872	6.523**	8.542***
	(0.782)	(1.075)	(2.745)	(2.562)
Health Status (Good)	8.738***	19.022***	7.689***	8.400*
	(1.492)	(4.586)	(2.941)	(4.595)
Health Status (Very Good)	12.348***	21.607***	4.553	3.547
	(0.469)	(3.714)	(3.672)	(5.224)
Health Status (Excellent)	13.744***	22.711***	5.055	5.071
	(0.127)	(2.918)	(4.418)	(6.455)
Separated, Divorced, or Widowed	-1.778	-2.788	13.248***	10.792***
	(1.206)	(2.700)	(2.894)	(1.869)
Never married/Single	0.335	-1.645	13.556***	11.882***
	(3.089)	(2.147)	(2.546)	(3.513)
White (Hispanic)	1.581***	0.943*	-1.551	-1.564
	(0.248)	(0.494)	(2.303)	(2.013)
Black	-4.158*	-9.450	-0.514	-0.421
	(2.192)	(6.777)	(2.366)	(1.740)
Others	-4.283	-4.960	-3.174***	-0.211
	(4.471)	(7.396)	(0.189)	(2.297)
# of children age <=6	-0.061	-0.642	-3.410**	-3.792**
	(0.599)	(0.719)	(1.510)	(1.644)
# of children age<=19	0.817*	1.003**	1.708***	1.788***
	(0.440)	(0.436)	(0.145)	(0.042)
Dummy whether living in a city	-0.646	-0.687	0.318	1.779
	(0.428)	(1.393)	(2.174)	(3.090)
Observations	1,288	1,288	1,186	1,186
Year FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES

Note: Cluster-robust standard errors in parentheses. The dependent variable is weeks worked last year. Each column shows marginal effects of tobit or or negative binomial (NBReg) model. All predictors are at their mean value.
*** p<0.01, ** p<0.05, * p<0.1
Pre-period: 1998-2000, Post-period: 2001-2003

Table-S1.15 Placebo Test for Work Weeks for Married and Single Women

VARIABLES	(1) tobit Married Women	(2) NBReg Married Women	(2) tobit Single Women	(4) NBReg Single Women
$Treat_s \times Post_t$	0.462***	0.636	-1.773	-5.578
	(0.112)	(0.467)	(3.145)	(4.026)
Age-1	0.264	0.527***	2.843***	5.470***
	(0.250)	(0.053)	(0.767)	(1.040)
(Age-1) squared	-0.006***	-0.009***	-0.040***	-0.079***
	(0.002)	(0.002)	(0.010)	(0.015)
High School	7.081***	7.638**	7.709***	8.959***
	(2.138)	(2.995)	(0.909)	(0.315)
College or above	9.406***	9.346***	3.438***	7.518***
	(1.183)	(0.726)	(0.851)	(0.568)
Health Status (Good)	5.287***	5.282**	6.672***	13.361***
	(2.033)	(2.191)	(0.512)	(1.195)
Health Status (Very Good)	1.942	1.543	10.177***	15.843***
	(4.834)	(4.055)	(1.028)	(1.963)
Health Status (Excellent)	-0.348	-0.140	10.318***	17.215***
	(2.537)	(2.186)	(1.488)	(1.974)
White (Hispanic)	1.672***	0.583	-1.729***	-0.689
	(0.520)	(1.172)	(0.546)	(0.773)
Black	5.459***	5.658***	1.550	3.500**
	(1.021)	(1.602)	(1.472)	(1.464)
Others	0.406	1.150***	-5.974*	-8.092**
	(0.958)	(0.438)	(3.244)	(3.436)
# of children age <=6	-3.765***	-3.896***	-0.599	1.948
	(0.979)	(0.912)	(0.902)	(1.959)
# of children age<=19	1.113*	0.896	1.128**	-0.597
	(0.596)	(0.817)	(0.573)	(0.563)
Dummy whether living in a city	5.554***	6.093***	-0.272	-1.686
	(1.139)	(0.534)	(0.854)	(2.408)
Observations	1,132	1,132	448	448
Year FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES

Note: Cluster-robust standard errors in parentheses. The dependent variable is weeks worked last year. Each column shows marginal effects of tobit or or negative binomial (NBReg) model. All predictors are at their mean value.
*** p<0.01, ** p<0.05, * p<0.1
Pre-period: 1998-2000, Post-period: 2001-2003

Table-S1.16 The Effect of SCHIP Premiums on Work Status for All Women, All Men, Married Women, and Single Women

VARIABLES	(1) All Men	(2) All Women	(3) Married Women	(4) Single Women
$Treat_s \times Post_t$	0.045***	-0.009	-0.058***	0.072***
	(0.008)	(0.012)	(0.018)	(0.023)
Age	0.007	0.050***	0.025	0.045***
	(0.006)	(0.008)	(0.016)	(0.009)
Age squared	-0.000**	-0.001***	-0.000	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
High School	-0.007	0.156***	0.157***	0.150***
	(0.037)	(0.021)	(0.026)	(0.021)
College or above	0.014	0.177***	0.159***	0.156***
	(0.015)	(0.020)	(0.014)	(0.012)
Health Status (Good)	0.123***	0.283***	0.163***	0.215***
	(0.006)	(0.035)	(0.050)	(0.025)
Health Status (Very Good)	0.142***	0.303***	0.175***	0.308***
	(0.014)	(0.020)	(0.033)	(0.032)
Health Status (Excellent)	0.156***	0.246***	0.091***	0.307***
	(0.010)	(0.054)	(0.030)	(0.013)
Separated, Divorced, or Widowed	-0.038***	0.276***		
	(0.006)	(0.097)		
Never married/Single	-0.042	0.256***		
	(0.054)	(0.067)		
White (Hispanic)	0.022***	0.075***	0.105***	0.117***
	(0.005)	(0.012)	(0.037)	(0.041)
Black	-0.038	0.017	0.044***	0.068***
	(0.047)	(0.029)	(0.009)	(0.026)
Others	-0.004	0.039	0.011	-0.054
	(0.045)	(0.025)	(0.145)	(0.047)
# of children age <=5	-0.010	-0.033	-0.043	-0.058***
	(0.007)	(0.022)	(0.046)	(0.020)
# of children age<=18	0.021***	-0.006	0.003	0.011
	(0.002)	(0.005)	(0.008)	(0.041)
Dummy whether living in a city	0.013	0.048**	0.078***	-0.044
	(0.014)	(0.024)	(0.017)	(0.032)
Observations	1,917	4,505	2,046	997
Year FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES

Note: Cluster-robust standard errors in parentheses. The dependent variable is work status. Each column shows marginal effects of Probit model. All predictors are at their mean value. *** p<0.01, ** p<0.05, * p<0.1. Pre-policy Period: 1998-2003, Post-policy period: 2005-2007

Table-S1.17 The Effect of SCHIP Premiums on Work Weeks for Men and Women

VARIABLES	(1) tobit All Men	(2) NBReg All Men	(3) tobit All Women	(4) NBReg All Women
$Treat_s \times Post_t$	3.263***	0.465	-3.643***	-5.266***
	(0.742)	(1.702)	(0.767)	(1.167)
Age-1	0.695	2.082	1.077**	1.347**
	(0.432)	(1.449)	(0.452)	(0.577)
(Age-1) squared	-0.011**	-0.031	-0.017***	-0.021***
	(0.005)	(0.020)	(0.005)	(0.007)
High School	0.156	1.799	7.289***	8.841***
	(1.188)	(2.067)	(0.359)	(0.551)
College or above	-0.304	1.219	7.409***	8.971***
	(1.102)	(1.485)	(0.405)	(0.373)
Health Status (Good)	9.097***	18.713***	8.999***	9.283***
	(0.524)	(4.246)	(1.033)	(0.938)
Health Status (Very Good)	12.941***	21.145***	10.040***	9.598***
	(1.091)	(5.088)	(1.960)	(2.389)
Health Status (Excellent)	13.814***	22.315***	8.094***	7.966***
	(0.855)	(5.017)	(1.913)	(1.969)
Separated, Divorced, or Widowed	-1.548	-1.630	14.342***	12.467***
	(0.970)	(2.336)	(3.060)	(2.562)
Never married/Single	1.680	0.319	12.080***	11.897***
	(1.860)	(0.677)	(4.473)	(4.558)
White (Hispanic)	2.818***	3.195**	0.941	1.747**
	(0.467)	(1.624)	(0.891)	(0.883)
Black	-3.956***	-6.458***	-1.842***	-1.152**
	(0.855)	(0.982)	(0.517)	(0.454)
Others	-4.299***	-6.450***	1.195	0.328
	(0.136)	(0.762)	(1.578)	(1.281)
# of children age <=6	0.138	0.062	-3.211***	-3.408***
	(0.936)	(1.176)	(0.622)	(0.881)
# of children age<=19	0.668	0.595	0.579	0.296
	(0.507)	(0.509)	(0.880)	(1.016)
Dummy whether living in a city	-0.026	-0.575	2.463*	3.267**
	(0.979)	(1.913)	(1.278)	(1.395)
Observations	1,444	1,444	3,258	3,258
Year FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES

Note: Cluster-robust standard errors in parentheses. The dependent variable is weeks worked last year. Each column shows marginal effects of tobit or or negative binomial (NBReg) model. All predictors are at their mean value.
*** p<0.01, ** p<0.05, * p<0.1
Pre-policy Period: 1999-2004, Post-policy period: 2006-2008

Table-S1.18 The Effect of SCHIP Premiums Work Weeks for Married and Single Women

VARIABLES	(1) tobit Married Women	(2) NBReg Married Women	(2) tobit Single Women	(4) NBReg Single Women
$Treat_s \times Post_t$	-7.997***	-9.320***	5.618***	6.494***
	(0.247)	(0.168)	(1.080)	(1.821)
Age-1	0.354	0.678**	2.246***	4.223***
	(0.365)	(0.267)	(0.650)	(1.390)
(Age-1) squared	-0.007*	-0.011***	-0.031***	-0.059***
	(0.004)	(0.002)	(0.008)	(0.019)
High School	9.191***	10.244***	4.042***	5.335***
	(0.716)	(0.851)	(0.998)	(0.621)
College or above	8.379***	9.153***	1.847***	6.019***
	(0.192)	(0.728)	(0.664)	(0.861)
Health Status (Good)	7.222***	7.491***	5.868**	10.731***
	(0.153)	(0.453)	(2.591)	(4.062)
Health Status (Very Good)	5.277***	5.756***	11.684***	14.256***
	(1.025)	(0.211)	(1.352)	(3.068)
Health Status (Excellent)	2.959***	3.975***	8.013***	11.497***
	(0.357)	(0.345)	(2.575)	(3.733)
White (Hispanic)	2.601	3.484	0.443	0.380
	(1.605)	(2.146)	(0.451)	(0.590)
Black	3.299***	3.879***	-2.765*	-2.732
	(0.122)	(0.255)	(1.673)	(2.184)
Others	-0.961	-0.790	-0.269	-1.315
	(2.139)	(2.060)	(3.643)	(3.876)
# of children age <=6	-2.794***	-2.827***	-1.674**	-0.128
	(0.701)	(0.793)	(0.697)	(2.001)
# of children age<=19	0.762	0.479	1.463	0.235
	(0.858)	(1.159)	(1.157)	(0.732)
Dummy whether living in a city	4.708***	5.105***	-0.667	-1.450
	(1.257)	(0.947)	(1.126)	(2.314)
Observations	1,669	1,669	1,381	1,381
Year FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES

Note: Cluster-robust standard errors in parentheses. The dependent variable is weeks worked last year. Each column shows marginal effects of tobit or or negative binomial (NBReg) model. All predictors are at their mean value.
*** p<0.01, ** p<0.05, * p<0.1
Pre-policy Period: 1999-2004, Post-policy period: 2006-2008

CHAPTER 2

Market Incentives for Safe Foods: An examination of the effect of food recalls on firms' stock returns

2.1. Introduction

The Centers for Disease Control and Prevention (CDC) estimates that 48 million people, or one-sixth of the U.S. population are sickened, 128,000 are hospitalized, and 3,000 die of foodborne illness each year (CDC, 2016). To take an specific example, in 2012, 33 consumers fell ill and 13 were hospitalized, some of whom suffered hemolytic uremic syndrome (HUS) such as kidney failure, after consuming Wegmans Organic Spinach & Spring Mix contaminated with *E. coli* O157:H7 (FDA, 2012).

Cases of foodborne illnesses have consequences not only for the individuals who consume the contaminated food, but also for the companies producing it. For example, between late 2008 and early 2009, the Peanut Corporation of America (PCA) was involved in a massive *Salmonella* outbreak which killed 9 people and sickened at least 714 others after consuming contaminated peanut products (Redman and Morrone, 2017).[5] As a result, CEO was sentenced to 28 years in prison, and went bankrupt in 2009. Another example can be seen in the 2011 recall of Jensen Farms' cantaloupes contaminated with *Listeria monocytogenes*. This outbreak resulted in 33 deaths and 147 individuals being sickened, with 99% of those who fell ill requiring hospitalization (CDC, 2012).[6] This company filed for bankruptcy after the outbreak (Roman and Moore, 2012).

Companies make a variety of efforts to protect their corporate image to consumers.

[5] The former PCA Chief Executive Stewart Parnell was sentenced to 28 years in prison in September 2015.

[6] The company went Bankrupt, and the CEO was sentenced to five years' probation and six months home detention.

Problems such as recalls and efforts to prevent them would be reflected in stock prices. Ernst & Young (2011) surveyed 36 companies and found that 77% of respondents estimated the financial costs such as sales losses and direct recall costs to be up to $30Ms. Also, 23% experienced higher costs of more than $30Ms for firms that have issued a recall in the past five years. It also mentioned that over 81% of firms reported the financial consequences of a recall as "significant" or "catastrophic" because of the following major reasons: business interruption or lost profits; recall execution costs such as storing, supplying replacement products, transporting or destroying products; or public relations to manage reputation or brand damage; potential liability risk; and reputation damage or loss of brand equity. Therefore, the impact of recalls could influence consumer's well-being as well as companies' profits.

Several federal agencies have regulatory oversight of the food industry. The U.S. Department of Agriculture (USDA)'s Food Safety Inspection Service (FSIS) has authority concerning domestically produced and imported meat, poultry, and processed egg products. Processed food products, pet food, and animal feed are regulated by the Department of Health and Human Services (DHHS)' Food and Drug Administration (FDA). This oversight is mainly exercised through inspections and audits and, in cases where health is at risk, recalls may be used to withdraw products from the marketplace. Recalling products from the food marketplace may be one of the most effective ways to avoid outbreaks and minimize other damages. The USDA and FDA, however, have slightly different policies and procedures regarding initiating, implementing, and reporting upon recalls. These differences can be important to understand the impact of recalls on companies and consumers.

Many studies have analyzed the effect of recalls on stock prices, which reflect the value of publicly traded firms (Chen, Ganesan, and Liu, 2009; Ni, Flynn, and Jacobs, 2016; Pozo and

Schroeder, 2015, 2016; Rupp, 2004; Salin and Hooker, 2001; Thirumalai and Sinha, 2011; Thomsen and McKenzie, 2001). This is likely because stock prices bear the most visible and significant impact of a recall. Additionally, several studies have examined aspects of food recalls including meat products (Pozo and Schroeder, 2015, 2016), meat and poultry products (Thomsen and McKenzie, 2001), and a collection of processed food products (Salin and Hooker, 2001; Wang et al., 2002).

The objective of this study is to examine the impact of food recalls on the corporate valuation of companies who have issued a recall of a food or beverage product under the jurisdiction of the FDA because effects of a recall event on firm profitability are immediately reflected by stock prices (Pozo and Schroeder, 2016), and they are observable. In addition to examining a unique set of products, this analysis also explores sub-sector variance and considers the longer-term impact of a recall on company valuations.

This paper makes several contributions relative to the existing literature. To date, a majority of studies examining the impact of agri-food sector recalls focused on products under the jurisdiction of the USDA. The impact of recalls on corporate valuations of products overseen by the FDA has not yet been examined and is the focus of this study. We examine both long and short-run effects of food recalls on stock market returns while previous studies have often focused only on the short-run effects. Secondly, we separately examine the impact on stock prices of recalls across a variety of categories of food products, and due to a variety of causes such as presence of pathogens, contamination, and mis-labeling. Finally, this paper contributes to the growing literature on food recalls by analyzing the impact on stock market returns on not just the manufacturers but also other organizations in the food supply chain such as distributors and retailers.

Our baseline results indicate that returns fell on the day of the recall announcement and reached a lowest point on the second to fifth days. However, returns generally tended to rebound after a few days. In the long run, the cumulative average abnormal returns (CAAR) started to decrease again and continued to do so. For example, those regarding class I recalls continued to fall after 40 days of a recall event. The two big industries in this sample are the Food Manufacturers (e.g. ConAgra and General Mills) and Food and Beverage Retailers (e.g. Kroger and Harris Teeter) industries. We found that cumulative average abnormal returns of the food manufacturing industry decreased slightly by 0.3% overall for the first three days after a recall. After the third day, there were no longer decreases in returns, and CAAR recovered to their original level. In contrast, the CAAR of the Food and Beverage Retailers industry experienced fluctuations in CAAR amounting over 90 days. More specifically, these results suggest there are differences in the risks to long-term profit faced by retailers and food manufacturers in the event of a recall. These outcomes may be due to differences in industry characteristics and how these industries and the risk of their products are perceived by investors.

The remainder of this paper is organized as follows. Section two provides an overview of previous literature on both food and non-food recalls, as well as the possible impacts of food recalls on food producers and other industry stakeholders. A background of food recall oversight and procedures is provided in section three. The next section details the study methodology, including data analysis. This section also provides descriptive statistics in terms of the period affected by the recall and duration of the impact of the recall (long-horizon or short-horizon), and the type of recall. The fifth section presents regression results. The final section of this paper provides a discussion of the implications of food recalls and provides a conclusion of the results of the study.

2.2. Literature Review

Many previous researchers have examined the impact of recalls on stock prices for a variety of products. Some notable examples of such studies include automobiles (Rupp 2004), toys (Ni, Flynn, and Jacobs, 2016), and food products (Thomsen and McKenzie, 2001). A majority of these studies make use an event-study methodology because this approach can be used to measure the effect of recalls on the stock prices of affected firms, and the data required for this analysis is generally readily available.

2.2.1. Stock price impacts of product recalls

There are several previous studies on non-food product recalls focusing on companies' stock prices, and they include various industries such as toys, automobiles, medical devices, household products, and sports products. For instance, Chen, Ganesan, and Liu (2009) compared a proactive product recall strategy, which is one that a firm issues a recall timely when it is aware of a potential risks of food, to a passive recall strategy after injury or illnesses has occurred related to a defective product prior to the recall. They conducted cross-sectional regression and found that a dummy variable for proactive strategy had a negative effect on abnormal returns, whereas that for high product hazard risk and that for outdoor product had a positive effect on abnormal returns.

Using event study methodology, Ni, Flynn, and Jacobs (2016) examined the effect of toy recalls on abnormal returns between 2000 and 2014 and found negative impacts on cumulative abnormal returns after toy recall announcements. Their linear regression analysis showed that the decline in stock prices was less severe for manufacturers than for retailers or distributors. In addition, hazard types from Class A, which is the most severe, to Class C and growth potential, which refers to the ratio of market to book value of equity, were negatively associated with firms'

financial values. The magnitude of coefficient of hazard type A, more significant hazard risk, was greater than hazard type B, meaning that more severe hazard risk resulted in larger drops in cumulative abnormal returns. Firm size was negatively associated with stock returns.

Rupp (2004) studied the automotive industry to explore the relationship between cumulative abnormal returns and automotive recalls. The author argued that heater, defroster, and air conditioner recalls had significantly smaller losses for stock values than visual systems such as the windshield glass, windshield wipers, mirrors, and sun-roofs. Additionally, firms with an AAA bond rating had a negative impact on the returns.

Thirumalai and Sinha (2011) investigated medical device recalls between 2002 and 2005. The authors found that such recalls had a negative effect on cumulative abnormal returns. They calculated the mean CAR(cumulative abnormal return) for 276 individual recall events. The CAR was negative for all examined periods including 2, 3, 7, 11, and 21-day windows after the recall. They also explained that the FDA classifies medical devices into 19 different categories, such as ophthalmic and radiology devices, and argued that companies with products in multiple categories were more likely to deal with the recall than those focusing one category, which means that market reactions are more severe for companies with a single category. In addition, firms with growth prospects and higher sales had negative impact on abnormal returns. This result is contrary to their expectations, and the authors argued that the market would respond more seriously to the quality failure on profitability such as additional costs, lowered revenue, and loss of reputation for firms with higher sales.

2.2.2. Studies of Recalls of Food Products

Food recalls are a main concern since food has been directly related to consumer health and numerous foodborne illnesses occur every year. To date, a relatively small number of studies have

examined this issue. Salin and Hooker (2001) examined daily closing stock prices for three companies that had experienced major food recalls - Sara Lee Corp., IBP Inc., and Odwalla, Inc. These authors found that following a recall event, returns to shareholders for larger firms were not statistically significant, whereas those for the smallest manufacturer, Odwalla Inc., decreased immediately. Thomsen and McKenzie (2001) questioned the impact of meat and poultry recalls on the value of firms. Studying meat and poultry recalls from 1982 to 1998, they found that there was a decrease in CAAR in the case of Class I recalls, the most serious of the types of recalls, for publicly traded food companies. More specifically, the CAAR was -0.004% on the day of the recall and declined to a low of -0.24% on day six of the recall. However, these authors found mostly insignificant and even positive effects on shareholder losses involving less severe hazards such as Class II and Class III recalls.

Johnson-Hall (2012) analyzed the effects of factors related to FDA-mediated food recalls on time to recall days, the difference between the date of the recall and the beginning of the shelf life. The author found that recalls detected by external entities such as consumers or regulatory agencies had a longer time to recall than those by internal entities such as suppliers or recalling firms. In addition, refrigerated products were associated with a shorter period to recall than frozen or shelf stable products because of their shorter shelf lives, and major recalls designated by FDA[7] had greater time to recall.

Several studies have used econometric models in addition to event studies to evaluate the effects of various determinants on the abnormal returns related to recalls. Pozo and Schroeder (2016) studied U.S. meat and poultry recalls from January 1994 to December 2013 using both

[7] Plainview Milk Cooperative (powdered milk), Basic Food Flavors (hydrolyzed vegetable protein), Peanut Corporation of America (peanuts/peanut products), Setton Pistachios (whole & shelled pistachios), and Galt, Wright County, etc. (shell eggs).

event study and ordinary least squares (OLS) models. From the event study, they found that the abnormal returns fell by 1.15% within 5 days after the Class I recall event. However, abnormal returns did not negatively respond to Class II recalls which are a less serious class of food hazard. OLS results indicated that firm size, experience in terms of a recall, recall size, and the extent of media attention on a recall were associated with shareholders' wealth. They conducted four models by event periods. Each model studied the effects on the abnormal returns within 5, 10, 15, and 20 days after the recalls, respectively. Recall size was significant and negative in the second model that an event window for dependent variable ranges from 1 to 10 days, third one from 1 to 15 days, and fourth one from 1 to 20 days. Firm size was positively associated with abnormal returns, which means that smaller firms experienced greater impacts from recalls. Whether a firm had experienced a recall in the past year positively impacted the stock prices in models 1, which ranges from 1 to 5 days, model 2, and model 3. The media index was only significant and positive in the last horizon model ranging from 1 to 20 days. Table 2.1 summarizes the main independent variables and brief results of previous studies that estimated the impact of product or food recalls on stock returns using cross-sectional regression analysis.

Table 2.1 Main Independent Variables in Previous Literature Using Cross-sectional Analysis

Independent Variable Name	Description	F/NF	Sign	Sig.	References
1. Characteristics of Recall					
Severity of the threat	1 if the recall belongs to Class I category, 0 otherwise	F	–		Pozo and Schroeder (2016)
		NF	+	**	Chen, Ganesan, and Liu (2009)
		NF	–	*	Ni, Flynnb, and Jacobsc (2015)
		NF	–		Thirumalai and Sinha (2011)
Foodborne pathogen	1 if it caused by a pathogen, 0 otherwise	F	+		Pozo and Schroeder (2016)
Size of the recall	The number of products on a food recall	F	–		Pozo and Schroeder (2016)
		NF	–		Chen, Ganesan, and Liu (2009)
		NF	–		Ni, Flynnb, and Jacobsc (2015)
		NF	–		Thirumalai and Sinha (2011)
Experience	1 if a firm had another recall in the past year, 0 otherwise	F	+	***	Pozo and Schroeder (2016)
Diversification	1 if meat is the firm's main production, 0 otherwise	F	+		Pozo and Schroeder (2016)
Cluster	1 if any firm issued other recall that occurred within the last 10 days	F	+		Pozo and Schroeder (2016)
Distribution Patterns	The number of states in which recalled product was distributed	NF	–		Thirumalai and Sinha (2011)
Supply Chain Entity	1 if a firm issuing a recall is a manufacturer, 0 if one is a distributor/retailer	NF	–	*	Ni, Flynnb, and Jacobsc (2015)
Government-initiated	1 if a recall is a government-initiated recall, 0 if that is a manufacturer-initiated one	NF	+		Rupp (2004)
Brand	1 if a recalled product used its company name in its brand name, 0 otherwise	NF	–		Chen, Ganesan, and Liu (2009)
Price	The maximum retail price of a recalled product	NF	–		Chen, Ganesan, and Liu (2009)
2. Characteristics of a company					
Firm size	Market Equity		+	*	Pozo and Schroeder (2016)
	Sales Revenue	NF	+		Chen, Ganesan, and Liu (2009)
	Market Capitalization	NF	+		Rupp (2004)
	Sales (Number of products sold)	NF	-	**	Thirumalai and Sinha (2011)
Subsidiary	1 if a recalling firm is a subsidiary	F	–		Pozo and Schroeder (2016)

Table 2.1 Main Independent Variables in Previous Literature Using Cross-sectional Analysis (Continued)

Momentum	Return over previous 12 months (%)	F	+	*	Pozo and Schroeder (2016)
Trading Volume	Percentage of shares outstanding which is traded	F	–		Pozo and Schroeder (2016)
Reputation	The ratings which companies are most respected based on Fortune's annual survey of "America's Most Admired Companies."	NF	+		Chen, Ganesan, and Liu (2009)
Sell time	How long the recalled products have been sold in the market before the recall	NF	+		Chen, Ganesan, and Liu (2009)
Firm growth potential	The ratio of market to book value of equity	NF	–	*	Ni, Flynnb, and Jacobsc (2015)
AAA bond rating	Excellent financial ratings	NF	–	***	Rupp (2004)
Debt-to-equity ratio	The proportion of a company's asset burden borne by the shareholders	NF	+	*	Thirumalai and Sinha (2011)
R&D intensity	R&D expenditure/sales	NF	–		Thirumalai and Sinha (2011)
The extent of labor use	Employees/Sales	NF	–	*	Thirumalai and Sinha (2011)
3. Other Information					
Media Index	The number of articles issued per recall	F	–		Pozo and Schroeder (2016)
Years	Year fixed effect	NF	–		Rupp (2004)
Yeartrend	The number of years between the first year of the recall ample and the year of the recall	NF	+	*	Chen, Ganesan, and Liu (2009)

Notes: Dependent variable is a cumulative abnormal returns (CAR). F/NF : Food Recalls or Non Food Recalls (F : Food Recalls, N : Non-Food Recalls). Sign and significance (Sig.) are based on the first model in papers other than Thirumalai and Sinha (2011). They are based on the third model in Thirumalai and Sinha (2011) because the third model includes all independent variables. In Rupp (2004), the authors say that most companies have the identical bond rating regardless of the length until maturity. In cases where these differ, they use the bond rating for the note with the earliest maturity date. *** refers to statistical significance at the 0.01 level, ** does statistical significance at the 0.05 level, and * does statistical significance at the 0.10 level.

Table 2.2 Main Independent Variables in Johnson-hall (2012)

Independent Variable Name	Description	Sign	Sig.
1. Characteristics of Recall			
Recall magnitude	The number of products on a food recall	+	
Defect type	Pathogen	-	
Distribution patterns	The number of states in which recalled product was distributed	+	
Detection entity	1 if recalls detected by external entities (Agency/Consumer) or internal entities (Recalling Firm/Supplier)	+	**
Product type	Refrigerated (1)	base	
	Frozen (2)	+	**
	Shelf Stable (3)	+	**
Recall breadth	1 if a recall is associated with a major recall, 0 otherwise	+	**
2. Characteristics of a company			
Firm size	Firm Revenue	+	
	The number of employees	–	
Public	1 if a recalling firm is a publicly traded company, 0 otherwise	-	*
3. Other Information			
Years	Year dummies	+	

Notes: Different from other previous papers regarding food recalls, Johnson-hall (2012) used FDA recall data. However, its dependent variable is $T_i^* = \text{Shelf Life}_i - (\text{Expiry}_i - \text{Recall}_i)$ where Shelf Life_i is the length of time that a product can be stored. Expiry_i refers to the expiration date of a product, and Recall_i is the date of the recall announcement for product i. Therefore, T_i^* means the number of days between a recall and the end of production.

2.3. An introduction to Food Recalls

2.3.1. FSIS and FDA Recalls

The Food Safety and Inspection Service (FSIS) under the U.S. Department of Agriculture (USDA) and the Food and Drug Administration (FDA) under the U.S. Department of Health and Human Services are the public health agencies responsible for inspecting and regulating different aspects of the U.S. food supply. The FSIS oversees meat, poultry, and processed egg products, which are produced in federally inspected plants. They ensure that these products are safe, healthful, and correctly labeled (USDA, 2015). The FSIS is responsible for regulating domestic and imported meat, poultry, and related products. For example, meat- or poultry-containing pizzas, stews, frozen foods, and processed egg products fall under control of the FSIS.

Other food products, including pet food and animal feed are regulated by the FDA. The FDA monitors the food supply for all domestic and imported food, with the exceptions of the items noted above which fall under FSIS jurisdiction. For example, the FDA regulates cooked omelets, hard boiled eggs, imitation egg products, egg substitutes, frozen egg patties, noodles, freeze-dried products, dietary foods, cake mixes, dried no-bake custard mixes, acidic dressings, mayonnaise, milk and egg dip, eggnog mixes, foods containing egg extracts, sandwiches containing eggs or egg products, French toast, and other similar cultural foods.

Other agencies responsible for monitoring and enforcing food safety regulations include the U.S. Department of the Treasury and the U.S. Environmental Protection Agency (EPA). The Alcohol and Tobacco Tax and Trade Bureau (TTB) within the Department of the Treasury, is responsible for regulating beverages with more than 7% alcohol content and the EPA establishes tolerances for pesticide residues in foods and requirements for drinking water (FDA, 2016). Table 2.3 provides a comparison of the food oversight responsibilities of the selected federal agencies.

Table 2.3 Comparison of Selected Agency Responsibilities for Food Safety and Quality

Agency	Responsibility
Food and Drug Administration (FDA)	Food (but not meat)
	Dietary supplements
	Bottled water
	Seafood
	Wild game ("exotic" meat)
	Eggs in the shell
U.S. Department of Agriculture (USDA)	Grading of raw fruit and vegetables
	Meat and poultry
	Eggs, processing and grading
	Certifying organic production
National Oceanic and Atmospheric Administration	Grading of fish and seafood
Environmental Protection Agency (EPA)	Drinking water
	Pesticide residues
Alcohol and Tobacco Tax and Trade Bureau (TTB)	Alcohol

Source: Fortin (2016)

Table 2.4 presents several special examples of the division of jurisdiction between the USDA and FDA. These unique cases are based on authorities granted under the Poultry Products Inspection Act (PPIA) and the Federal Meat Inspection Act (FMIA) (OPPED, 2005). Some products exempt from USDA jurisdiction and inspection include those containing meat or poultry ingredients in relatively small proportions. Specifically, "relatively small proportions" of livestock ingredients refer to less than 3% for raw meat, less than 2% for cooked meat, or less than 30% for fat including tallow or meat extract. For instance, products composed of less than 2% cooked poultry meat or less than 10% poultry skins are exempt from the USDA jurisdiction and inspection (refer to 9 CFR Part 381.15(a)). These percentages are calculated on the basis of the moist cooked chicken in the ready-to-serve product. In addition, USDA is not required to inspect some products. For instance, USDA defines a closed-faced sandwich as "one containing at least 35% cooked meat and no more than 50% bread" and an open-faced sandwich as one with "at least 50% cooked meat". Therefore, according to the federal meat and poultry inspection laws, a closed-faced sandwich is not required to be inspected by USDA (McCready, 2008).

Table 2.4 Special cases of jurisdiction matters of USDA and FDA

USDA	FDA
Pepperoni pizza	Cheese pizza
Open-faced sandwiches	Closed-faced sandwiches
Processed egg products	Shell eggs
Exotic species at slaughter	Elk, bison, etc. in commerce
Beef broth	Chicken broth

Source: Volk (2010)

Products exempt from USDA jurisdiction are instead regulated by the FDA. For example, the FDA has responsibility for stocks or broths with "relatively small amounts" of meat or poultry, dehydrated meat soups, bouillon cubes, pork and beans, bagel dogs, closed-faced sandwiches, mince meat, cheese balls with pepperoni, and pepperoni rolls (OPPED, 2005; Post et al., 2007). There are also notable discrepancies when it comes to the regulation of frozen pizzas. The FDA regulates pizzas with only cheese, whereas the USDA regulates pizzas with meat and cheese. This is because cheese is only an ingredient in cheese pizza even though cheese is regulated by USDA. In addition, cheese is not the final product in this case because it is not cheese itself but a pizza. Therefore, FDA monitors pizza where cheese is used as an ingredient (Saxowsky, 2010). In other words, USDA regulation has more to do with the meat pizzas containing meat than the cheese pizzas only containing cheese as an ingredient.

2.3.2. Recall Procedures

In cases where a food product is found to be unsafe, it is important to get that product out of the marketplace as soon as possible to reduce the potential impact of foodborne illness. To do so, public notifications are released and the affected product is recalled. Recalls initiated through the FDA and USDA differ slightly in the details of their recall procedures. However, both agencies follow the same general steps: determining whether or not a recall should be initiated, announcing the recall to the firm and the public, evaluating the recall, and terminating the recall. The following discussion provides additional details regarding recall procedures of the FDA and USDA.

2.3.2.1. FDA Recalls

Recalls of products that fall under FDA jurisdiction may be voluntarily initiated by the 'at fault' food firm, initiated at the request of the FDA, or mandated by the FDA. A manufacturer or distributor may make voluntary recalls at any time. FDA may hold informal discussions with a manufacturer or distributor and also ask for a recall based on 21 CFR 7.45. The Commissioner of Food and Drugs or designee may request a company to recall a product when it is determined that there is risk of illness, injury, or deception. However, if there is a probability of serious health problems or death, the FDA would order the firm to immediately stop distribution of products.

The next step is to determine the recall classification in terms of health hazard evaluation. The FDA evaluates the health hazard and classifies the recall under the guidance of 21 CFR 7.41. The FDA takes samples of food products not only in the market but also in-process and raw ingredients. The FDA typically uses the Bacteriological Analytical Manual (BAM) laboratory method to test the samples. Using this information, the FDA classifies situations into three classes. The highest class, Class I, is for dangerous or defective products which may cause serious health

problems or death. Next, a Class II recall is a situation with products which may result in temporary health consequences. Finally, a Class III recall is related to products which are not likely to lead to adverse health problems.

After the decision, the FDA notifies the company of necessary actions and information such as the need for press releases and the classification of the recall. Since the implementation of the FDA Food Safety Modernization Act (FSMA) under Section 423 of the Act, FDA posts press releases and alerts on www.fda.gov for all new recalls. Following this the FDA makes and conducts a recall audit program to ensure that the recall is effective. The final step is to terminate the recall. A recall is terminated after the monitoring district office determines that the recalling firm has fulfilled all recall activity. If a firm refuses the recall or fails to fulfill recall activity, the FDA would take appropriate regulatory actions. The appropriate center recall and compliance staff, the district compliance branch, the Office of Enforcement and Import Operations/Division of Enforcement, and the Office of Chief Counsel are consulted and work to coordinate any regulatory actions (FDA, 2013).

2.3.2.2. USDA Recalls

The USDA recalls are administered through the FSIS through a recall process. First, like FDA, the FSIS determines the need for recall. Establishments are required to notify FSIS district office personnel within 24 hours of finding a contaminated or misbranded product (9 CFR 418.2). The FSIS notifies firms that they need to contact the Recall Management and Technical Analysis Staff (RMTAS) or other FSIS personnel. FSIS personnel collect information such as product information, contact information, and additional relevant information. The RMTAS organizes all of the information from FSIS personnel and forwards the materials to the Recall Committee.

Next, members of the Recall Committee discuss the materials, determine if there should be a recall, and decide the proper recall classification. After the Recall Committee makes a decision to recommend a recall, the RMTAS submits a Recall Recommendation in documentation for approval by the Office of Field Operations (OFO) Assistant Administrator (AA). After the OFO AA approves the Recall Recommendation, RMTAS sends a letter to the firm checking the assessment of the hazard, the extent of the recall, and the area of distribution. If the OFO AA does not approve the Recall Recommendation, the OFO AA calls AAs from other departments in order to discuss it. Each AA needs to talk about the potential recall with his or her office representative to the Recall Committee.

Next, the FSIS provides "Product Recall Guidelines for Firms" to companies. If a firm refuses the Agency's recommendation and opts not to issue a recall, FSIS personnel would detain any product as indicated in FSIS Directive 8410.1. The Congressional and Public Affairs Office (CPAO) would put out a press release in order to inform the public that the product in question appears to be contaminated or misbranded. This ress release is posted in the Recall Release to media outlets in affected areas, media wire services, the FSIS email subscription service, and the @USDAfoodsafety Twitter Feed as well as the FSIS website.

Finally, RMTAS is required to hand in a recommendation for closing a recall to the AA OFO. After obtaining the consent of OFO AA, RMTAS notifies the recalling firm that the recall is closed and alerts the FSIS webmaster to change the case from "open" to "archived" in the recall case files on the FSIS Website (USDA, 2004, 2013 and 2014). A comparison of the recall processes of the FDA and the USDA FSIS is shown in Table 2.5.

Table 2.5 Comparison of FDA and FSIS recall procedures

FDA	FSIS
1. Initiation of a Recall	1. Determining Need for Recall
2. Determination that the Action is a Recall	2. Deliberations of the Recall Committee
3. Notification and Public Warning	3. Recall Recommendation
4. Monitoring and Auditing the Recall	4. Announcing the Recall
5. Termination of a Recall	5. The RO Determination on the Effectiveness of the Recall
	6. Closure

Sources: FSIS Directive 8080.1 and FDA recall procedure of Regulatory Procedures Manual (2013)

2.3.3. Voluntary and Mandatory Recalls under FSMA

FSMA was signed into law in January 2011. This act thoroughly updated the nation's food safety laws for the first time since the Great Depression (Strauss 2011). FSMA highlights primary prevention at food processing facilities to reduce cases of foodborne illness. Before FSMA, the FDA was reactive and tended to respond only after the food safety event occurred. FSMA forced the FDA to adopt preventive control plans and increase the frequency of inspection for facilities under its jurisdiction. One of the most important results of FSMA was the impact on food recalls. Among important changes introduced by FSMA was the expansion of FDA authority for mandatory recalls rather than just recommended ones. Prior to FMSA, recalls were voluntary and tended to have slow response times because the FDA did not have the authority to conduct mandatory recalls for food, infant formula was the only exception (Stewart and Gostin, 2011).

2.4. Methodology and Data

2.4.1. Analytical Approach

Event studies measure the effect of a particular event. In this study, they were used to evaluate the impact of food recalls on the stock returns of the affected companies. This method has its foundation in the efficient-market hypothesis by Fama et al. (1969), which assumes all available

information is fully and promptly reflected in the prices of financial assets. In the context of this study, the "event" was a company's announcement of a food recall. As this analysis requires stock prices, it was limited to firms who had a recall event and those firms who were themselves, or whose parent company was, publicly traded.

To conduct an event study, abnormal stock price returns, which are the difference between actual and expected returns, are estimated over the period of time potentially affected an event. The formula for abnormal returns using the market model of Brown and Warner (1985) and MacKinlay (1997) is as follows:

$$R_{it} = \alpha_i + \beta_i RM_t + u_{it} \quad [2.1]$$

,where R_{it} is the actual return of firm i generated at time t, RM_t is the market returns at time t, α_i and β_i represent the parameters to estimate for each firm i, u_{it} is an error term. Next, the predicted value of returns for a given firm is obtained by:

$$\hat{R}_{it} = \hat{\alpha}_{\bar{i}} + \hat{\beta}_i RM_t \quad [2.2]$$

Using this predicted value, daily abnormal returns can be estimated as:

$$\hat{u}_{it} = R_{it} - \hat{R}_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i RM_t = AR_{it} \quad [2.3]$$

,where AR_{it} is an abnormal return of firm i at time t. The abnormal returns which could have been normal returns without the event can be calculated using the estimation window from T_1 to T_2, (T_1, T_2), which is a period before the event. Various event windows, (τ_1, τ_2), are examined to assess abnormal returns in the immediate, short, and long- term after event day ($t = 0$). Estimates of cumulative abnormal returns (CAR) and cumulative average abnormal returns (CAAR), from T_1 to T_2, (T_1, T_2) and are compared with a period of 'normal' returns before the event.

Event study tests the following hypothesis:

$H_0: CAR_i(\tau_1,\tau_2) \geq 0, \quad H_1: CAR_i(\tau_1,\tau_2) < 0$ for firms with an event window (τ_1,τ_2),

$H_0: CAAR(\tau_1,\tau_2) \geq 0, \quad H_1: CAAR(\tau_1,\tau_2) < 0$ for an industry with an event window (τ_1,τ_2).

,where $CAR_i(\tau_1,\tau_2) = \sum_{t=\tau_1}^{\tau_2} AR_{it}$ and $CAAR(\tau_1,\tau_2) = \frac{1}{N}\sum_{i=1}^{N} CAR_i(\tau_1,\tau_2)$.

Estimation windows could link past stock returns with future ones. Therefore, the parameters of the model should be estimated using a subset of the sample which is called the estimation window (Campbell, Lo, and MacKinlay, 1997). Previous literature normally used 120 or 250 trading days before the recall announcement as an estimation window. However, most of the previous papers regarding food recalls used 250 trading days (Pozo and Schroeder, 2016 and Thomsen and McKenzie, 2001). Likewise, 250 trading days before the recall announcement is used as the estimation window because reflecting the market situation for around one-year period may be properly expected to obtain predicted values.

Considering dynamic relationships with time series data in a single-equation, we use an autoregressive distributed lag (ARDL) model due to serial correlation (Mazzocchi et al., 2009).

$$R_{it} = \alpha_i + \beta_{1i} RM_t + \beta_{2i} R_{it-1} + \beta_{3i} RM_{t-1} + u_{it} \quad [2.4]$$

$$\hat{R}_{it} = \hat{\alpha}_{\bar{i}} + \hat{\beta}_{1i} RM_t + \hat{\beta}_{2i} R_{it-1} + \hat{\beta}_{3i} RM_{t-1} \quad [2.5]$$

$$\hat{u}_{it} = R_{it} - \hat{R}_{it} = R_{it} - \hat{\alpha}_{\bar{i}} + \hat{\beta}_{1i} RM_t + \hat{\beta}_{2i} R_{it-1} + \hat{\beta}_{3i} RM_{t-1} = AR_{it} \quad [2.6]$$

Following Brown and Warner (1980, 1985) and Rani, Yadav, and Jain (2016), the statistical significance of the cumulative average abnormal return (CAAR) for the sample is calculated by using a t-statistic based on the cross-sectional standard deviation.

$$t_{CAAR} = \sqrt{N}\frac{CAAR}{S_{CAAR}} \quad [2.7]$$

,where N is the number of recall events in an industry, and S_{CAAR} is the standard deviation of the cumulative average abnormal returns (CAAR) in the sample.

$$S_{CAAR}^2 = \frac{1}{N-1}\sum_{i=1}^{N}(CAR_i - CAAR)^2 \quad [2.8]$$

2.4.2. Data

This study focuses on recalls of human food in the U.S. from 2014 through 2018 because the openFDA food enforcement reports data are accessible from September 2012, and fully available from 2014 based on recall initiation dates. FDA Food Recall Enforcement reports were used to identify food recall cases by industry and recall classification.[8] To conduct an event study estimating the effect of food recall on returns, daily stock price data is required. However, most food companies who have a recalled product recall are private companies, and therefore there are no stock prices. Among the 3,157 identified food and beverages recalls, 428 recalls were issued by publicly traded companies. Table 2.6 summarizes characteristics of these recalls.[9] A majority of recalls were Class II and were issued by food manufacturing firms, and Class I recalls (the most severe; reasonable probability of serious illness or death) are the second largest ones.

[8] FDA enforcement reports for food is obtained from OpenFDA (https://open.fda.gov/food/enforcement))

[9] The Kraft-related recall cases were dropped because The Kraft Heinz Company had begun trading on the NASDAQ on July 6, 2015. Kraft Heinz was formed following the merger of two food companies (Kraft Foods Group, Inc. and H.J. Heinz Company). First, before the merger, Kraft Foods Group Inc. recalled products on March 17, 2015. Therefore, there are 75 trading days after the recall. Second, FDA stated that Kraft Foods North America had recalled items on June 5, 2015. As a result, Kraft Foods had stock prices for 19 days after the recall (June 5, 2015). In addition, we have already dropped recalls of The Kraft Heinz Company because there was little information about estimation window. The Kraft Heinz Company recalled products on December 29, 2015. A recall case of Cost Plus Management Services, Inc. because the recall products were spoons are also dropped although FDA had classified it as "Food".

Table 2.6 Characteristics of FDA recalls by publicly traded firms, 2014 – 2018

Attribute	Description	No.	Freq. (%)
Class			
Class I	Most severe	186	43.5
Class II		207	48.4
Class III	Least severe	35	8.2
Industry			
Food Manufacturing	311	175	40.9
Food and Beverage Retailers	445	125	29.2
Merchant Wholesalers, Nondurable Goods	424	78	18.2
Health and Personal Care Stores	446	14	3.3
Beverage and Tobacco Product Manufacturing	312	14	3.3
Nonstore Retailers	454	8	1.9
Chemical Manufacturing	325	8	1.9
Professional, Scientific, and Technical Services	541	5	1.2
Food Services and Drinking Places	722	1	0.2

Market index information was obtained from Bloomberg Terminal. Abnormal returns and predicted values were estimated using general market indexes (e.g. S&P 500 in the U.S). To more accurately compare the performance of firms with recalls to the food sector, these estimates were also generated using food sector market indexes (e.g. S&P 500 Beverage and Tobacco Industry Group index in the U.S.) since all recall cases are associated with food. Table 2.7 shows stock market indexes and food sector indexes used to estimate abnormal returns. The S&P 500 index has been commonly used for U.S. companies in previous literature, but there is little information for foreign market index. Therefore, foreign indexes which include as many stocks as possible such as all share index were selected for each country. Most Market Indexes were selected to include companies which issued recalls. For example, stock prices of AAK AB in Sweden belongs to OMX Stockholm Index (All share) while OMX Stockholm 30 index does not include it. Therefore, OMX Stockholm Index (All share) instead of OMX Stockholm 30 index was used for the market index in Sweden. As a food stock market index was not available for Hong Kong, Italy, Mexico,

Netherlands, and Spain, Sweden, and China, stock market indexes are instead used in both comparisons against the total market index and the food sector index.[10]

Daily stock prices for each company were also collected from Bloomberg Terminal. Bloomberg Terminal provides both domestic and foreign stock prices. Foreign stock prices were applied for recall cases where firms issuing the recall were privately held U.S. companies, but had an international, publicly traded parent company.

Table 2.7 Used Market Portfolios and Food Market Indexes

Country	Total Market Index	Food Sector Index
U.S.	S&P 500 Index	S&P 500 Beverage and Tobacco Industry Group index
Canada	The S&P/TSX Composite Index	S&P/TSX Food Beverage and Tobacco Industry Group index
Switzerland	Swiss All Share Index	SPI® ICB Supersector 3500 "Food & Beverage" Price
U.K.	FTSE All-Share	FTSE ASX Food Producers Index
Norway	OSEAX	Oslo Stock Exchange 3020 Food Beverage & Tobacco Industry Group Index
Mexico	S&P/BMV IPC	S&P/BMV IPC
Japan	TOPIX	Topix Foods Index
Thailand	FTSE SET All-Share Index	Stock Exchange of Thailand Food and Beverages Index
France	CAC All-Tradable	CAC Food Produce Index
Ireland	Irish Stock Exchange Overall Index	FTSE ASX Food Producers Index
Hong Kong	Hong Kong Hang Seng Index	Hong Kong Hang Seng Index
China	Shanghai Stock Exchange Composite Index	Shanghai Stock Exchange Composite Index
Germany	Deutsche Boerse AG German Stock Index	DAXsector All Food & Beverages Price Index
Netherlands	Amsterdam Exchange index	Amsterdam Exchange index
Spain	Madrid Stock Exchange General Index	Madrid Stock Exchange General Index
Sweden	OMX Stockholm Index (All share)	OMX Stockholm Food Producers index
South Korea	Korea Stock Exchange KOSPI index	Korea Stock Exchange Food and Beverage Index
Italy	FTSE MIB Index	FTSE MIB Index

[10] Hang Seng Index in Hong Kong, FTSE MIB Index in Italy, S&P/BMV IPC in Mexico, Amsterdam Exchange index in Netherlands, OMX Stockholm Index (All share) in Sweden, Shanghai Stock Exchange Composite Index in China, and Madrid Stock Exchange General Index in Spain are used for food stock market indexes, which are the same as the general stock market index.

It may be essential to classify food industries in order to analyze the impacts of food recalls because each industry would have different characteristics. Food industries in the sample were classified by North American Industry Classification System (NAICS). Compared to Standard Industrial Classification (SIC), NAICS had the advantage of offering recent updates such as 2017 NAICS codes.[11] In contrast, Bloomberg Terminal lacked information about North American Industry Classification System (NAICS) and instead it provided industry classification such as SIC and Industry Classification Benchmark (ICB). ReferenceUSA were used for industry classification, and NAICS 3-digit group codes and the distribution of firms in the recall dataset by sector are represented in Table 2.6. Firms engaged in "Food Manufacturing" represent the largest share of firms with recalls, while "Food and Beverage Retailers" are responsible for the second largest number of recalls.

[11] It is available on https://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2017

Table 2.8 Time differences among countries in the sample due to various stock market open and close times

Country	Time Difference	GMT	Application
Mexico	-1	-6	0
U.S.(New York)	0	-5	0
Canada(Toronto)	0	-5	0
U.K.	5	0	0
Ireland	5	0	0
France	6	1	0
Switzerland	6	1	0
Italy	6	1	0
Germany	6	1	0
Netherlands	6	1	0
Spain	6	1	0
Sweden	6	1	0
Norway	6	1	0
Thailand	12	7	+1 day
Hong Kong	13	8	+1 day
China	13	8	+1 day
South Korea	14	9	+1 day
Japan	14	9	+1 day

Notes: Daylight saving time is not used in this table. Japanese and Thailand stock prices are applied to values on the next day of the U.S. stock price.

Time zone differences (and market opening and closing times) were considered in obtaining foreign market information. As shown in Table 2.8, time differences among 18 countries were considered because each country may have different stock market open and close times and operate in different time zones. Thus, different market days may be the appropriate comparison to assess market response of a U.S. recall. Compared with the U.S., the difference in time among countries including Canada, France, Germany, Ireland, Italy, Mexico, the Netherlands, Norway, Spain, Sweden, Switzerland, and the U.K., is up to six hours.[12] Therefore, these countries were

[12] GMT refers to Greenwich Mean Time measured by Royal Observatory in Greenwich in London. Therefore, GMT of London is zero, and in the U.S. GMT of LA is -8 and that of New York City is -5.

applied the same recall date as the U.S. Hong Kong, Japan, South Korea, and Thailand have a time difference of more than 12-hours from the U.S. Thus, they were assumed to have a one-day market delay from the date the recall occurred in the U.S.

2.4.3. Cross-sectional Study

The impacts of recalls and other variables of interest can be estimated using cross-sectional analysis. The dependent variable is a cumulative abnormal return for firm i from the event study method, and the following model is estimated:

$$CAR_i(\tau_1, \tau_2) = \alpha + R_i^{'} \beta + C_i^{'} \gamma + v_i \quad [2.9]$$

where R_i is the vector of characteristics of a recall for firm i, C_i is the vector of characteristics of a company i, and v_i is an error term. β and γ are parameter vectors to be estimated for characteristics of a recall and those of a recalling firm, respectively. Variables included in these vectors are described in Table 2.9.

Table 2.9 Definition of Independent Variables

Independent Variable Name	Description	Data Source	Variable name in database	Hypothesi -zed Sign
1. Characteristics of Recall				
Class I	1 if a recall belongs to Class I category, 0 otherwise	FDA Food Enforcement Report (2014-2018)	classification	Class I: -
Reason for recall	Categorical Variable: Foodborne Pathogen (1), Labeling (2), Contamination (3), Manufacturing or Holding (4), Packaging (5)	FDA Food Enforcement Report (2014-2018)	reason_for_recall	Foodborne Pathogen: -
Recall Experience	1 if a firm had another recall in the past year, 0 otherwise	FDA Food Enforcement Report (2014-2018)	-	-
Industry	Categorical Variable: Food Manufacturing (1), Beverage and Tobacco Product (2), Chemical Manufacturing (3), Merchant Wholesalers (4), Food and Beverage Retailers (5), Health and Personal Care Stores (6), Nonstore Retailers (7), Professional, Scientific, and Technical Services (8), Food Services and Drinking Places (9)	ReferenceUSA	NAICS code	Food Manufacturing: -

Table 2.9 Definition of Independent Variables (Continued)

Product type (PType)	Categorical Variable: Fruit and Vegetable (1), Bakery (2), Beverages (3), Breakfast Cereals (4), Confectionery (5), Dairy (6), Desserts and Ice Cream (6), Prepared Meals (7), Processed Fish, Meat, and Eggs (8), Relevant Ingredient (9), Sauces and Seasonings (10), Side Dishes (11), Snacks (12), Soup (13), Spreads (14), Supplements (15), Sweeteners and Sugar (16)	FDA Food Enforcement Report (2014-2018)	product_description	Fruit and Vegetable: -
Storage type (SType)	Categorical Variable: Refrigerated (1), Frozen (2), Shelf (3), and Shelf Stable (4)	FDA Food Enforcement Report (2014-2018)	product_description	Frozen: -
Distribution of Recalled Product	ln(Domestic Distribution with Population) The number of states in which recalled product was distributed multiplied by population	FDA Food Enforcement Report (2014-2016) and U.S. Census Bureau (2021)	distribution_pattern	-
International Distribution	1 if a recall has been distributed internationally, 0 otherwise	FDA Food Enforcement Report (2014-2018)	distribution_pattern	-
2. Characteristics of a company				
ln (Sales)	Amount of sales generated by a company	Bloomberg (2021)	SALES_REV_TURN	+
Ln (Assets)	The total of assets as reported on the Balance Sheet.	Bloomberg (2021)	BS_tot_asset	+
Subsidiary	1 if a firm issuing a recall is a subsidiary	Bloomberg (2021)	-	-
3. Other Information				
Measure of Media Attention	The number of articles issued when recall occurred (Google News or LexisNexis)	Google News, LexisNexis		-
Years	Year fixed effect			

Notes: There is no variable for experience and cluster in the FDA Food Enforcement Report, and it was counted manually. The corporate structure was found with the command "rel" in Bloomberg Terminal and checked whether it is a subsidiary or a parent company.

Unlike the event study, all products are taken into account because each event may have multiple products. For example, John B. Sanfilippo & Son, Inc. issued food recalls on December

30, 2014, and it counts one recall event. However, there are two different products recalled on that day: 8 oz packages of pecan cookie pieces and 8 oz packages of chopped walnuts. Therefore, this analysis uses 1,985 individual products as a sample for 428 recall event cases, which may play weights for each recall event.

There are several factors related to food recalls which may influence on stock returns. First, Class I recalls may be negatively associated with stock returns. Second, foodborne pathogens such as *Salmonella* or *Listeria monocytogenes* are considered severe problems, so recalls related to pathogens may be more harmful to CAR for the recalling firm than other reasons such as mislabeling.[13] However, a characteristic of experience would be ambiguous because a firm that had another recall in the past year might be damaging signal to CAR, whereas shareholders would not react well if the company is recognized as having frequent recalls. For distribution patterns, it is likely that the more recalled products are distributed to more states, the greater the effects on stock prices.

Next, there are four categorical variables: food industry, product type, storage type, and

and reasons for food recalls. There were nine industries included in this sample with the Food Manufacturing industry having the largest number of sample observations as shown in Table 2.10. Food and Beverage Retailers and Merchant Wholesalers came in second with 632 observations and third with 576 observations, respectively. Therefore, we chose to focus on those three industries. Based on CAR(0,1), which refers that cumulative abnormal returns between the day of a food recall and a day after the recall announcement, three simple regression results of CAR(0,1) are shown in Table 2.11. Performing a simple regression analysis for each food industry category, food manufacturing industry shows a negative coefficient-value for cumulative abnormal

[13] Pozo and Schroeder (2016) also examines pathogen variable, but it is not statistically significant.

returns (CAR) in Table 2.11. Likewise, ‘fruit and vegetables’ category in Table 2.13 and foodborne pathogen in Table 2.15 have a negative impact on CAR, respectively. To avoid the problem of multicollinearity, this study used food manufacturing industry indicator instead of exploiting two or more categorical indicators of industries. Similarly, Fruit and Vegetables and Pathogen indicator variables were chosen for product types for food in Table 2.12 and Table 2.13 and reasons for food recalls in Table 2.14 and Table 2.15 considering R-squared and multicollinearity, respectively.

Table 2.10 Frequency Distribution of food recalls by industry in 2014 - 2018

Industry	Freq.	Percent of Sample
Food Manufacturing	680	34.26
Food and Beverage Retailers	632	31.84
Merchant Wholesalers	576	29.02
Health and Personal Care Stores	38	1.91
Professional, Scientific, and Technical Services	30	1.51
Nonstore Retailers	11	0.55
Chemical Manufacturing	9	0.45
Beverage and Tobacco Product	8	0.40
Food Services and Drinking Places	1	0.05
Total	1,985	100

Table 2.11 Simple regression results of CAR(0,1) for three major food industries in the sample

VARIABLES	(1) CAR(0,1)	(3) CAR(0,1)	(2) CAR(0,1)
Food Manufacturing	-0.034*** (0.002)		
Food and Beverage Retailers		0.012*** (0.003)	
Merchant Wholesalers			0.021*** (0.003)
Constant	-0.001 (0.001)	-0.016*** (0.001)	-0.018*** (0.001)
Observations	1,962	1,962	1,962
R-squared	0.093	0.012	0.031

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.12 Frequency Distribution of product types in the sample

Category	Freq.	Percent of Sample
Prepared Meals	309	15.57
Bakery	248	12.49
Snacks	246	12.39
Processed Fish, Meat, and Eggs	241	12.14
Fruit and Vegetables	236	11.89
Desserts and Ice Cream	135	6.80
Sauces and Seasonings	127	6.40
Dairy	123	6.20
Beverages	104	5.24
Spreads	68	3.43
Side Dishes	44	2.22
Supplements	41	2.07
Confectionery	30	1.51
Baby Food	12	0.60
Breakfast Cereals	11	0.55
Soup	4	0.20
Sweeteners and Sugar	4	0.20
Relevant Ingredient	2	0.10
Total	1,985	100

Table 2.13 Simple regression results of CAR(0,1) for four major food categories in the sample

	(1)	(2)	(3)	(4)
VARIABLES	CAR(0,1)	CAR(0,1)	CAR(0,1)	CAR(0,1)
Prepared Meals	0.007**			
	(0.003)			
Bakery		0.007**		
		(0.004)		
Snacks			-0.010***	
			(0.004)	
Fruit and Vegetables				-0.070***
				(0.003)
Constant	-0.013***	-0.013***	-0.011***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	1,962	1,962	1,962	1,962
R-squared	0.002	0.002	0.004	0.182

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.14 Frequency Distribution of reasons for food recall in the sample

Reason	Freq.	Percent of Sample
Pathogen	813	40.96
Labeling	580	29.22
Manufacturing or Holding	347	17.48
Contamination	200	10.08
Packaging	38	1.91
Other	7	0.35
Total	1,985	100

Table 2.15 Simple regression results of CAR(0,1) for four main reasons for food recall in the sample

VARIABLES	(1) CAR(0,1)	(2) CAR(0,1)	(3) CAR(0,1)	(4) CAR(0,1)
Pathogen	-0.022***			
	(0.002)			
Manufacturing or Holding		-0.004		
		(0.003)		
Labeling			0.024***	
			(0.003)	
Contamination				0.007*
				(0.004)
Constant	-0.003**	-0.011***	-0.019***	-0.013***
	(0.002)	(0.001)	(0.001)	(0.001)
Observations	1,962	1,962	1,962	1,962
R-squared	0.042	0.001	0.043	0.001

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Following Chen et al. (2019), Ni, Flynn, and Jacobs (2016), and Dang, Li, and Yang (2018), sales revenue was used as a control variable. Total assets were also considered, but sales revenue was chosen as a control variable because a model with sales revenue has lower Akaike's information criterion (AIC), lower Bayesian information criterion (BIC), and higher R-squared compared to a model with total assets. In addition, it is not desirable to use both of them since correlation between sales revenue and total assets is about 0.7.

Lastly, regression results would be quite similar using cumulative abnormal returns calculated from market index or food market index. Table 2.16 shows correlation between market

index and food market index by country in cases where market indexes are used differently.[14] The correlation between market index and food market index in the U.S. from September 2012 to September 2017 was 0.93 and the number of recall cases between 2014 and 2016 was 224 among 284 recall cases. Therefore, it can be expected that regression results from cumulative abnormal returns using two different indexes would be similar.

[14] For some countries such as Mexico, Japan, Hong Kong, Netherlands, Spain, and Italy, food market indexes are not available.

Table 2.16 Correlation between market index and food market index by country (Sep. 2012 ~ Sep. 2017)

Country	Market Index	Food Market Index	Correlation	Freq.
U.S.	S&P 500 Index	S&P 500 Beverage and Tobacco Industry Group index	0.93	224
Japan	TOPIX	Topix Foods Index	0.90	12
Norway	OSEAX	Oslo Stock Exchange 3020 Food Beverage & Tobacco Industry Group Index	0.85	1
Switzerland	Swiss All Share Index	SPI® ICB Supersector 3500 "Food & Beverage" Price	0.85	9
France	CAC All-Tradable	CAC Food Produce Index	0.84	6
Ireland	Irish Stock Exchange Overall Index	FTSE ASX Food Producers Index	0.84	5
Germany	Deutsche Boerse AG German Stock Index	DAXsector All Food & Beverages Price Index	0.78	3
Canada	The S&P/TSX Composite Index	S&P/TSX Food Beverage and Tobacco Industry Group index	0.70	7
Thailand	FTSE SET All-Share Index	Stock Exchange of Thailand Food and Beverages Index	0.60	3
Sweden	OMX Stockholm Index (All share)	OMX Stockholm Food Producers index	0.53	2
U.K.	FTSE All-Share	FTSE ASX Food Producers Index	0.50	2
South Korea	Korea Stock Exchange KOSPI index	Korea Stock Exchange Food and Beverage Index	0.10	1

2.5. Results and Discussion

2.5.1. Event Study Results

CAAR were calculated for all firms which had a recall (Column 2 in Table 2.17, Table 2.18 and Table 2.19; the blue line in Figure 2.2 and Figure 2.3 and Figure 2.4), separately for firms within each subsector (Tables 2.20-2.28; Figures 2.5-2.12), and especially firms within major food industry subsectors (Column 3-4 in Table 2.17 and the purple and orange lines in Figure 2.2).

The first and the fourth columns of the tables represent various event windows (τ_1, τ_2), over which CAAR is estimated. For example, (0,1) means cumulative abnormal returns of firms in certain industry on average from recall date (0) to one day (1) after the recall. To show the immediate, short-term, and medium-term impacts of a recall on a firm's stock market performance, CAAR were estimated over a variety of event windows. The second and third columns show the CAAR estimated using total stock market indexes and food sector indexes, respectively. These values use information from the previous 250 trading days to predict the actual returns to firms in the absence of a recall.

Figure 2.4 represents a trend of CAAR in all industries for 90 days after a recall announcement. In Table 2.17; Figure 2.2-2.4, for the food industry as a whole, returns decreased on the day of the recall and trough on the second to fifth days, but generally rebounded for a few days following this. However, after 10 days the CAAR began to decrease again and continued to do so throughout the event window. This may be because of the trend including all industries and classes. For example, CAAR for Class I recalls (Figure 2.14) dropped immediately after the recall, whereas the CAAR for other classes (Figures 2.15 and 2.16) was affected in the long run. In general, these patterns of returns follow a similar pattern. Returns generally decrease on the day of the recall and trough on the second to fifth days. If only a Class I recall were taken into consideration,

the degree of the decline would be larger.

In Table 2.17, the CAAR of the Food Manufacturing industry (e.g. ConAgra and General Mills) slightly decreased by 0.5% within the first 2 days after a recall announcement. After that day, there was no longer a decline in returns, and returns recovered to their original state. However, the CAAR of the Food and Beverage Retailers industry (e.g. Kroger and Harris Teeter) experienced fluctuations in CAAR amounting over 90 days. One possible explanation for this difference is due to the difference in risk to long-term profit faced by retailers compared to the perceived profit impact for food manufacturers.

Table 2.17 CAAR due to FDA recalls based on food market indexes, 2014-2018

Event Windows	All Industries	Food Manufacturing	Food and Beverage Retailers
(0, 1)	-0.0019	-0.0038*	0.0009
(0, 2)	-0.0029*	-0.0054**	0.0000
(0, 3)	-0.0027	-0.0057**	0.0003
(0, 4)	-0.0037**	-0.0049*	-0.0010
(0, 5)	-0.0039**	-0.0052*	-0.0010
(0, 10)	-0.0018	-0.0040	0.0011
(0, 15)	-0.0028	-0.0042	0.0045
(0, 30)	-0.0007	-0.0001	-0.0032
(0, 45)	-0.0018	-0.0021	-0.0022
(0, 60)	-0.0042	-0.0043	-0.0095
(0, 90)	-0.0063	-0.0109	-0.0147
Obs. (#)	428	175	125

Several industries including the Beverage and Tobacco Product Manufacturing Industry and the Chemical Manufacturing Industry had a different response. For example, the cumulative average abnormal returns sharply increased passing 30 days after recalls in the Beverage and Tobacco Product Manufacturing Industry. This could be due to the relatively small samples available for these industries as each industry among them included less than 14 recall events. In addition, results estimated using the full market and food market indexes are quite similar in the

short run. However, for some industries such as the Food Manufacturing Industry, the difference between performance of firms with a recall and average market performance increases in the long run.

Figures 2.5 through 2.13 graphically present results for each subsector, showing the CAAR outcomes of firms with recalls relative to the outcomes of the whole market and food sector index. Although each industry had a different response to the recall, most of them tended to decrease continuously in the long run.

Table 2.18 CAAR for all classes, Class I, Class II, and Class III based on food market indexes

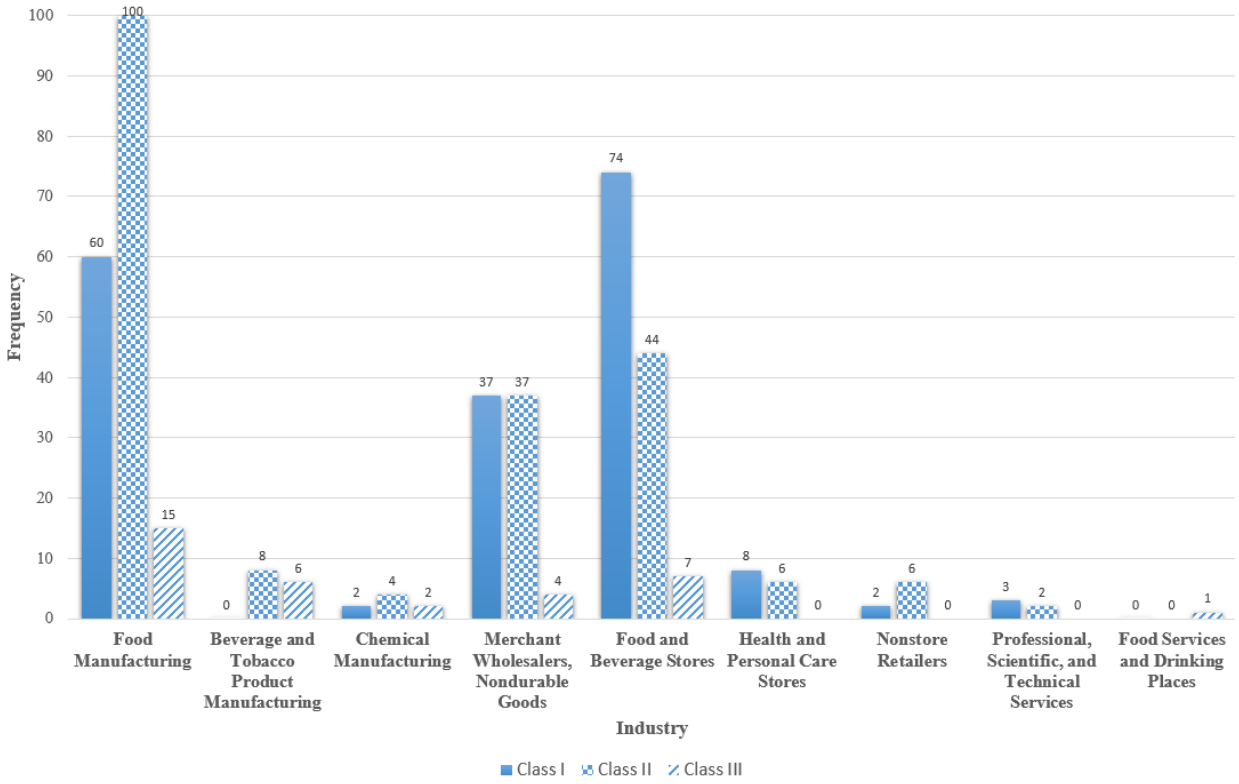
Event Windows	All Classes	Class I	Class II	Class III
(0, 1)	-0.0019	-0.0039	-0.0003	-0.0008
(0, 2)	-0.0029*	-0.0046*	-0.0014	-0.0021
(0, 3)	-0.0027	-0.0033	-0.0023	-0.0027
(0, 4)	-0.0037**	-0.0042	-0.0032	-0.0033
(0, 5)	-0.0039**	-0.0053	-0.0028	-0.0031
(0, 10)	-0.0018	-0.0007	-0.0019	-0.0075
(0, 15)	-0.0028	-0.0013	-0.0025	-0.0124
(0, 30)	-0.0007	0.0051	-0.0006	-0.0326**
(0, 45)	-0.0018	0.0074	-0.0019	-0.0493***
(0, 60)	-0.0042	-0.0008	0.0037	-0.0688***
(0, 90)	-0.0063	-0.0092	0.0065	-0.0666**
Obs. (#)	428	186	207	35

The variation in the impact of the recall among subsectors could be explained by the relative risk of illness, and thus, the class of the recall, across industry subsectors. The FDA classifies recall situations into three categories of risk from Class I to Class III dependent upon the severity of hazard on human health or defective products. As a result, Class I recalls could be expected to have immediate and negative stock market reactions compared to the other two recall categories. To consider the different impacts on various industries, a clustered bar chart is

presented in Figure 2.2. This chart illustrates the distribution of recalls by class in each of the 8 food industries for which a recall incident occurred. The Beverage and Tobacco Product Manufacturing subsector had only Class II and Class III recalls, and the CAAR results for the short run were not significant and even positive. For this reason, the CAAR results for industrial classification may be sensitive to recall classes, and therefore it may be necessary to consider the relationships between these factors.

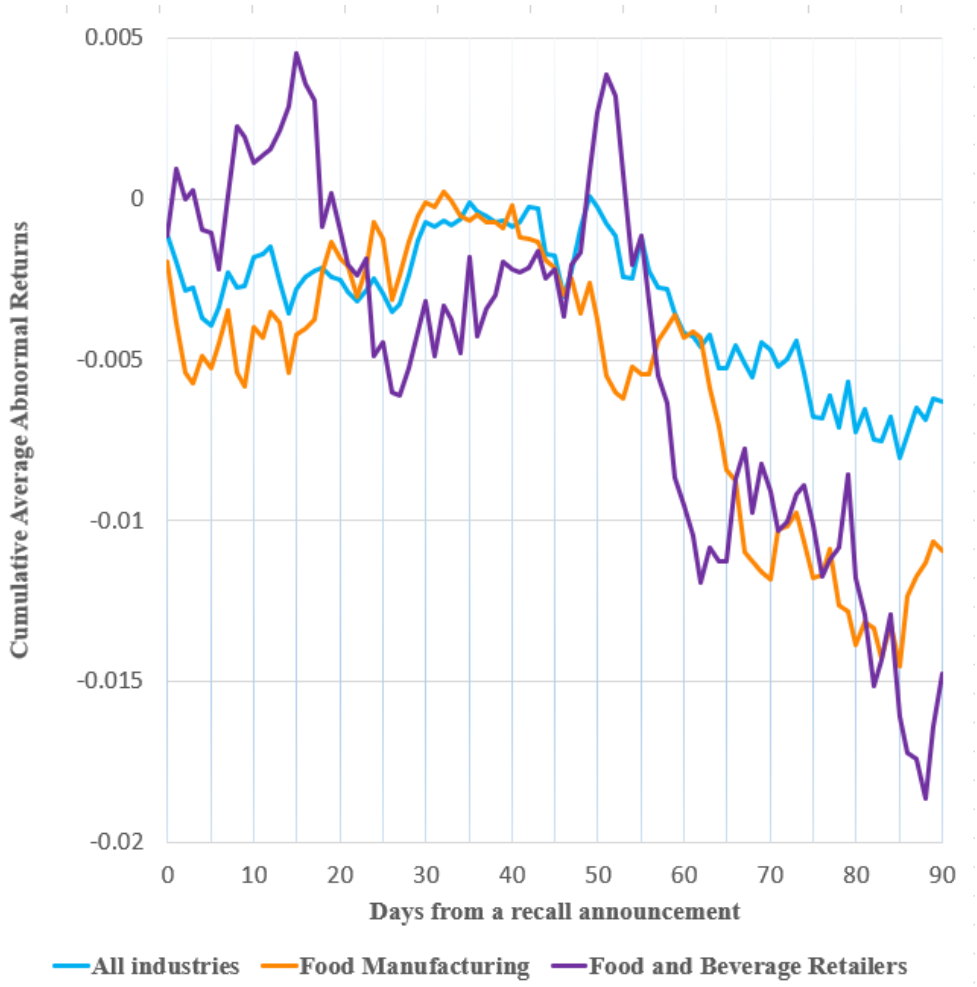
CAAR results were estimated for all recalls within each class. These results are presented in Columns 3-5 in Table 2.18 and Tables 2.29 through 2.31; the red and green lines in Figures 2.3 and Figures 2.14 through 2.16. The stock prices of firms that had products recalled under a Class I recall responded immediately and significantly to the recall announcement. Based on food market index, CAAR immediately decreased by 0.5% within five days after the recall announcement as shown in Figure 2.14. After that day, there was no longer a decline in returns, and returns gradually increased.

Stock prices of firms that experienced Class II or Class III recalls were not as sensitive to the recall announcement in the short run. In Figure 2.13, the decrease in returns started at 0.03% after a Class II recall, but it was not significant and became positive five days after the recall. It could be interpreted that Class II recalls have a relatively small impact on investors. This is because class 1 is normally treated seriously by the danger. More specifically, stock markets react negatively to Class I recalls due to the health risk involved (Pozo and Schroeder, 2016; Thomsen and McKenzie, 2001). The CAAR of Class III recalls also increased in the short-term following the recall, but at 15 and 30 days after the recall, it continually decreased to about 1.5% and 4%, respectively. It may relatively take longer than Class 1 to be perceived by investors because serious food recalls might tend to have more articles published.



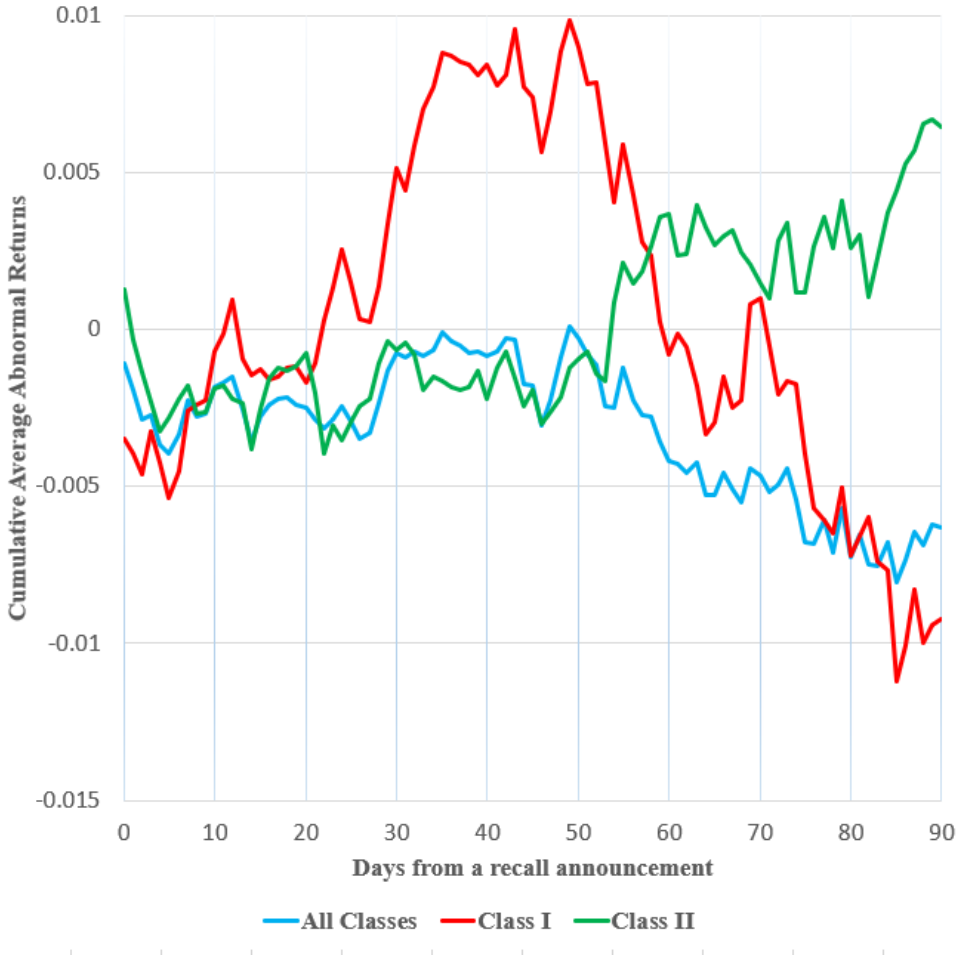
Notes: The NAICS 3-digit group names for those codes used in $x-axis$ are as follows: 311: Food Manufacturing; 312: Beverage and Tobacco Product Manufacturing; 325: Chemical Manufacturing; 424: Merchant Wholesalers, Nondurable Goods; 445: Food and Beverage Retailers; 446: Health and Personal Care Stores; 454: Nonstore Retailers; 541: Professional, Scientific, and Technical Services; 722: Food Services and Drinking Places

Figure 2.1 Distribution of nine industries by class



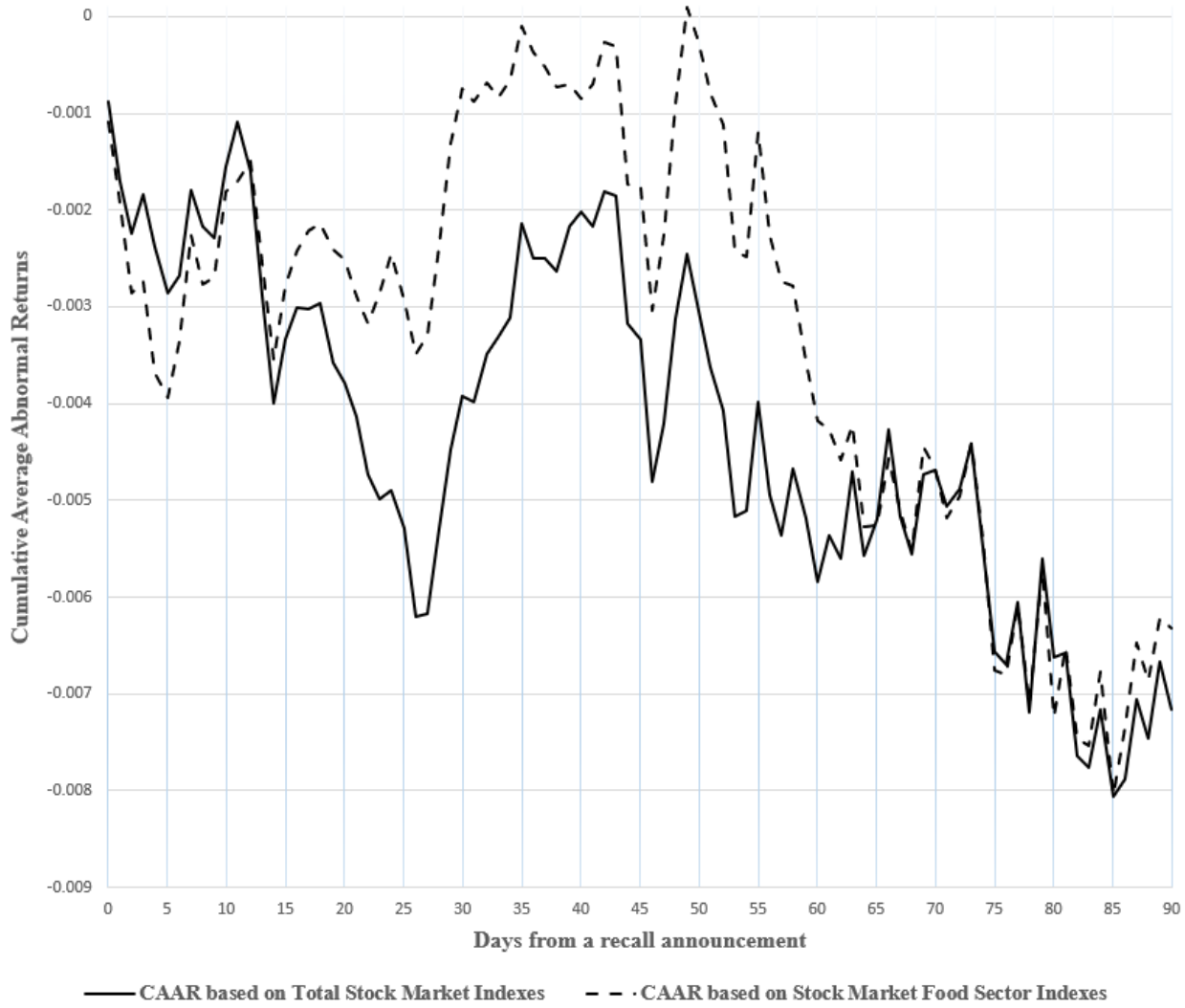
Notes: Day 0 indicates a recall announcement date by FDA. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.2 Trends of CAAR in all industries, Food Manufacturing industry, and Food and Beverage Retailers industry based on food market indexes



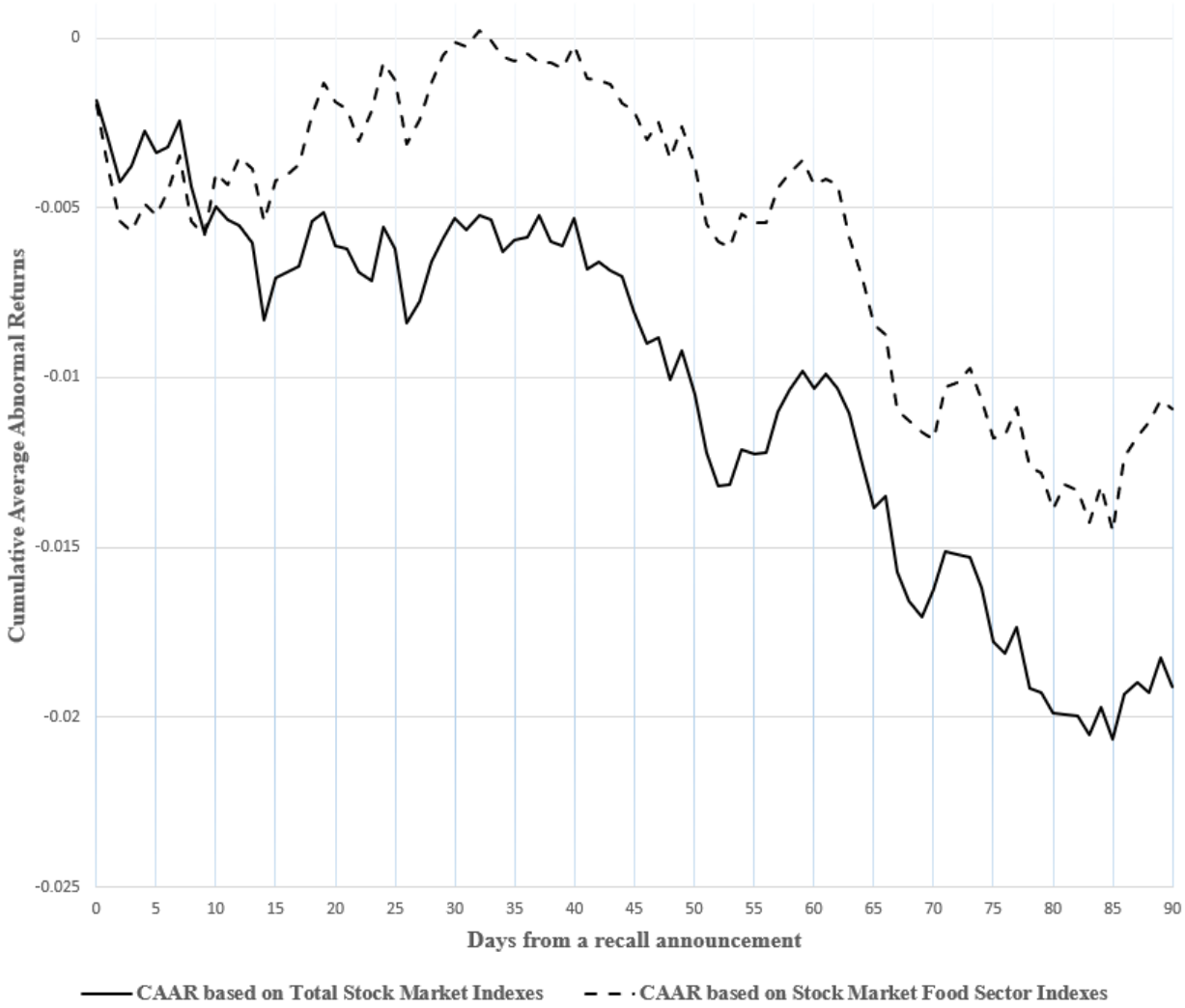
Notes: Day 0 indicates a recall announcement date by FDA. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.3 Trends of CAAR in all classes, Class I, Class II, and Class III based on food market indexes



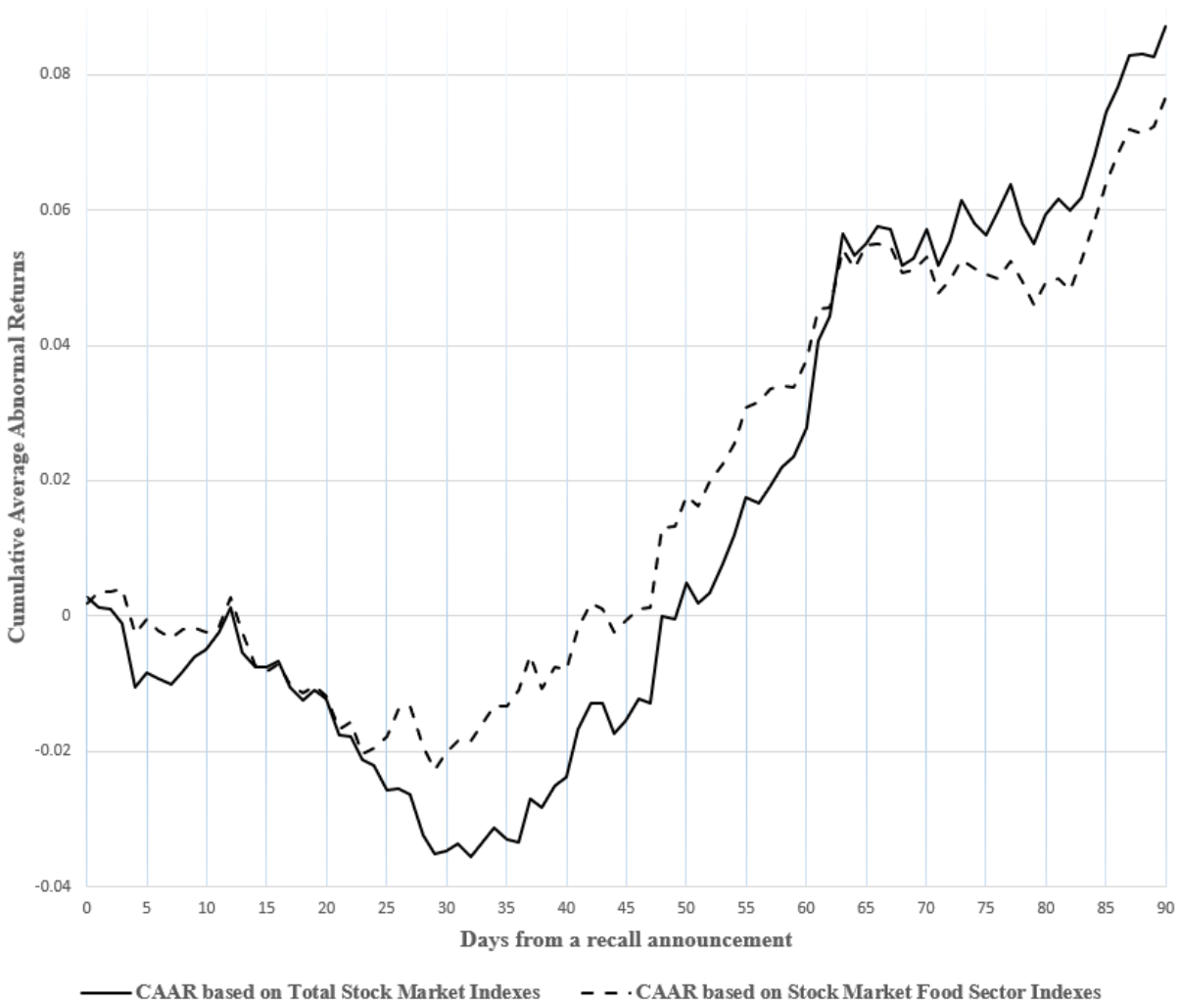
Notes: Day 0 indicates a recall announcement date by FDA. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.4 Trend of Cumulative Average Abnormal Returns for All Industries and Classes for 90 days



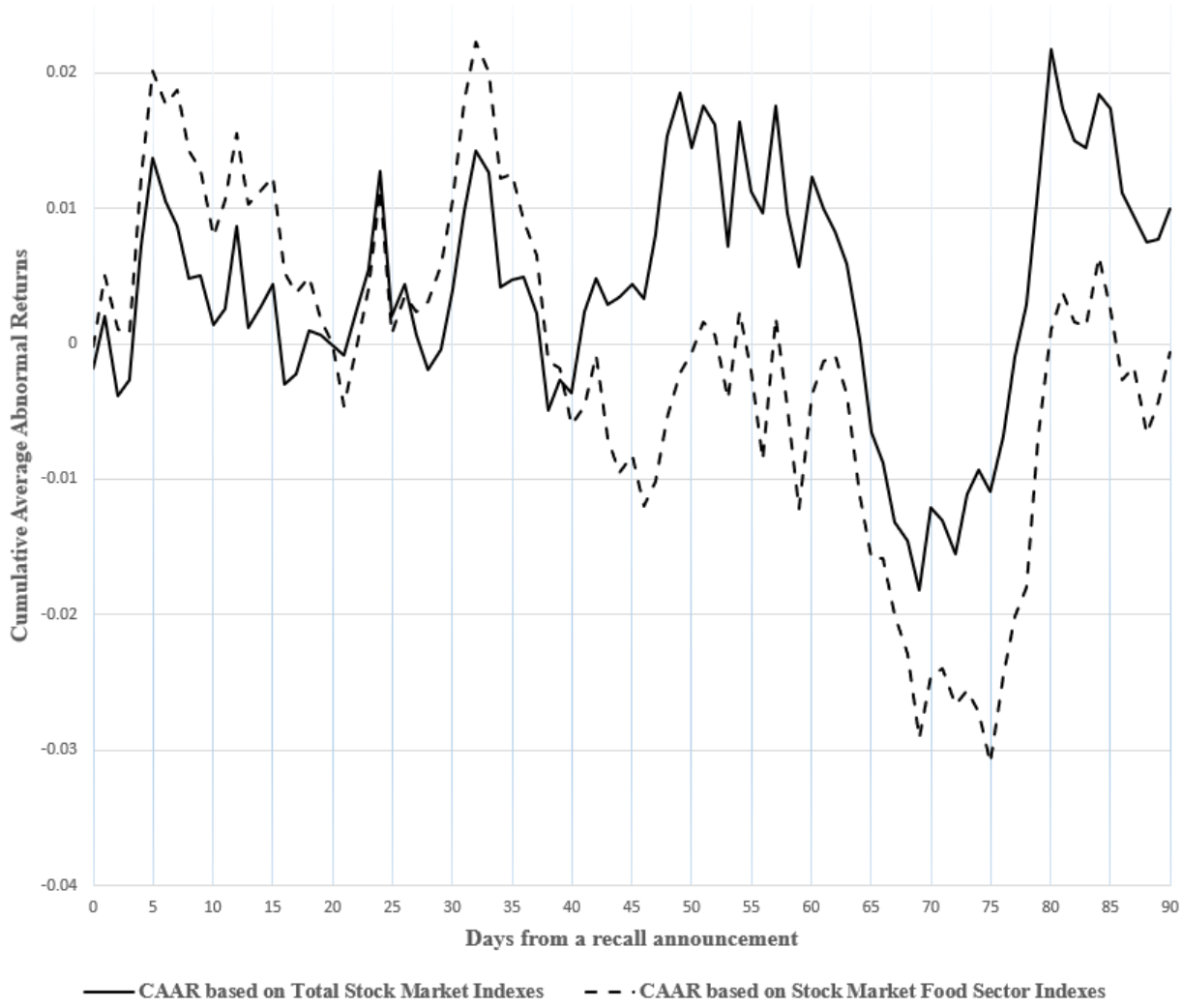
Notes: Day 0 indicates a recall announcement date by FDA. NAICS 3-digit group code is 311. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.5 Trend of Cumulative Average Abnormal Returns in the Food Manufacturing Industry for 90 days



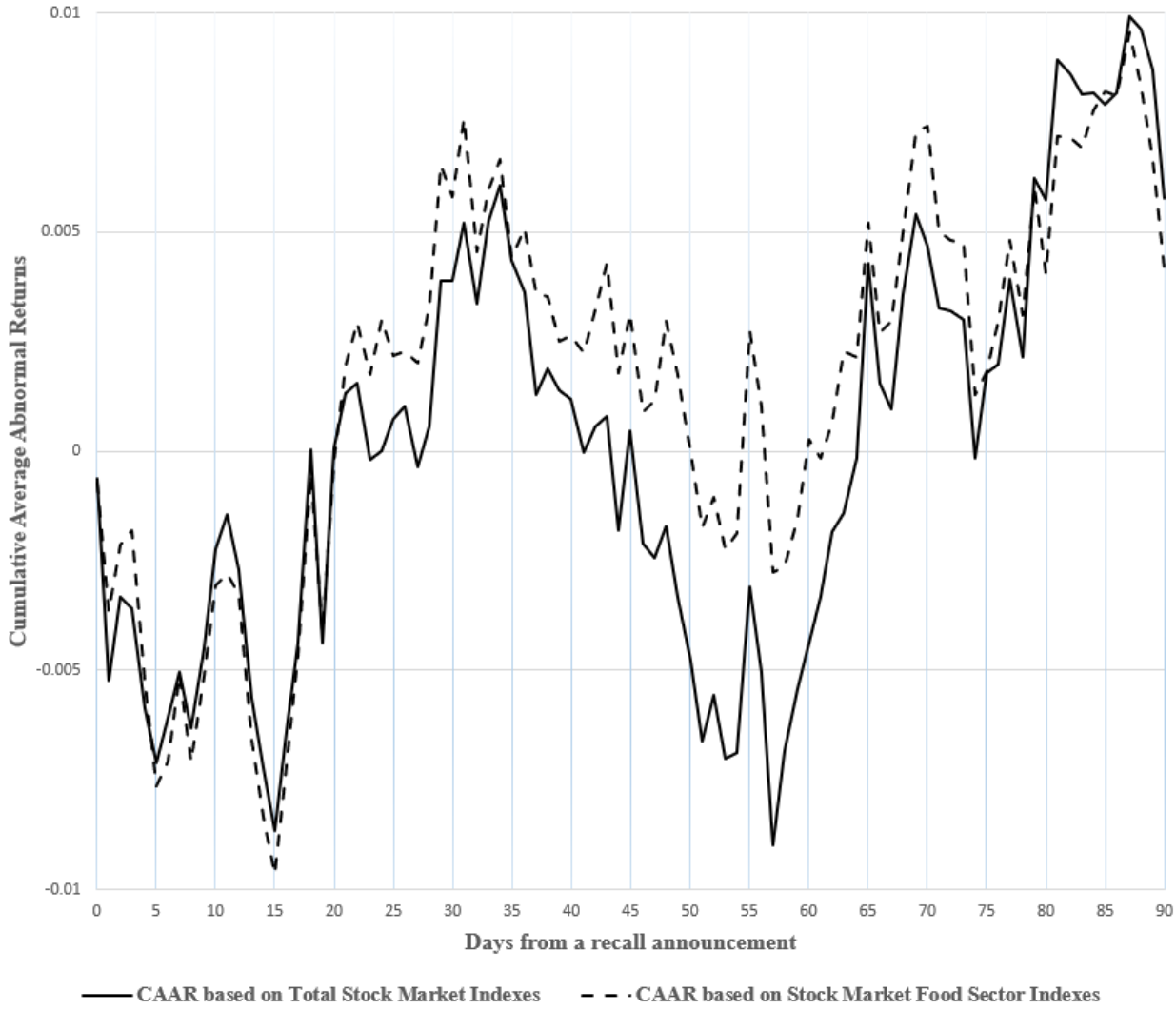
Notes: Day 0 indicates a recall announcement date by FDA. NAICS 3-digit group code is 312. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.6 Trend of Cumulative Average Abnormal Returns in the Beverage and Tobacco Product Manufacturing Industry for 90 days



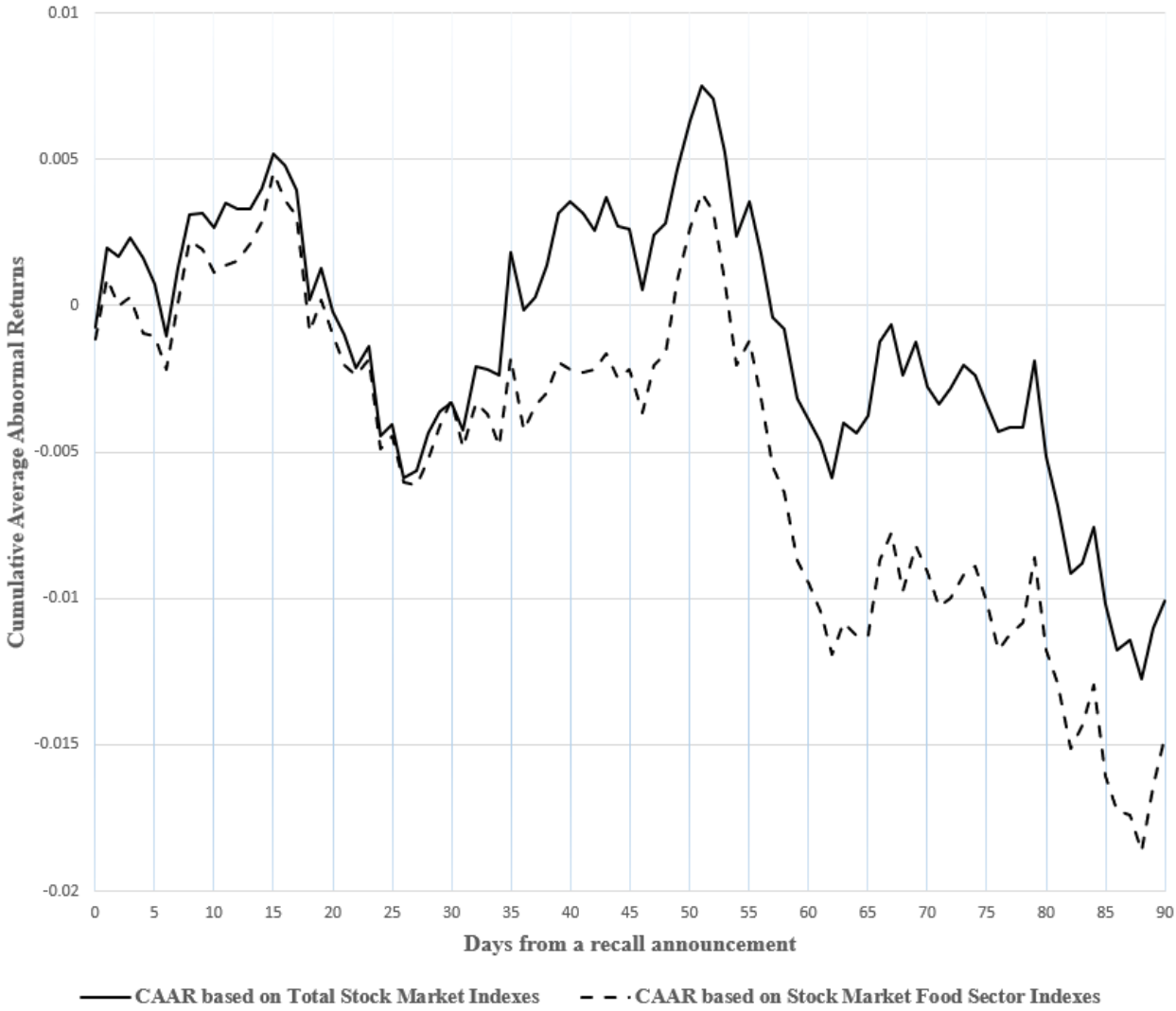
Notes: Day 0 indicates a recall announcement date by FDA. NAICS 3-digit group code is 325. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.7 Trend of Cumulative Average Abnormal Returns in the Chemical Manufacturing Industry for 90 days



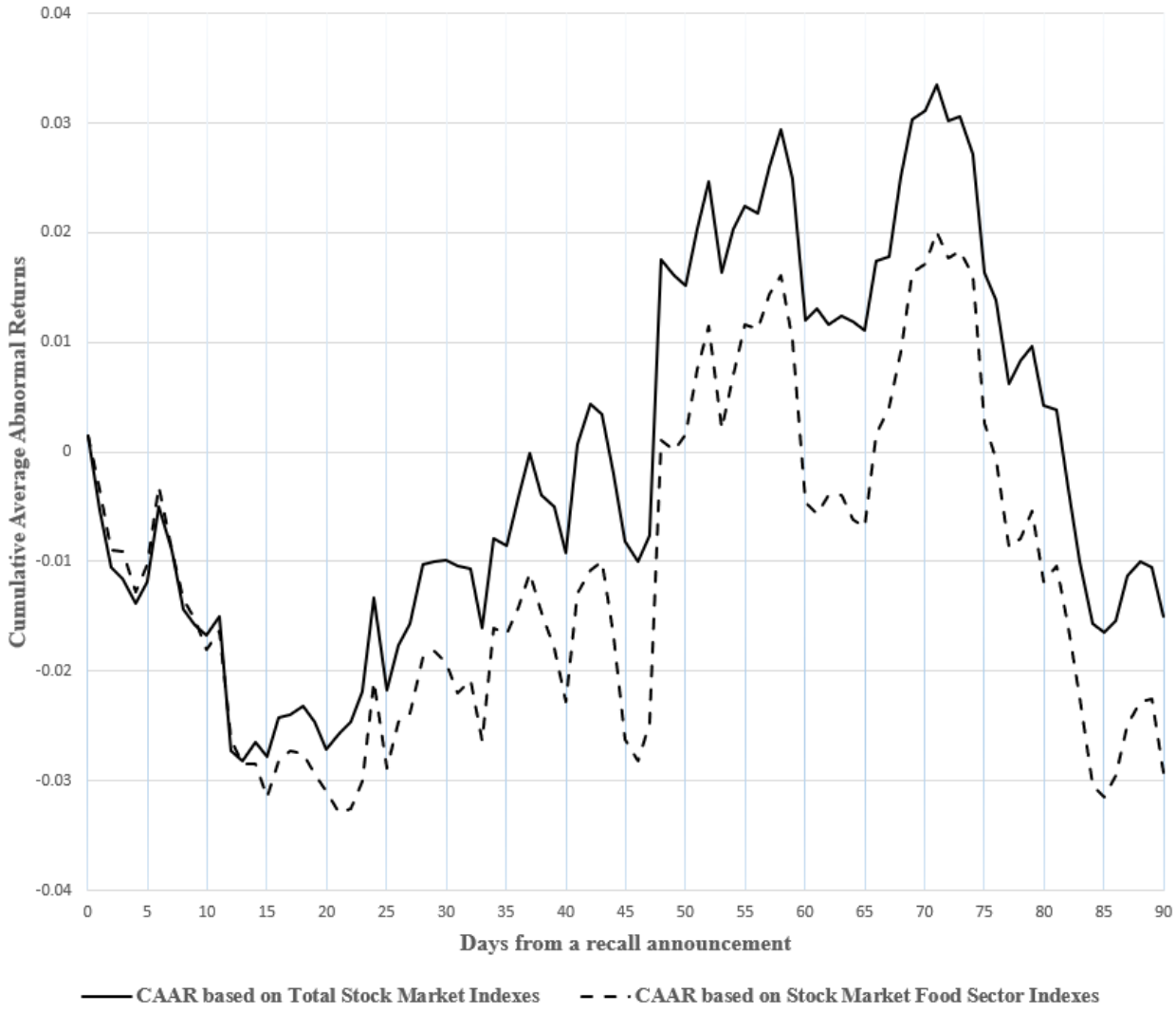
Notes: Day 0 indicates a recall announcement date by FDA. NAICS 3-digit group code is 424. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.8 Trend of Cumulative Average Abnormal Returns in the Merchant Wholesalers, Nondurable Goods Industry for 90 days



Notes: Day 0 indicates a recall announcement date by FDA. NAICS 3-digit group code is 445. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.9 Trend of Cumulative Average Abnormal Returns in the Food and Beverage Retailers Industry for 90 days

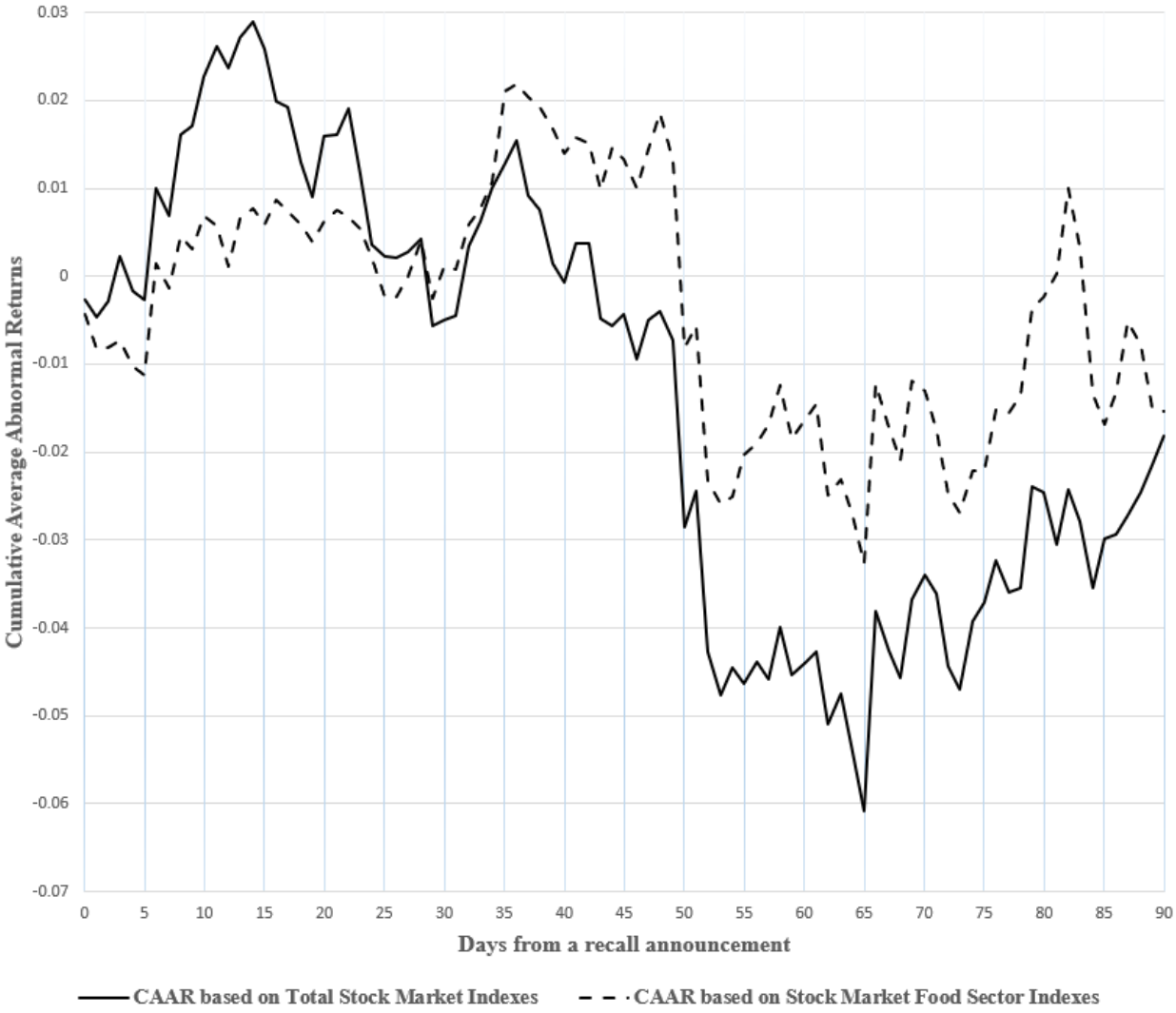


Notes: Day 0 indicates a recall announcement date by FDA. NAICS 3-digit group code is 446. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.10 Trend of Cumulative Average Abnormal Returns in the Health and Personal Care Stores Industry for 90 days

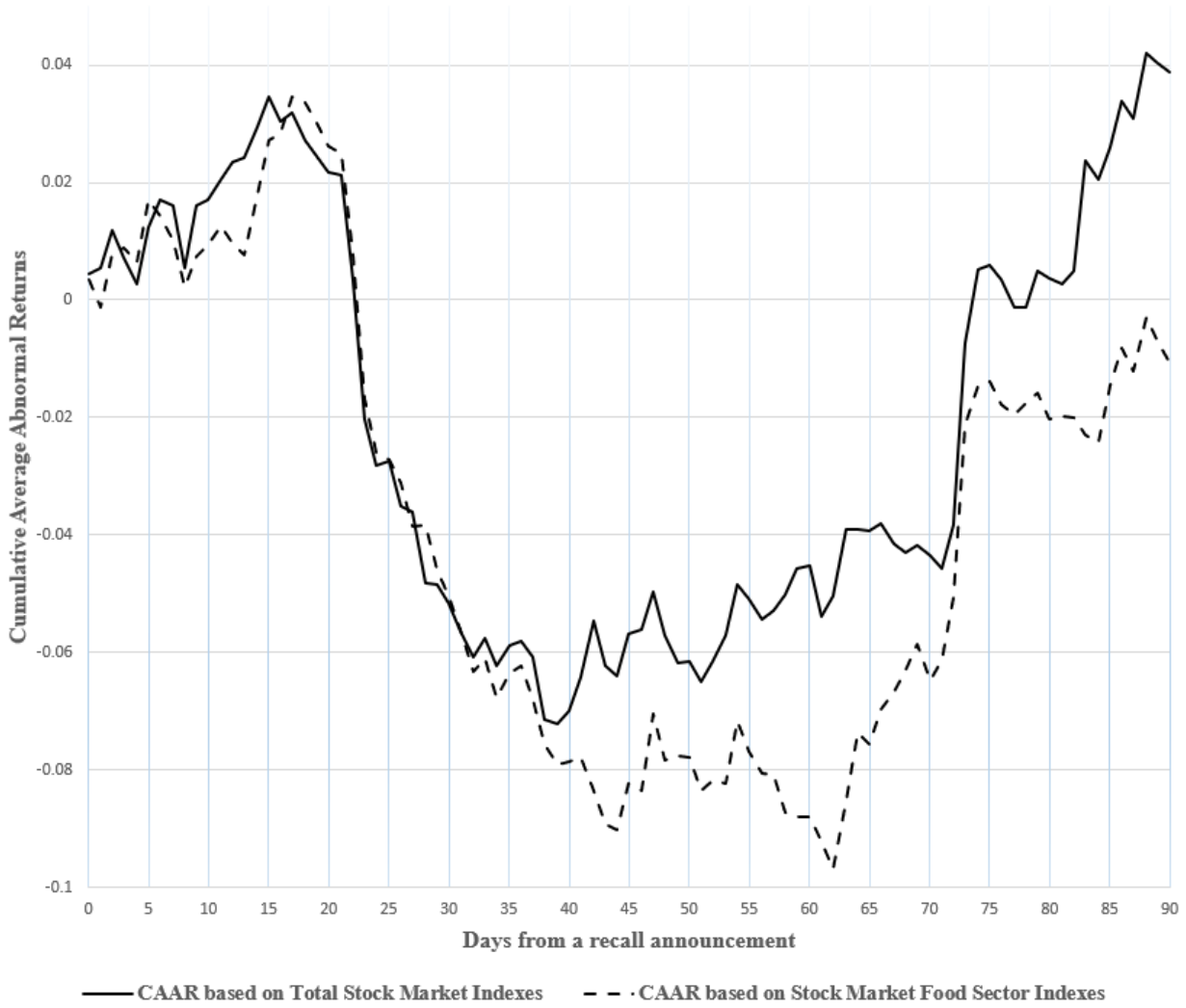
Notes: Day 0 indicates a recall announcement date by FDA. NAICS 3-digit group code is 454. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.11 Trend of Cumulative Average Abnormal Returns in the Nonstore Retailers Industry for 90 days



Notes: Day 0 indicates a recall announcement date by FDA. NAICS 3-digit group code is 541. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.12 Trend of Cumulative Average Abnormal Returns in the Professional, Scientific, and Technical Services Industry for 90 days

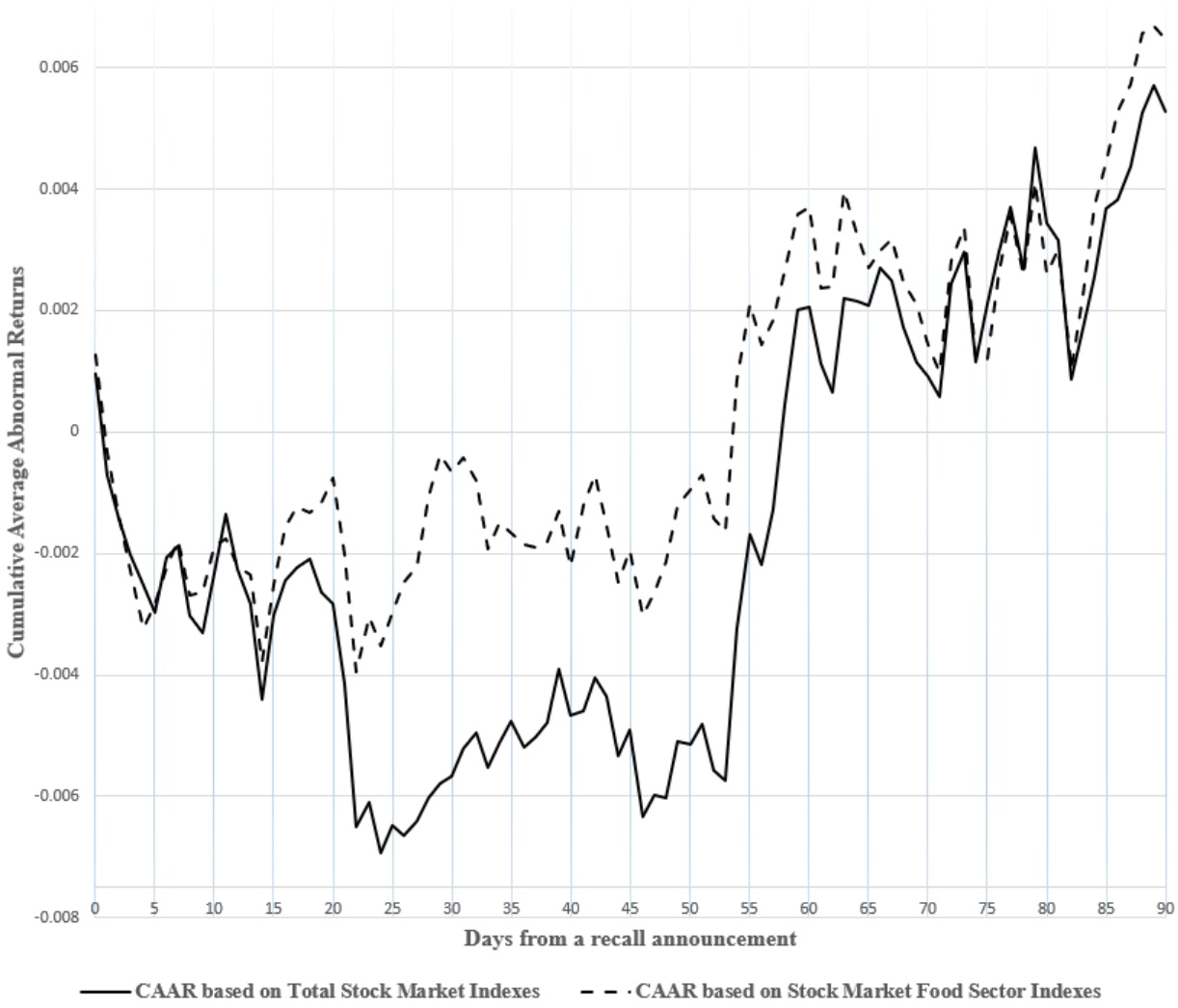


Notes: Day 0 indicates a recall announcement date by FDA. NAICS 3-digit group code is 541. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.13 Trend of Cumulative Average Abnormal Returns in the Food Services and Drinking Places Industry for 90 days

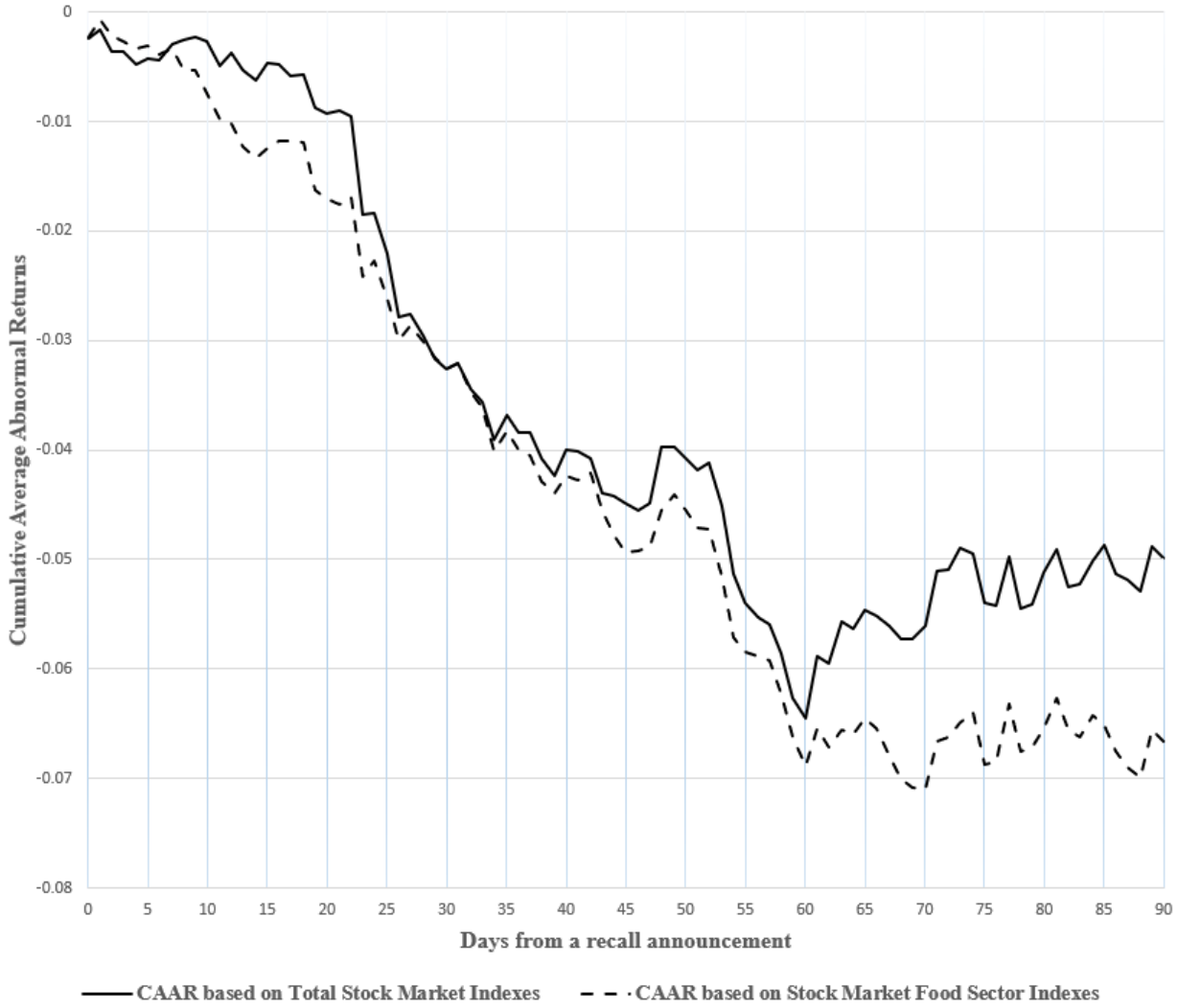
Notes: Day 0 indicates a recall announcement date by FDA. Class I is a recall for dangerous or defective products which may result in serious health problems or death. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.14 Trend of Cumulative Average Abnormal Returns for Class I food recalls for 90 days



Notes: Day 0 indicates a recall announcement date by FDA. Class II recalls are for products which may cause temporary health consequences. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.15 Trend of Cumulative Average Abnormal Returns for Class II food recalls for 90 days



Notes: Day 0 indicates a recall announcement date by FDA. Class III recall is a situation where use of products is not likely to lead to adverse health problems. Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

Figure 2.16 Trend of Cumulative Average Abnormal Returns for Class III food recalls for 90 days

Table 2.19 Cumulative Average Abnormal Returns for All Industries and Classes

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(-5, -5)	0.0011	0.0010	(1, 1)	-0.0008	-0.0008
(-5, -1)	0.0009	-0.0008	(1, 2)	-0.0014	-0.0018*
(-3, -3)	0.0002	-0.0002	(1, 3)	-0.0010	-0.0017
(-2, -2)	-0.0006	-0.0006	(1, 4)	-0.0015	-0.0026*
(-1, -1)	0.0001	-0.0006	(1, 5)	-0.0020	-0.0029*
(0, 0)	-0.0009	-0.0011	(1, 10)	-0.0007	-0.0007
(0, 1)	-0.0017	-0.0019	(1, 15)	-0.0025	-0.0017
(0, 2)	-0.0022	-0.0029*	(1, 30)	-0.0030	0.0003
(0, 3)	-0.0018	-0.0027	(1, 45)	-0.0024	-0.0007
(0, 4)	-0.0024	-0.0037**	(1, 60)	-0.0050	-0.0031
(0, 5)	-0.0029	-0.0039**	(1, 90)	-0.0063	-0.0052
(0, 10)	-0.0016	-0.0018			
(0, 15)	-0.0033	-0.0028			
(0, 30)	-0.0039	-0.0007			
(0, 45)	-0.0033	-0.0018			
(0, 60)	-0.0058	-0.0042			
(0, 90)	-0.0072	-0.0063			
# of observations	428				

Notes: (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.20 Cumulative Average Abnormal Returns in the Food Manufacturing Industry

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(0, 1)	-0.0030	-0.0038*	(1, 2)	-0.0024	-0.0035**
(0, 2)	-0.0043*	-0.0054**	(1, 3)	-0.0020	-0.0038
(0, 3)	-0.0038	-0.0057**	(1, 4)	-0.0009	-0.0029
(0, 4)	-0.0027	-0.0049*	(1, 5)	-0.0015	-0.0033
(0, 5)	-0.0034	-0.0052*	(1, 10)	-0.0031	-0.0020
(0, 10)	-0.0050	-0.0040	(1, 15)	-0.0052	-0.0023
(0, 15)	-0.0071	-0.0042	(1, 30)	-0.0035	0.0018
(0, 30)	-0.0053	-0.0001	(1, 45)	-0.0062	-0.0002
(0, 45)	-0.0081	-0.0021	(1, 60)	-0.0085	-0.0024
(0, 60)	-0.0103	-0.0043	(1, 90)	-0.0173	-0.0090
(0, 90)	-0.0191*	-0.0109			
# of observations	175				

Notes: NAICS 3-digit group code is 311. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.21 Cumulative Average Abnormal Returns in the Beverage and Tobacco Product Manufacturing Industry

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(0, 1)	0.0013	0.0035*	(1, 2)	-0.0019	0.0017
(0, 2)	0.0010	0.0036	(1, 3)	-0.0039	0.0022
(0, 3)	-0.0011	0.0040	(1, 4)	-0.0133*	-0.0045
(0, 4)	-0.0105	-0.0027	(1, 5)	-0.0112*	-0.0023
(0, 5)	-0.0083	-0.0005	(1, 10)	-0.0077	-0.0043
(0, 10)	-0.0049	-0.0025	(1, 15)	-0.0103	-0.0101
(0, 15)	-0.0074	-0.0083	(1, 30)	-0.0376***	-0.0220**
(0, 30)	-0.0348***	-0.0202**	(1, 45)	-0.0182	-0.0024
(0, 45)	-0.0154	-0.0006	(1, 60)	0.0249	0.0360
(0, 60)	0.0278	0.0378**	(1, 90)	0.0842	0.0749
(0, 90)	0.0871***	0.0767***			
# of observations	14				

Notes: NAICS 3-digit group code is 312. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.22 Cumulative Average Abnormal Returns in the Chemical Manufacturing Industry

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(0, 1)	0.0021	0.0050	(1, 2)	-0.0020	0.0014
(0, 2)	-0.0039	0.0011	(1, 3)	-0.0008	0.0010
(0, 3)	-0.0027	0.0008	(1, 4)	0.0090	0.0124
(0, 4)	0.0071	0.0122	(1, 5)	0.0156	0.0203
(0, 5)	0.0137	0.0201	(1, 10)	0.0032	0.0081
(0, 10)	0.0014	0.0079	(1, 15)	0.0063	0.0125
(0, 15)	0.0044	0.0123	(1, 30)	0.0058	0.0109
(0, 30)	0.0040	0.0106	(1, 45)	0.0062	-0.0081
(0, 45)	0.0044	-0.0083	(1, 60)	0.0141	-0.0035
(0, 60)	0.0123	-0.0037	(1, 90)	0.0118	-0.0005
(0, 90)	0.0100	-0.0007			
# of observations	8				

Notes: NAICS 3-digit group code is 325. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.23 Cumulative Average Abnormal Returns in the Merchant Wholesalers, Nondurable Goods Industry

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(0, 1)	-0.0052	-0.0037	(1, 2)	-0.0027	-0.0014
(0, 2)	-0.0033	-0.0021	(1, 3)	-0.0030	-0.0011
(0, 3)	-0.0036	-0.0018	(1, 4)	-0.0052	-0.0046
(0, 4)	-0.0059	-0.0053	(1, 5)	-0.0065	-0.0069
(0, 5)	-0.0071	-0.0076	(1, 10)	-0.0016	-0.0024
(0, 10)	-0.0022	-0.0031	(1, 15)	-0.0080	-0.0089
(0, 15)	-0.0086	-0.0097	(1, 30)	0.0045	0.0065
(0, 30)	0.0039	0.0058	(1, 45)	0.0011	0.0038
(0, 45)	0.0005	0.0031	(1, 60)	-0.0038	0.0010
(0, 60)	-0.0044	0.0003	(1, 90)	0.0064	0.0049
(0, 90)	0.0058	0.0042			
# of observations	78				

Notes: NAICS 3-digit group code is 424. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.24 Cumulative Average Abnormal Returns in the Food and Beverage Retailers Industry

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(0, 1)	0.0020	0.0009	(1, 2)	0.0024	0.0011
(0, 2)	0.0017	0.0000	(1, 3)	0.0031	0.0014
(0, 3)	0.0023	0.0003	(1, 4)	0.0024	0.0002
(0, 4)	0.0016	-0.0010	(1, 5)	0.0015	0.0001
(0, 5)	0.0007	-0.0010	(1, 10)	0.0034	0.0022
(0, 10)	0.0027	0.0011	(1, 15)	0.0059	0.0056
(0, 15)	0.0052	0.0045	(1, 30)	-0.0026	-0.0021
(0, 30)	-0.0033	-0.0032	(1, 45)	0.0034	-0.0011
(0, 45)	0.0026	-0.0022	(1, 60)	-0.0032	-0.0084
(0, 60)	-0.0039	-0.0095	(1, 90)	-0.0094	-0.0136
(0, 90)	-0.0101	-0.0147			
# of observations	125				

Notes: NAICS 3-digit group code is 445. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.25 Cumulative Average Abnormal Returns in the Health and Personal Care Stores Industry

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(0, 1)	-0.0052	-0.0035	(1, 2)	-0.0120**	-0.0105**
(0, 2)	-0.0105	-0.0089	(1, 3)	-0.0130*	-0.0106*
(0, 3)	-0.0115	-0.0090	(1, 4)	-0.0153	-0.0143
(0, 4)	-0.0138	-0.0128	(1, 5)	-0.0134	-0.0118
(0, 5)	-0.0119	-0.0103	(1, 10)	-0.0182	-0.0196
(0, 10)	-0.0167	-0.0181	(1, 15)	-0.0293	-0.0331*
(0, 15)	-0.0278	-0.0315	(1, 30)	-0.0114	-0.0207
(0, 30)	-0.0099	-0.0192	(1, 45)	-0.0097	-0.0277
(0, 45)	-0.0082	-0.0262	(1, 60)	0.0105	-0.0062
(0, 60)	0.0120	-0.0046	(1, 90)	-0.0165	-0.0308
(0, 90)	-0.0150	-0.0293			
# of observations	14				

Notes: NAICS 3-digit group code is 446. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.26 Cumulative Average Abnormal Returns in the Nonstore Retailers Industry

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(0, 1)	0.0015	0.0020	(1, 2)	-0.0057	-0.0069
(0, 2)	-0.0004	-0.0011	(1, 3)	0.0003	-0.0025
(0, 3)	0.0056	0.0033	(1, 4)	-0.0052	-0.0094
(0, 4)	0.0001	-0.0036	(1, 5)	-0.0047	-0.0076
(0, 5)	0.0006	-0.0018	(1, 10)	0.0202	0.0188
(0, 10)	0.0256*	0.0246*	(1, 15)	0.0111	0.0108
(0, 15)	0.0164	0.0166	(1, 30)	-0.0011	0.0139
(0, 30)	0.0042	0.0197	(1, 45)	-0.0061	0.0075
(0, 45)	-0.0007	0.0133	(1, 60)	-0.0371	-0.0221
(0, 60)	-0.0318	-0.0163	(1, 90)	0.0007	0.0133
(0, 90)	0.0060	0.0191			
# of observations	8				

Notes: NAICS 3-digit group code is 454. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.27 Cumulative Average Abnormal Returns in the Professional, Scientific, and Technical Services Industry

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(0, 1)	-0.0047	-0.0083**	(1, 2)	-0.0002	-0.0038
(0, 2)	-0.0029	-0.0081	(1, 3)	0.0049	-0.0030
(0, 3)	0.0022	-0.0073	(1, 4)	0.0010	-0.0059
(0, 4)	-0.0017	-0.0102	(1, 5)	0.0000	-0.0069
(0, 5)	-0.0027	-0.0112	(1, 10)	0.0254	0.0113
(0, 10)	0.0227	0.0070	(1, 15)	0.0285	0.0102
(0, 15)	0.0258	0.0059	(1, 30)	-0.0023	0.0055
(0, 30)	-0.0050	0.0012	(1, 45)	-0.0017	0.0176
(0, 45)	-0.0044	0.0133	(1, 60)	-0.0414	-0.0121
(0, 60)	-0.0441	-0.0164	(1, 90)	-0.0155	-0.0110
(0, 90)	-0.0182	-0.0153			
# of observations	5				

Notes: NAICS 3-digit group code is 541. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.28 Cumulative Average Abnormal Returns in the Food Services and Drinking Places Industry

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(0, 1)	0.0054	-0.0014	(1, 2)	0.0074	0.0043
(0, 2)	0.0120	0.0078	(1, 3)	0.0025	0.0053
(0, 3)	0.0071	0.0089	(1, 4)	-0.0019	0.0029
(0, 4)	0.0026	0.0065	(1, 5)	0.0079	0.0135
(0, 5)	0.0124	0.0171	(1, 10)	0.0126	0.0057
(0, 10)	0.0172	0.0093	(1, 15)	0.0300	0.0237
(0, 15)	0.0346	0.0272	(1, 30)	-0.0561	-0.0539
(0, 30)	-0.0516	-0.0504	(1, 45)	-0.0614	-0.0860
(0, 45)	-0.0569	-0.0824	(1, 60)	-0.0499	-0.0916
(0, 60)	-0.0453	-0.0881	(1, 90)	0.0343	-0.0142
(0, 90)	0.0389	-0.0106			
# of observations	1				

Notes: NAICS 3-digit group code is 722. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level

Table 2.29 Cumulative Average Abnormal Returns for Class I food recalls

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(-5, -5)	0.0016	0.0016	(1, 1)	-0.0002	-0.0004
(-5, -1)	0.0030	0.0009	(1, 2)	-0.0002	-0.0011
(-3, -3)	-0.0007	-0.0009	(1, 3)	0.0013	0.0002
(-2, -2)	-0.0003	-0.0004	(1, 4)	0.0009	-0.0008
(-1, -1)	0.0002	-0.0005	(1, 5)	0.0002	-0.0019
(0, 0)	-0.0027*	-0.0035*	(1, 10)	0.0022	0.0028
(0, 1)	-0.0028	-0.0039	(1, 15)	−0.0008	0.0022
(0, 2)	-0.0029	-0.0046*	(1, 30)	0.0060	0.0086
(0, 3)	-0.0013	-0.0033	(1, 45)	0.0089	0.0109
(0, 4)	-0.0018	-0.0042	(1, 60)	-0.0009	0.0027
(0, 5)	-0.0025	-0.0053	(1, 90)	-0.0103	-0.0057
(0, 10)	-0.0005	-0.0007			
(0, 15)	-0.0034	-0.0013			
(0, 30)	0.0034	0.0051			
(0, 45)	0.0062	0.0074			
(0, 60)	-0.0036	-0.0008			
(0, 90)	-0.0130	-0.0092			
# of observations	186				

Notes: Class I is a recall for dangerous or defective products which may result in serious health problems or death. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.30 Cumulative Average Abnormal Returns for Class II food recalls

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(-5, -5)	0.0008	0.0006	(1, 1)	-0.0017*	-0.0016*
(-5, -1)	-0.0008	-0.0024	(1, 2)	-0.0024*	-0.0027**
(-3, -3)	0.0004	-0.0001	(1, 3)	-0.0030	-0.0036*
(-2, -2)	-0.0009	-0.0010	(1, 4)	-0.0035*	-0.0045**
(-1, -1)	0.0007	0.0000	(1, 5)	-0.0039*	-0.0041*
(0, 0)	0.0010	0.0013	(1, 10)	-0.0033	-0.0031
(0, 1)	-0.0007	-0.0003	(1, 15)	−0.0040	-0.0038
(0, 2)	-0.0014	-0.0014	(1, 30)	-0.0066	-0.0019
(0, 3)	-0.0020	-0.0023	(1, 45)	-0.0059	-0.0032
(0, 4)	-0.0025	-0.0032	(1, 60)	0.0011	0.0024
(0, 5)	-0.0030	-0.0028	(1, 90)	0.0043	0.0052
(0, 10)	-0.0023	-0.0019			
(0, 15)	-0.0030	-0.0025			
(0, 30)	-0.0057	-0.0006			
(0, 45)	-0.0049	-0.0019			
(0, 60)	0.0021	0.0037			
(0, 90)	0.0053	0.0065			
# of observations	207				

Notes: Class II recalls are for products which may cause temporary health consequences. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 2.31 Cumulative Average Abnormal Returns for Class III food recalls

Event Windows	Based on Total Market Index	Based on Food Market Index	Event Windows	Based on Total Market Index	Based on Food Market Index
(0, 1)	-0.0017	-0.0008	(1, 2)	-0.0013	0.0001
(0, 2)	-0.0036	-0.0021	(1, 3)	-0.0012	-0.0004
(0, 3)	-0.0036	-0.0027	(1, 4)	-0.0025	-0.0011
(0, 4)	-0.0048	-0.0033	(1, 5)	-0.0019	-0.0008
(0, 5)	-0.0043	-0.0031	(1, 10)	-0.0003	-0.0052
(0, 10)	-0.0026	-0.0075	(1, 15)	-0.0023	-0.0101
(0, 15)	-0.0047	-0.0124	(1, 30)	-0.0302**	-0.0303**
(0, 30)	-0.0326**	-0.0326**	(1, 45)	-0.0425**	-0.0470**
(0, 45)	-0.0449**	-0.0493***	(1, 60)	-0.0621***	-0.0666***
(0, 60)	-0.0645***	-0.0688***	(1, 90)	-0.0475*	-0.0643**
(0, 90)	-0.0499*	-0.0666**			
# of observations	35				

Notes: Class III recall is a situation where use of products is not likely to lead to adverse health problems. (τ_1, τ_2) refers to the event window, which starts from τ_1 and ends at τ_2. "Based on Total Market Index" means that the total market index of each country is used when predicted values are calculated by market model, and "Based on Food Market Index" indicates that the food market indexes are used for the market model.

Total stock market indexes consist of stock market composite indexes of 18 countries, and stock market food sector indexes are composed of food market indexes of those countries except Hong Kong, Italy, Mexico, Netherlands, Sweden, China, and Spain because data are not available. FTSE ASX Food Producers Index for U.K. is applied to Ireland food sector.

*, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

2.5.2. Cross-sectional analysis results

Based on cross-sectional equation [2-9], the dependent variable is cumulative abnormal returns (CAR) ranging from one to five days to 90 days. All models are estimated exploiting ordinary least squares, and all independent variables remain unchanged over each model. The coefficient of Class I in Table 2.32 is negative in every column (1)-(4) during a short and long period of time. Therefore, Class I recalls consistently affected stock returns.

Foodborne pathogen such as *Salmonella* or *Listeria monocytogenes* slightly influenced short-run cumulative abnormal returns. It is noted that recall reasons consist of several categories such as foodborne pathogen, labeling, manufacturing or holding, contamination, and packaging. That is, other recall reasons are likely to be main factors that could negatively influence CAR in the long run instead of the foodborne pathogen. Also, it depends on the type of classes: Class I, Class II, and Class III. More specifically, Class I recalls are more affected by the foodborne pathogen in Table 2.33, whereas Class II recalls are negatively associated with contamination in Table 2.34.

Recall experience which refers to the number of previous recalls during the last 12 months shows a positive coefficient. It could be interpreted that investors may tend to be less sensitive to stocks because they may have already recognized previous recall events. In cases that recall companies have a foreign parent company and internationally sell their products, these firms experience lesser impacts after recall events. In other words, companies with a U.S. parent company or firms distributing only in the U.S. are negatively influenced by food recalls compared to the ones with an international parent company. Domestically, the more commodities distributed in more states, the worse the stock returns considering the state's population for the short run. Next, food recalls in the food manufacturing industry had a negative effect on cumulative abnormal

returns. Lastly, companies that made larger sales revenue positively affect stock returns.

Table 2.33 through Table 2.35 show results of regression for Class I, Class II, and Class III food recalls. Most of them produced similar results, but the foodborne pathogen in Class I had a strong negative impact on cumulative abnormal returns for (0,1), (0,5), and (0,15) event windows in Table 2.33. However, Class II recalls tend to be negatively affected by contamination instead of the foodborne pathogen in Table 2.34.

Table 2.32 - Table 2.35 and Table 2.36 - Table 2.39 present similar models except for media attention. Information on the number of news article about a recall is collected using Google and LexisNexis. Overall, news articles regarding food recall had not a negative impact on CAR. However, they negatively influenced CAR for Class II and Class III, but most of them were not significant. Lastly, Table 2.40 shows consistent results when we use total assets as a control variable instead of sales revenue.

Table 2.32 CAR (Cumulative Abnormal Returns) Regression Results for All Industries and Classes

VARIABLES	(1) CAR(0,1)	(2) CAR(0,5)	(3) CAR(0,15)	(4) CAR(0,90)
Class of Recall - Class I	-0.022***	-0.023***	-0.029***	-0.075***
	(0.002)	(0.003)	(0.005)	(0.009)
Industry - Food Manufacturing	-0.031***	-0.008***	-0.004	-0.050***
	(0.002)	(0.002)	(0.004)	(0.008)
Recall Reason - Foodborne Pathogen	-0.009***	0.010***	0.006	0.074***
	(0.002)	(0.003)	(0.005)	(0.010)
Recall Reason - Contamination	-0.007**	-0.002	-0.007	0.069***
	(0.003)	(0.004)	(0.006)	(0.013)
PType - Fruit and Vegetables	-0.027***	-0.008**	-0.014**	-0.043***
	(0.003)	(0.004)	(0.006)	(0.012)
SType - Frozen	-0.022***	-0.018***	-0.025***	-0.053***
	(0.002)	(0.003)	(0.005)	(0.009)
Recall Experience (< 1 year)	0.001***	0.003***	0.002***	-0.002
	(0.000)	(0.000)	(0.001)	(0.001)
Distribution of Recalled Product	-0.001	0.001	-0.002*	-0.017***
	(0.001)	(0.001)	(0.001)	(0.003)
International Distribution	0.032***	0.038***	0.033***	0.110***
	(0.003)	(0.003)	(0.005)	(0.011)
Sales	0.005***	0.006***	0.013***	0.020***
	(0.001)	(0.001)	(0.001)	(0.002)
Momentum	0.000***	0.000	0.000***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Subsidiary	0.028***	-0.005*	-0.012***	-0.043***
	(0.002)	(0.003)	(0.004)	(0.008)
Media Attention: Google Search Counts(0,1)	0.000***			
	(0.000)			
Media Attention: Google Search Counts(0,5)		0.000***		
		(0.000)		
Media Attention: Google Search Counts(0,15)			0.001***	
			(0.000)	
Media Attention: Google Search Counts(0,90)				0.000
				(0.000)
Constant	-0.020	-0.050***	-0.047	0.202***
	(0.015)	(0.018)	(0.029)	(0.058)
Observations	1,952	1,952	1,952	1,952
R-squared	0.537	0.319	0.248	0.430
Year Fixed Effects	YES	YES	YES	YES

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively. Dependent variables are CAR (Cumulative Abnormal Returns) based on food market indexes.

Table 2.33 CAR (Cumulative Abnormal Returns) Results for Class I Recalls

VARIABLES	(1) CAR(0,1)	(2) CAR(0,5)	(3) CAR(0,15)	(4) CAR(0,90)
Industry - Food Manufacturing	-0.036***	-0.007*	-0.001	-0.075***
	(0.004)	(0.004)	(0.008)	(0.014)
Recall Reason - Foodborne Pathogen	-0.031***	-0.022***	-0.035***	0.035**
	(0.004)	(0.004)	(0.009)	(0.016)
Recall Reason - Contamination	0.024	0.016	0.061	0.192**
	(0.023)	(0.024)	(0.049)	(0.084)
PType - Fruit and Vegetables	-0.004	0.016***	0.023**	-0.077***
	(0.005)	(0.005)	(0.011)	(0.019)
SType - Frozen	-0.074***	-0.046***	-0.106***	-0.046**
	(0.006)	(0.006)	(0.013)	(0.022)
Recall Experience (< 1 year)	0.001	-0.000	-0.000	-0.003
	(0.001)	(0.001)	(0.001)	(0.002)
Distribution of Recalled Product	-0.006***	-0.005***	-0.004	-0.005
	(0.001)	(0.001)	(0.003)	(0.004)
International Distribution	0.033***	0.038***	0.016*	0.072***
	(0.005)	(0.005)	(0.010)	(0.017)
Sales	0.010***	0.010***	0.018***	-0.002
	(0.001)	(0.001)	(0.002)	(0.004)
Momentum	0.001***	0.000***	0.000	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Subsidiary	0.010**	-0.024***	-0.043***	0.039**
	(0.004)	(0.004)	(0.009)	(0.015)
Media Attention: Google Search Counts(0,1)	0.004***			
	(0.001)			
Media Attention: Google Search Counts(0,5)		0.003***		
		(0.000)		
Media Attention: Google Search Counts(0,15)			0.003***	
			(0.001)	
Media Attention: Google Search Counts(0,90)				-0.002**
				(0.001)
Constant	0.043*	0.010	-0.037	0.126
	(0.025)	(0.026)	(0.054)	(0.092)
Observations	731	731	731	731
R-squared	0.763	0.535	0.416	0.459
Year Fixed Effects	YES	YES	YES	YES

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively. Dependent variables are CAR (Cumulative Abnormal Returns) based on food market indexes.

Table 2.34 CAR (Cumulative Abnormal Returns) Results for for Class II Recalls

VARIABLES	(1) CAR(0,1)	(2) CAR(0,5)	(3) CAR(0,15)	(4) CAR(0,90)
Industry - Food Manufacturing	-0.017***	0.007**	0.013***	-0.001
	(0.002)	(0.003)	(0.005)	(0.010)
Recall Reason - Foodborne Pathogen	-0.001	0.020***	0.024***	0.111***
	(0.002)	(0.003)	(0.005)	(0.011)
Recall Reason - Contamination	-0.011***	-0.007*	-0.011*	0.083***
	(0.002)	(0.004)	(0.006)	(0.012)
PType - Fruit and Vegetables	-0.003	-0.013***	-0.013*	-0.010
	(0.003)	(0.005)	(0.007)	(0.015)
SType - Frozen	-0.003*	0.005	0.009**	-0.024**
	(0.002)	(0.003)	(0.005)	(0.010)
Recall Experience (< 1 year)	-0.001***	0.002***	0.001	-0.004***
	(0.000)	(0.000)	(0.001)	(0.001)
Distribution of Recalled Product	0.005***	0.001	-0.001	-0.012***
	(0.001)	(0.001)	(0.002)	(0.003)
International Distribution	0.004	0.017***	0.022***	0.055***
	(0.002)	(0.005)	(0.007)	(0.014)
Sales	-0.000	-0.000	0.006***	0.025***
	(0.001)	(0.001)	(0.001)	(0.003)
Momentum	-0.000***	-0.000**	-0.000	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Subsidiary	0.008***	-0.015***	-0.028***	-0.082***
	(0.002)	(0.003)	(0.005)	(0.011)
Media Attention: Google Search Counts(0,1)	-0.000			
	(0.000)			
Media Attention: Google Search Counts(0,5)		-0.000		
		(0.000)		
Media Attention: Google Search Counts(0,15)			0.000	
			(0.000)	
Media Attention: Google Search Counts(0,90)				0.000
				(0.000)
Constant	-0.089***	0.007	-0.024	0.109
	(0.013)	(0.025)	(0.036)	(0.079)
Observations	1,176	1,176	1,176	1,176
R-squared	0.350	0.444	0.288	0.593
Year Fixed Effects	YES	YES	YES	YES

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively. Dependent variables are CAR (Cumulative Abnormal Returns) based on food market indexes.

Table 2.35 CAR (Cumulative Abnormal Returns) Results for for Class III Recalls

VARIABLES	(1) CAR(0,1)	(2) CAR(0,5)	(3) CAR(0,15)	(4) CAR(0,90)
Industry - Food Manufacturing	0.009	0.036***	0.043*	0.002
	(0.007)	(0.013)	(0.024)	(0.116)
Recall Reason - Foodborne Pathogen	-0.036**	-0.033	-0.051	-0.432
	(0.017)	(0.031)	(0.058)	(0.281)
Recall Reason - Contamination	-0.003	0.006	-0.007	-0.201*
	(0.006)	(0.011)	(0.022)	(0.105)
PType - Fruit and Vegetables	-0.028	-0.104***	0.068	0.166
	(0.020)	(0.036)	(0.069)	(0.332)
Recall Experience (< 1 year)	-0.001	0.002	0.001	0.030
	(0.002)	(0.004)	(0.008)	(0.038)
Distribution of Recalled Product	0.005	0.014***	0.004	0.053
	(0.003)	(0.005)	(0.009)	(0.043)
International Distribution	-0.025	0.034	0.067	0.528
	(0.026)	(0.050)	(0.090)	(0.433)
Sales	-0.002	0.006	0.008	0.023
	(0.002)	(0.004)	(0.008)	(0.038)
Momentum	-0.000	-0.000	-0.000	-0.004
	(0.000)	(0.000)	(0.001)	(0.003)
Subsidiary	-0.003	-0.012	0.005	0.228*
	(0.008)	(0.014)	(0.026)	(0.127)
Media Attention: Google Search Counts(0,1)	-0.002			
	(0.001)			
Media Attention: Google Search Counts(0,5)		-0.001		
		(0.001)		
Media Attention: Google Search Counts(0,15)			-0.001	
			(0.001)	
Media Attention: Google Search Counts(0,90)				0.001
				(0.006)
Constant	-0.052	-0.318***	-0.165	-1.297
	(0.053)	(0.096)	(0.174)	(0.830)
Observations	45	45	45	45
R-squared	0.618	0.538	0.228	0.287
Year Fixed Effects	YES	YES	YES	YES

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively. Dependent variables are CAR (Cumulative Abnormal Returns) based on food market indexes.

Table 2.36 CAR (Cumulative Abnormal Returns) Regression Results for All Industries and Classes (LexisNexis)

VARIABLES	(1) CAR(0,1)	(2) CAR(0,5)	(3) CAR(0,15)	(4) CAR(0,90)
Class of Recall - Class I	-0.022***	-0.023***	-0.028***	-0.075***
	(0.002)	(0.003)	(0.005)	(0.009)
Industry - Food Manufacturing	-0.031***	-0.008***	-0.003	-0.050***
	(0.002)	(0.002)	(0.004)	(0.008)
Recall Reason - Foodborne Pathogen	-0.009***	0.009***	0.006	0.074***
	(0.002)	(0.003)	(0.005)	(0.009)
Recall Reason - Contamination	-0.006*	-0.002	-0.005	0.069***
	(0.003)	(0.004)	(0.006)	(0.013)
PType - Fruit and Vegetables	-0.027***	-0.010***	-0.018***	-0.044***
	(0.003)	(0.004)	(0.006)	(0.012)
SType - Frozen	-0.022***	-0.018***	-0.025***	-0.054***
	(0.002)	(0.003)	(0.005)	(0.009)
Recall Experience (< 1 year)	0.001***	0.003***	0.002***	-0.002*
	(0.000)	(0.000)	(0.001)	(0.001)
Distribution of Recalled Product	-0.001	0.001	-0.002	-0.016***
	(0.001)	(0.001)	(0.001)	(0.003)
International Distribution	0.031***	0.035***	0.027***	0.107***
	(0.003)	(0.004)	(0.006)	(0.011)
Sales	0.005***	0.005***	0.012***	0.019***
	(0.001)	(0.001)	(0.001)	(0.002)
Momentum	0.000***	0.000	0.000***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Subsidiary	0.029***	-0.004	-0.010**	-0.042***
	(0.002)	(0.003)	(0.004)	(0.009)
Media Attention: LexisNexis Search Counts(0,1)	0.000**			
	(0.000)			
Media Attention: LexisNexis Search Counts(0,5)		0.000***		
		(0.000)		
Media Attention: LexisNexis Search Counts(0,15)			0.000***	
			(0.000)	
Media Attention: LexisNexis Search Counts(0,90)				0.000
				(0.000)
Constant	-0.020	-0.050***	-0.046	0.198***
	(0.015)	(0.018)	(0.029)	(0.057)
Observations	1,952	1,952	1,952	1,952
R-squared	0.536	0.319	0.250	0.430
Year Fixed Effects	YES	YES	YES	YES

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively. Dependent variables are CAR (Cumulative Abnormal Returns) based on food market indexes.

Table 2.37 CAR (Cumulative Abnormal Returns) Results for Class I Recalls (LexisNexis)

VARIABLES	(1) CAR(0,1)	(2) CAR(0,5)	(3) CAR(0,15)	(4) CAR(0,90)
Industry - Food Manufacturing	-0.044***	-0.014***	-0.009	-0.066***
	(0.004)	(0.004)	(0.008)	(0.014)
Recall Reason - Foodborne Pathogen	-0.025***	-0.013***	-0.021**	0.024
	(0.004)	(0.004)	(0.009)	(0.015)
Recall Reason - Contamination	0.022	0.012	0.055	0.190**
	(0.024)	(0.025)	(0.050)	(0.084)
PType - Fruit and Vegetables	-0.008	0.014**	0.020*	-0.065***
	(0.005)	(0.006)	(0.012)	(0.020)
SType - Frozen	-0.067***	-0.045***	-0.103***	-0.051**
	(0.006)	(0.007)	(0.013)	(0.022)
Recall Experience (< 1 year)	0.000	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)
Distribution of Recalled Product	-0.005***	-0.003**	-0.002	-0.005
	(0.001)	(0.001)	(0.003)	(0.004)
International Distribution	0.043***	0.051***	0.029***	0.074***
	(0.005)	(0.005)	(0.010)	(0.017)
Sales	0.008***	0.010***	0.018***	0.001
	(0.001)	(0.001)	(0.002)	(0.004)
Momentum	0.000***	0.000*	0.000	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Subsidiary	0.010**	-0.021***	-0.039***	0.040***
	(0.004)	(0.005)	(0.009)	(0.015)
Media Attention: LexisNexis Search Counts(0,1)	0.001***			
	(0.000)			
Media Attention: LexisNexis Search Counts(0,5)		0.000		
		(0.000)		
Media Attention: LexisNexis Search Counts(0,15)			0.000	
			(0.000)	
Media Attention: LexisNexis Search Counts(0,90)				-0.001***
				(0.000)
Constant	0.052**	-0.017	-0.067	0.095
	(0.026)	(0.028)	(0.056)	(0.093)
Observations	731	731	731	731
R-squared	0.748	0.488	0.391	0.461
Year Fixed Effects	YES	YES	YES	YES

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively. Dependent variables are CAR (Cumulative Abnormal Returns) based on food market indexes.

Table 2.38 CAR (Cumulative Abnormal Returns) Results for Class II Recalls (LexisNexis)

VARIABLES	(1) CAR(0,1)	(2) CAR(0,5)	(3) CAR(0,15)	(4) CAR(0,90)
Industry - Food Manufacturing	-0.017***	0.006*	0.011**	-0.007
	(0.002)	(0.003)	(0.005)	(0.010)
Recall Reason - Foodborne Pathogen	-0.001	0.020***	0.023***	0.109***
	(0.002)	(0.003)	(0.005)	(0.011)
Recall Reason - Contamination	-0.011***	-0.007*	-0.010*	0.085***
	(0.002)	(0.004)	(0.006)	(0.012)
PType - Fruit and Vegetables	-0.003	-0.013***	-0.012*	-0.009
	(0.002)	(0.005)	(0.007)	(0.015)
SType - Frozen	-0.003*	0.004	0.008*	-0.031***
	(0.002)	(0.003)	(0.005)	(0.010)
Recall Experience (< 1 year)	-0.001***	0.002***	0.001	-0.004***
	(0.000)	(0.000)	(0.001)	(0.001)
Distribution of Recalled Product	0.005***	0.001	-0.001	-0.011***
	(0.001)	(0.001)	(0.002)	(0.003)
International Distribution	0.006**	0.014***	0.017**	0.046***
	(0.003)	(0.005)	(0.007)	(0.015)
Sales	-0.000	-0.000	0.006***	0.025***
	(0.001)	(0.001)	(0.001)	(0.003)
Momentum	-0.000***	-0.000***	-0.000	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Subsidiary	0.007***	-0.014***	-0.025***	-0.075***
	(0.002)	(0.003)	(0.005)	(0.011)
Media Attention: LexisNexis Search Counts(0,1)	-0.000*			
	(0.000)			
Media Attention: LexisNexis Search Counts(0,5)		0.000		
		(0.000)		
Media Attention: LexisNexis Search Counts(0,15)			0.000**	
			(0.000)	
Media Attention: LexisNexis Search Counts(0,90)				0.001***
				(0.000)
Constant	-0.088***	0.005	-0.029	0.077
	(0.013)	(0.025)	(0.036)	(0.079)
Observations	1,176	1,176	1,176	1,176
R-squared	0.351	0.445	0.290	0.595
Year Fixed Effects	YES	YES	YES	YES

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively. Dependent variables are CAR (Cumulative Abnormal Returns) based on food market indexes.

Table 2.39 CAR (Cumulative Abnormal Returns) Results for Class III Recalls (LexisNexis)

VARIABLES	(1) CAR(0,1)	(2) CAR(0,5)	(3) CAR(0,15)	(4) CAR(0,90)
Industry - Food Manufacturing	0.010	0.037***	0.043*	0.004
	(0.007)	(0.013)	(0.023)	(0.115)
Recall Reason - Foodborne Pathogen	-0.039**	-0.037	-0.076	-0.398
	(0.018)	(0.032)	(0.059)	(0.290)
Recall Reason - Contamination	-0.005	0.003	-0.016	-0.189*
	(0.006)	(0.011)	(0.021)	(0.104)
PType - Fruit and Vegetables	-0.027	-0.105***	0.057	0.179
	(0.020)	(0.037)	(0.068)	(0.329)
Recall Experience (< 1 year)	-0.000	0.002	0.006	0.024
	(0.002)	(0.005)	(0.008)	(0.041)
Distribution of Recalled Product	0.006*	0.015***	0.010	0.044
	(0.003)	(0.005)	(0.010)	(0.048)
International Distribution	-0.007	0.050	0.181	0.337
	(0.032)	(0.059)	(0.124)	(0.656)
Sales	-0.002	0.005	0.004	0.028
	(0.002)	(0.004)	(0.008)	(0.038)
Momentum	-0.000	-0.001	-0.001	-0.004
	(0.000)	(0.000)	(0.001)	(0.004)
Subsidiary	-0.004	-0.013	-0.002	0.235*
	(0.008)	(0.014)	(0.026)	(0.128)
Media Attention: LexisNexis Search Counts(0,1)	-0.003			
	(0.002)			
Media Attention: LexisNexis Search Counts(0,5)		-0.002		
		(0.002)		
Media Attention: LexisNexis Search Counts(0,15)			-0.004	
			(0.003)	
Media Attention: LexisNexis Search Counts(0,90)				0.005
				(0.012)
Constant	-0.059	-0.312***	-0.235	-1.207
	(0.055)	(0.095)	(0.178)	(0.861)
Observations	45	45	45	45
R-squared	0.617	0.536	0.267	0.291
Year Fixed Effects	YES	YES	YES	YES

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively. Dependent variables are CAR (Cumulative Abnormal Returns) based on food market indexes.

Table 2.40 CAR (Cumulative Abnormal Returns) Regression Results for All Industries and Classes (Total Assets)

VARIABLES	(1) CAR(0,1)	(2) CAR(0,5)	(3) CAR(0,15)	(4) CAR(0,90)
Class of Recall - Class I	-0.021***	-0.022***	-0.026***	-0.070***
	(0.002)	(0.003)	(0.004)	(0.009)
Industry - Food Manufacturing	-0.032***	-0.009***	-0.007*	-0.055***
	(0.002)	(0.002)	(0.004)	(0.008)
Recall Reason - Foodborne Pathogen	-0.008***	0.010***	0.008*	0.078***
	(0.002)	(0.003)	(0.005)	(0.009)
Recall Reason - Contamination	-0.007**	-0.003	-0.008	0.066***
	(0.003)	(0.004)	(0.006)	(0.013)
PType - Fruit and Vegetables	-0.026***	-0.007*	-0.012**	-0.039***
	(0.003)	(0.004)	(0.006)	(0.012)
SType - Frozen	-0.023***	-0.018***	-0.025***	-0.052***
	(0.002)	(0.003)	(0.005)	(0.009)
Recall Experience (< 1 year)	0.002***	0.003***	0.002***	-0.001
	(0.000)	(0.000)	(0.001)	(0.001)
Distribution of Recalled Product	-0.001*	0.001	-0.003**	-0.017***
	(0.001)	(0.001)	(0.001)	(0.002)
International Distribution	0.029***	0.035***	0.026***	0.099***
	(0.003)	(0.003)	(0.005)	(0.011)
Total Assets	0.006***	0.007***	0.016***	0.026***
	(0.001)	(0.001)	(0.001)	(0.002)
Momentum	0.000***	0.000	0.000**	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Subsidiary	0.028***	-0.004*	-0.011**	-0.041***
	(0.002)	(0.003)	(0.004)	(0.008)
Media Attention: Google Search Counts(0,1)	0.000**			
	(0.000)			
Media Attention: Google Search Counts(0,5)		0.000***		
		(0.000)		
Media Attention: Google Search Counts(0,15)			0.001***	
			(0.000)	
Media Attention: Google Search Counts(0,90)				0.000
				(0.000)
Constant	-0.017	-0.060***	-0.052**	0.169***
	(0.014)	(0.016)	(0.027)	(0.053)
Observations	1,952	1,952	1,952	1,952
R-squared	0.542	0.333	0.269	0.443
Year Fixed Effects	YES	YES	YES	YES

Note: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05 and 0.01 level, respectively. Dependent variables are CAR (Cumulative Abnormal Returns) based on food market indexes.

2.6. Conclusion

Without risk to health, the mutual benefits of both food companies and consumers could be achieved with the combination of demand for food and the profit-making behavior of firms. However, in the real world, one of the primary needs of consumers is that food be safe and healthful. In terms of profit maximization, the costs of management, inspection, and development of safe and healthful foods may affect firms' ability to meet consumer desires. There is the potential for new and different demands for food to arise as consumers lose trust in the safety of the food supplied or produced by a certain company.

On the firm side, companies may be sensitive to their returns as they can be a reflection of their image and have a potential impact on profits. Therefore, their desire to maximize profits could be affected by the response of these stock markets. Avoiding factors that could diminish the value of the firm, such as a food recall, may motivate companies to improve their production practices. Coupling consumer demand for safe food and the behavior of companies that place value on providing safe food may lead to a new equilibrium in terms of aspects of supply and demand. Therefore, it may be crucial to analyze of stock returns in terms of improved social welfare.

In light of these perspectives, this research fills a void in the literature concerning the impact of food recalls on market returns of food products under the jurisdiction of the FDA. As anticipated, Class I recalls have a larger impact on corporate valuation than Class II recalls. In addition, this study offers a first look at the variation in stock price impacts across food industry subsectors. In the short-run, food manufacturing firms were the most adversely impacted by recall events. Whereas food retailers were the most negatively affected by recalls in the medium-run.

Based on the results, one could imply that food recalls play a key role in preventing foodborne illnesses. This is especially important in the Food and Beverage Retailers industry

which experienced the most significant long-term impact from food recalls. The main reason for this being that the primary goal of a firm is to maximize profit, thus, there may be an incentive to commit food fraud such as continuous use of expired ingredients on purpose for cost reduction. If there were no relationship between food recalls and the valuation of a firm in stock markets, companies would not make an effort to improve food safety but rather would calculate only short-term damages received by regulatory authorities, but this is not the case. Stock market values are related to food recalls and are important to companies for several reasons. First, stock prices are a criterion for the financial health of a company, and therefore promising stock prices are essential for financing. Second, if a firm did not perform well and stock prices continuously decreased the executive management would be at a high risk of being removed by the Board of Directors. Finally, if a company had bad signals for its future stock prices, the likelihood of a takeover by other firms would increase. Thus, this study may help companies anticipate and communicate more effectively about the impact of a recall.

Event study and Cross-sectional analysis results show some similarities or differences. Class I recalls had persistently negative effects on cumulative abnormal returns in both the event study and cross-sectional analysis. However, considering all recall products as weights in the cross-sectional study, food recalls in the Food Manufacturing industry negatively impacted the industry for a longer period of time. We examined the effects of the detailed characteristics regarding food recalls such as experience and distribution patterns through a cross-sectional study. Thus, the event study has strengths in analyzing trends after the recall announcement. Through cross-sectional analysis, a comprehensive analysis was made by considering the weights of products recalled and various variables.

Still, there are several limitations remaining in this study. First, our study sample considers

only publicly-traded companies and excludes private companies. This study may be extended to include private companies by exploiting accessible firm-specific data. Second, this study depends on a voluntary recall. According to FDA Food Enforcement Reports, there have been only eight FDA mandated recalls and one FDA requested recall of the 4,101 FDA recall events between 2012 and 2018. After FSMA was signed into law in 2011, this time-frame is of interest, and FSMA may provide significant benefits to social welfare by actively enforcing policies related to food safety. Future research could take into account effects mandatory recalls by FSMA, which may greatly affect food recalls and food safety. Moreover, it may aid policy makers in conducting more accurate benefit-cost analyses of alternative mandatory or voluntary food safety recall policies.

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CHAPTER 3

The Effect of SCHIP Premiums on Medical Utilization, Medical Expenditure, and Health Outcomes in Arizona

3.1. Introduction

Chronic diseases, such as heart disease, cancer, and diabetes, account for 30% of total deaths, but they are often preventable. Also, they are responsible for 75% of the nation's health spending in the U.S. Preventive care may help people keep a healthy life and prevent diseases. However, many Americans did not have preventive health services due to financial barriers (Centers for Medicare and Medicaid Services (CDC), 2010). McGlynn et al (2003) surveyed 20,028 adults using random-digit-dial telephone surveys. Approximately half of the 13,275 participants didn't receive preventive care recommended by RAND's Quality Assessment Tools system. An estimated 11 million children and 59 million adults have private insurance, but it does not provide proper immunization coverage (Institute of Medicine, 2003; CDC 2010). Davis et al. (2005) mentioned that an estimated 69 million workers took sick leave because of illness and valued these missed times to be $48 billion of economic output lost. Some of this can be prevented by increasing the use of proven preventive care services, and early treatment and effective cancer screening would decrease the cancer death rate by 29 percent (Curry, Byers, and Hewitt, 2003; CDC, 2010). For these reasons, Medicaid and the Children's Health Insurance Program (CHIP) help millions of low-income beneficiaries obtain access to preventive health care services in order to enhance prevention (Medicaid, 2015).

In this study, medical utilization, medical expenses, and health outcomes resulting from a policy change are examined. More specifically, the main interest is the effect of the introduction

of SCHIP premiums in Arizona on medical utilization, medical expenditure and health outcomes of low-income children. The introduction of SCHIP premiums in Arizona caused an increase in the rate of disenrollment and a decrease in the rate of reenrollment (Kenney, 2007). As a result, it could affect the number of times health and medical services are used, their medical expenditure and as a result, children's health status. Previous studies have shown that Medicaid expansion would increase the number of doctor visits and improve health outcomes (Buchmueller, Miller, and Vujicic, 2016; Choi, 2011; Currie and Gruber 1996a, 1996b, 2001; Kaestner, Joyce, and Racine, 2001; Li and Baughman (2010); Lipton and Decker, 2015; Nasseh and Vujicic, 2013). However, there have been few studies for the effects on medical expenses and health outcomes of Medicaid or SHIP reduction. Arizona imposed a relatively large amount of premiums on low-income individuals in 2004. In addition, Arizona cut expenditure on medical assistance programs for two consecutive years compared to other states according to the Financial Management Report between 1997 and 2014 from Medicaid.gov.

In this paper, I use the triple difference method to identify and estimate the impact of the introduction of SCHIP premiums in Arizona. Results show that the policy change had a negative effect on the number of visits for preventive care, the number of visits to hospital outpatient services and the associated expenditure by the affected children as well as on their health outcomes. There is no conclusive evidence on the effect of the policy on visits to the emergency rooms. Surprisingly, it is also found the policy had a positive effect on the number of doctor's office visits and its associated expenditure by the affected children.

The remainder of this paper proceeds as follows. Section 3.2 provides literature review. Section 3.3 explains how data are organized and presents descriptive statistics. Section 3.4

introduces empirical strategy. Section 3.5 presents results and discusses them. Section 3.6 concludes.

3.2. Literature Review

A large number of previous literature have studied the effects of Medicaid eligibility on medical care utilization and health outcomes. To begin with, Currie and Gruber have made great contributions to studies regarding the effects of Medicaid expansion on medical utilization, and health outcomes. Currie and Gruber (1996a) studied the effect of an expansion of Medicaid for low-income children on their utilization of medical care and health outcomes using the National Health Interview Survey (NHIS), The Medicaid expansion increased the fraction of children eligible for Medicaid between 1984 and 1992. The authors argued that eligibility for Medicaid significantly raised the utilization of medical care, especially care delivered in physicians' offices. The authors used child mortality as a health outcome. Their working paper dealt with other health outcomes such as health status, but they only included child mortality, which is not individual data. They found that when eligibility for Medicaid expanded, child mortality significantly and largely decreased.

Currie and Gruber (1996b) estimated the effect of changes in women's Medicaid eligibility for Medicaid on infant birth weight and mortality rate using the Current Population Surveys (CPS), Vital Statistics data, the Health Care Financing Administration (HCFA), and the National Longitudinal Survey of Youth (NLSY) data between 1979 and 1992. The results showed that when eligibility increased by 30 percentage points over the time period between 1979 and 1992, there were a decrease of 1.9 percent in the incidence of low birth weight and a reduction of 8.5 percent in infant mortality rate.

Currie and Gruber (2001) also studied the effect of Medicaid expansion on medical treatment received by women at childbirth using Vital Statistics data between 1987 and 1992 from the National Center for Health Statistics (NCHS). The authors constructed the medical treatment variables as a set of dependent variables such as the average rate of utilization of procedures such as cesarean section delivery, fetal monitor, induction of labor, and ultrasound. They found that there were significant increases in the use of obstetric procedures because of the Medicaid policy change.

Next, Kaestner, Joyce, and Racine (2001) explored the impact of Medicaid expansions on the incidence of ACS (Ambulatory Care Sensitive) hospitalizations for children with difference-in-differences estimation using data from the Healthcare Cost and Utilization Project (HCUP-3) Nationwide Inpatient Sample (NIS) between 1988 and 1992. They found that the Medicaid expansions decreased the incidence of ACS hospitalizations for children aged 2–6 in low-income families.

Li and Baughman (2010) investigated the effects of the Children's Health Insurance Program (SCHIP), which started in states between 1997 and 2002 on health insurance coverage, medical utilization of preventive care, and health status using the National Survey of America's Families (1997–2002) data. They found that higher coverage rates of SCHIP raised utilization of medical care. However, the effects on health outcomes were small and statistically insignificant.

Next, there are several papers on the impact of health reforms on specific areas such as Medicaid dental and vision care. For example, Choi (2011) examined the impact of new comprehensive health system reform from 2014 using Behavioral Risk Factor Surveillance System (BRFSS) data. This reform extended Medicaid coverage to people with incomes up to 133 percent of the federal poverty level. Therefore, millions of people were eligible to receive Medicaid dental

benefits. The author found that the expansion regarding Medicaid adult dental coverage increased the likelihood of a dental visit by 7.9 percentage points including control variables.

Next, a few previous papers used Medical Expenditure Panel Survey (MEPS) data to study health outcomes. For example, Perry and Rosen (2003) studied how the self-employed and a person who works for wages or salary differ in terms of health status and insurance coverage using data from the 1996 MEPS. The authors assumed that self-employment and lack of health insurance are correlated and found that the two groups are statistically indistinguishable from each other in terms of health outcomes.

3.3. Background and Data

Unlike Medicare, which is a federal program providing health coverage for people over 65 years old or those with severe disability, Medicaid is a state and federal joint program offering health coverage for people with low income who cannot afford private health insurance. The Medicaid program was designed based on Title XIX of the Social Security Amendments of 1965 signed into law by President Lyndon Johnson.

Even though Medicaid offers insurance for children, it only covers those in families with very low income. Therefore, the State Children's Health Insurance Program (SCHIP) was initiated for children in families whose incomes are higher than the Medicaid threshold but still cannot afford private coverage. The Social Security Act was revised when Section 4901 of the Balanced Budget Act of 1997 was signed into law by President Bill Clinton by adding a new title, title XXI. This title provides funds to states to finance the SCHIP programs. The total number of Medicaid and SCHIP enrollees was 73,189,584 in July 2018 in the entire US, with 66,692,681 enrolled in Medicaid and 6,496,903 enrolled in SCHIP (Medicaid, 2018). Although the SCHIP program is not mandatory, all 50 states have their own programs. Children under 19 years of age can participate

in the program if their family incomes are higher than the Medicaid threshold but lower than the SCHIP threshold. Each state has its own threshold for SCHIP and the threshold varies for children of different ages. As an example, Table 3.1 shows Medicaid and SCHIP income thresholds by children's age in Arizona.

Table 3.1 Medicaid and SCHIP Income Thresholds by Age in Arizona

Children's age	Medicaid Income Threshold (as percentages of FPL [15])	SCHIP Income Threshold (as percentages of FPL)
<1	1-140%	141-200%
1-5	1-133%	134-200%
6-18	1-100%	101-200%

Source: Ross, D. C., A. Horn, and C. Marks (2008) " Health Coverage for Children and Families in Medicaid and SCHIP: State Efforts Face New Hurdles: A 50-State Update on Eligibility Rules, Enrollment and Renewal Procedures, and Cost-Sharing Practices in Medicaid and SCHIP in 2008," The Henry J. Kaiser Family Foundation

Premiums for the SCHIP programs vary by state. Since the implementation of SCHIP, all states have adjusted the cost-sharing policies such as the premiums. Specifically, Arizona started to impose a relatively large amount of premium for low-income families in 2004. In more detail, Arizona introduced a monthly premium of $10 for a family with one child and $15 for families with more than one child if the families earn incomes between 101% and 150% of the federal poverty line (FPL). For families with incomes between 151% and 175% of the FPL, monthly premium was raised from $10 to $20 for families with one child and from $15 to $30 for families with two or more children. For families with incomes between 176% and 200% of the FPL, monthly premium was increased from $10 to $25 for families with one child and from $20 to $30 for families with more than one child. Due to this policy intervention, many children in low-income families in Arizona lost health coverage. As a result, the number of disenrollment increased and the number of reenrollment fell (Kenney et al., 2007).

[15] FPL stands for the federal poverty level. It is available at HealthCare.gov (https://www.healthcare.gov/glossary/federal-poverty-level-fpl)

Table 3.2 SCHIP Income Thresholds by Age in eight control states

	SCHIP Income Threshold (as percentages of FPL)			
Children's age	Arkansas	Iowa	Nebraska	New Mexico
<1	0-200%	134-200%	0-185%	0-235%
1-5	0-200%	134-200%	0-185%	0-235%
6-18	0-200%	134-200%	0-185%	0-235%
	SCHIP Income Threshold (as percentages of FPL)			
Children's age	North Dakota	Ohio	Oklahoma	South Carolina
<1	134-140%	0-200%	101-185%	0-185%
1-5	134-140%	0-200%	101-185%	0-150%
6-18	101-140%	0-200%	101-185%	0-150%

Source: Ross, D. C., A. Horn, and C. Marks (2008) " Health Coverage for Children and Families in Medicaid and SCHIP: State Efforts Face New Hurdles: A 50-State Update on Eligibility Rules, Enrollment and Renewal Procedures, and Cost-Sharing Practices in Medicaid and SCHIP in 2008," The Henry J. Kaiser Family Foundation

Table 3.2 presents SCHIP income thresholds by children's age in eight control states[16]. Each state should submit a Title XXI SCHIP policy plan to receive federal funds and may have its own children's health insurance program (CHIP) in the following three ways: separate CHIP program (S-SCHIP), Medicaid expansion CHIP (M-SCHIP), and combination of M-SCHIP and S-SCHIP (COMBO). Arizona has S-SCHIP, New Mexico, Ohio, and South Carolina created Medicaid expansion SCHIP, and Arkansas, Iowa, Nebraska, North Dakota, and Oklahoma run COMBO program.

3.3.1. Data

In order to study the effects of Arizona's 2014 change in SCHIP premiums on medical utilization and health outcomes of children in low income families, the Medical Expenditure Panel Survey (MEPS) data is used. MEPS was designed by the Agency for Healthcare Research and Quality (AHRQ) to provide information on medical utilization, expenditures, sources of payment, and health insurance coverage for the U.S. residents. It also contains information on health status,

[16] Arkansas, Iowa, Mississippi, Nebraska, New Mexico, North Dakota, Ohio, Oklahoma, and South Carolina

demographic and socio-economic characteristics, access to and satisfaction with health care. The MEPS sample is a subsample of households participating in previous year's National Health Interview Survey (NHIS) by the National Center for Health Statistics. A new panel of sample, about 9,000-10,000 households, is selected every year (Chowdhury, 2013). For each cohort, MEPS conducts five rounds of interviews over a two-year period. Therefore, there are several variables for the same item such as Rounds 3/1, 4/2, 5/3 status and status as of December 31 each year. Variable names ending in 53 refers Round "5" of previous panel or Round 3 of current panel.[17] For consistency, variables as of December 31 each year are used in this study. In addition, MEPS survey uses computer assisted personal interviewing (CAPI), and a single household member reports information.

Unlike other medical-related data such as the National Health Interview Survey (NHIS) or the Behavioral Risk Factor Surveillance System (BRFSS), the income variable in MEPS reports the actual amount, not just a category where the income falls into. This feature of the MEPS data is critical for this research as our analysis depends on the proper classification of income groups, and income eligibility of treatment and control groups are different by state.

The total number of observations between 2001 and 2007 except 2004 in the dataset is 206,006 individuals from 72,570 families. Among them, there are 65,963 children under the age of 18 from 31,934 families. Imposing the SCHIP eligibility criteria for treatment and control states further reduces the sample to be about 6,700 observations depending on which dependent variable are used. Table 3.3 reports the summary statistics for the variables used in estimation below for the sample of SCHIP eligible children in Arizona and average value of control states between 2001 and 2003, and Table 3.4 provides the variable definitions.

[17] For example, there are four variables for marital status: Marry18x, Marry31x, Marry42x, and Marry53x. Marry53x in 2018 means Round "5" of panel in 2017 or Round 3 of current panel in 2018.

Table 3.3 Descriptive statistics for SCHIP eligible children in Arizona and control states between 2001 and 2003

	Arizona			Control States		
Variable	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Doctor's Office Visits	1.60	0	15	2.44	0	51
Outpatient Department Visits	0.02	0	1	0.12	0	14
Emergency Room Visits	0.14	0	4	0.22	0	5
log (Expenses for Doctor’s office)	2.65	0	8	3.06	0	9
log (Expenses for Outpatient Department)	0.11	0	8	0.35	0	9
log (Expenses for Emergency Room)	0.48	0	8	0.82	0	8
Less healthy than other children	1.33	1	4	1.42	1	4
Appointment	0.52	0	1	0.59	0	1
Preventive Care (Height)	0.74	0	1	0.76	0	1
Preventive Care (Weight)	0.77	0	1	0.81	0	1
Age	9.26	0	18	8.52	0	18
Male	0.53	0	1	0.50	0	1
# of Male Adults	1.05	0	4	0.77	0	3
# of Female Adults	1.09	0	3	1.09	0	3
log (Household Income)	10.21	9	11	9.62	0	11
# of Children<18	1.89	0	5	1.96	0	6
MSA	0.91	0	1	0.52	0	1
White (Non-Hispanic)	0.18	0	1	0.40	0	1
White (Hispanic)	0.75	0	1	0.32	0	1
Black	0.02	0	1	0.23	0	1
Others	0.05	0	1	0.06	0	1
<High School	0.49	0	1	0.40	0	1
High School	0.38	0	1	0.47	0	1
College or above	0.13	0	1	0.13	0	1

Table 3.4 Variable definitions

Dependent Variables	**Description**
Office	The number of visits to a doctor's office
Outpatient	The number of visits to an outpatient department
ER	The number of visits to a hospital emergency department
Officeexp	The amount of total expenses for doctor's office visits
Officeslf	The amount of out-of-pocket expenses for doctor's office visits
Outpatientexp	The amount of total expenses for outpatient department visits
Outpatientslf	The amount of out-of-pocket expenses for outpatient department visits
Erexp	The amount of total expenses for emergency room visits
Erslf	The amount of out-of-pocket expenses for emergency room visits
Lesshealthy	A child seems less healthy than other children (Definitely False: 1, Mostly False: 2, Mostly true:3, Definitely true: 4)
Appointment	1 if a child made any appointments for health care at a doctor's office during the last 12 months when they needed health care right away, otherwise 0
PreventiveH	1 if a doctor or other health provider has ever measured child's height within past 2 years
PreventiveW	1 if a doctor or other health provider has ever measured child's weight within past 2 years
Independent Variables	**Description**
Age	Children's age
Male	Male child: 1, Female child: 0
# of Male Adults	The number of male adults in the household
# of Female Adults	The number of female adults in the household
log (Household Income)	Log of household income for SCHIP eligible children
# of Children<18	The number of children under the age of 18 in the household
MSA	MSA(Metropolitan statistical area) status (MSA: 1, non-MSA: 0)
White (Non-Hispanic)	Non-Hispanic White: 1, otherwise 0
White (Hispanic)	Hispanic White: 1, otherwise 0
Black	Black: 1, otherwise 0
Others	Others such as American Indian or Asian: 1, otherwise 0
<High School	Level of education of parents is below high school: 1, otherwise 0[18]
High School	Level of education of parents is high school: 1, otherwise 0
College or above	Level of education of parents is college or above: 1, otherwise 0

[18] If a child in a household has both a mother and a father, the highest level of education of parents is taken into account because separate variables for parents' education may result in many missing values. For example, a father of a child graduated from a high school and a mother did from a college, his/her parents' education is set to be "college and above".

3.4. Estimation

3.4.1. Empirical Methods

I use the triple-difference regression model to identify the causal effect of the introduction of SCHIP premiums in Arizona in 2004 on medical utilization, medical expenditure, and health outcomes for children. For medical utilization, the total number of visits to the doctor's office, hospital outpatient visits, emergency room visits, and hospital inpatient services are used. The analysis of the total number of visits is to be conducted by estimating the count regression model following the specification used in Garthwaite, Gross, and Notowidigdo (2014),

$$Utilization_{ijst} = \lambda I\{j = SCHIP\} \cdot I\{s = AZ\} \cdot I\{t \geq 2005\} + X'_{ijst}\beta + \gamma_j \times \alpha_s + \gamma_j \times \delta_t + \alpha_s \times \delta_t + \gamma_j + \alpha_s + \delta_t + \varepsilon_{ijst} \quad [3.1]$$

where $Utilization_{ijst}$ is a set of dependent variables measuring individual $i's$ medical utilization in state s, in year t, and for demographic group j with respect to SCHIP eligibility. α_s, δ_t, and γ_j are a full set of state, year, and demographic group fixed effects. In addition, this equation includes the two-way interactions among α_s, δ_t, and γ_j. $I\{j = SCHIP\}$, $I\{s = AZ\}$, and $I\{t \geq 2005\}$ are indicator variables for children who are eligible for SCHIP, those who are in Arizona, or those who are in 2005, 2006, and 2007, respectively. More specifically, in Arizona, the treatment group includes children under age 1 with household incomes between 141-200% of the FPL, those aged between 1 and 5 with family incomes between 134-200% of the FPL, or those aged between 6 and 18 with household incomes between 101-200% of the FPL. λ is the main coefficient representing the policy effect of the introduction of SCHIP premiums. To control for other heterogeneity across different individuals, a vector of characteristics X_{ijst} is added. X_{ijst} includes age, age squared, race, sex, parents' education, the number of female adults, the number of male adults, the number of

children under age 19, and MSA (Metropolitan statistical area). ε_{ijst} is an error term and assumed to be not correlated with unobserved factors of the $Utilization_{ijst}$.

$Utilization_{ijst}$ is a set of count variables, so that Poisson and negative binomial models are popular choices. In this study, the negative binomial regression is used because the distribution of medical utilization exhibits over-dispersion. More specifically, I estimate the following model,

$$Utilization_{ijst} \sim Poisson(\lambda^*_{ijst}) \quad [3.2]$$

, where $\lambda^*_{ijst} = \exp(\lambda_2 I\{j = SCHIP\} \cdot I\{s = AZ\} \cdot I\{t \geq 2005\} + X'_{ijst}\beta_2 + \gamma_j \times \alpha_s + \gamma_j \times \delta_t + \alpha_s \times \delta_t$

$+\gamma_j + \alpha_s + \delta_t + v_{ijst})$, $e^{v_{ijst}} \sim Gamma(1/r, r)$, and r is the over-dispersion parameter.

The larger r is, the greater the variance of medical utilization. If r =0, it is reduced to Poisson regression.

For medical expenditures, the Poisson pseudo maximum likelihood (PPML) estimator is to be used because zeroes are very common for medical expenses, and zeroes are dropped by taking the logarithm. In addition, OLS results are also reported for comparison. OLS may yield inconsistent and biased results (Sheperd, 2016; Silva and Tenreyro, 2006). The specific form of Poisson PPML is as follows,

$$Expenditure_{ijst} = \exp(\lambda_3 I\{j = SCHIP\} \cdot I\{s = AZ\} \cdot I\{t \geq 2005\} + X'_{ijst}\beta_3 + \gamma_j \times \alpha_s + \gamma_j \times \delta_t$$

$$+\alpha_s \times \delta_t + \gamma_j + \alpha_s + \delta_t + \varepsilon_{ijst}) \quad [3.3]$$

Next, perceived health status for children is used as the measure for health outcomes. This is the answer to the following questions: “is that child seems to be less healthy than other children?” and there are 4 possible answers: definitely false (1), mostly False (2), mostly true (3), definitely true (4). The ordered Probit model is used,

$$Lesshealthy^{*}_{ijst} = \lambda_4 I\{j = SCHIP\} \cdot I\{s = AZ\} \cdot I\{t \geq 2005\} + X^{'}_{ijst}\beta_4 + \gamma_j \times \alpha_s + \gamma_j \times \delta_t + \alpha_s \times \delta_t$$

$$+\gamma_j + \alpha_s + \delta_t + u_{ijst} \ , \quad u_{ijst} \sim N(0,1) \qquad [3.4]$$

, where $Lesshealthy^{*}_{ijst}$ is a latent variable and perceived health status as follows:

$$Lesshealthy = \begin{cases} Lesshealthy = 1 \ \ if \ \ -\infty < Lesshealthy^{*} < \mu_1 \\ Lesshealthy = 2 \ \ if \ \ \mu_1 \leq Lesshealthy^{*} < \mu_2 \\ Lesshealthy = 3 \ \ if \ \ \mu_2 \leq Lesshealthy^{*} < \mu_3 \\ Lesshealthy = 4 \ \ if \ \ \mu_3 \leq Lesshealthy^{*} < \infty \end{cases}$$

3.4.2. Identification Strategy

This model is based on relaxed assumptions than the difference-in-difference model by Boyle and Lahey (2016). Following Boyle and Lahey (2016), four identification assumptions for difference-in-differences estimation are considered. First, people in the treatment group should be influenced by the policy change, whereas those in the control groups should not. Second, there should be no other contemporaneous shocks that may influence the treatment and control groups differently other than the policy intervention. Third, during the control period, individuals in the treatment group and those in the control group look similar. Fourth, for the periods when there are no policy changes, the treatment and control groups should have a similar trend. Among these assumptions, the "common trend" assumption could be relaxed using the triple-difference model (DDD) following Chetty, Looney, Kroft (2009) and Jakobsson and Svensson (2016).

To satisfy the first and second assumptions for triple differences, the treatment group and control group are carefully set. First of all, the treatment group is defined as children in Arizona under age 1 with incomes between 141-200% of the FPL, or those between 1 and 5 with family incomes between 134-200% of the FPL, or those between 6 and 18 with incomes between 101-200% of the FPL based on Table 3.1. Unlike Arizona, some states did not change their SCHIP

cost-sharing system. Therefore, control states are set to states that did not change SCHIP policies during the sample period. The control group is defined as SCHIP recipients in those states where SCHIP policies had never changed between 2001 and 2007 in order for the first assumption to hold. Many states have implemented and changed SCHIP premiums due to financial reasons. The following four steps were conducted to ensure the satisfaction of the second assumption and define the control group properly. First, removing states that had changed premium policies between 2001 and 2007, the remaining states were 19 states as follows: Arkansas, Colorado, Delaware, Iowa, Louisiana, Mississippi, Montana, Nebraska, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Virginia, and Wyoming.

Second, Colorado, Delaware, Louisiana, Montana, New York, North Carolina, Oregon, South Dakota, Virginia, and Wyoming among these 19 states changed state income thresholds for SCHIP. For example, SCHIP income threshold was raised from 170% of the FPL to 185% of the FPL in Oregon in January 2003. Arkansas, Iowa, Mississippi, Nebraska, New Mexico, North Dakota, Ohio, Oklahoma, and South Carolina are left by eliminating these 10 states.

Third, Mississippi changed SCHIP copayments between 2001 and 2007. More specifically, it increased the copayment for prescriptions from $1 to $3 per generic drug prescription in 2005. Therefore, Mississippi is deleted, and 8 states are considered as candidate states for the control group. Next, the control group consists of a combination of eight control states, and the SCHIP eligibility for those eight control states are presented in Table 3.2. The descriptive statistics for treatment and control group are shown in Table 3.3 to examine the remaining assumptions. It shows that some means of the dependent variable and independent variables such as “Appointment”, “Preventive Care”, demographic variables are similar, but other averages for visits to medical facilities and expenditure are different.

3.5. Results and Discussion

Most previous studies regarding medical utilization and health outcomes in response to policy changes have focused on the expansion of qualifications such as Medicaid expansion. They have shown that the expansion increased the number of doctor visits and improved health outcomes. On the contrary, an introduction of SCHIP premiums reduced SCHIP eligibility because the rate of disenrollment increased, and that of reenrollment fell (Kenney et al., 2007).

First of all, perceived health status got worse in Arizona for the post period after the introduction of SCHIP premiums between 2005 and 2007. Table 3.5 shows the ordered Probit regression results, and the marginal effects are presented in Table 3.6. In Table 3.5, the SCHIP policy change negatively affected children's health, and the marginal effects in Table 3.6 can be interpreted that the introduction of SCHIP premiums was associated with being 9.6% less likely to respond that children do not seem definitely less healthy, 5.8% more likely to answer "mostly false", 2.4% more likely to do "mostly true", and 1.4% more likely to answer "mostly true" for less healthy status.

Table 3.5 Ordered Probit Regression Results on Health Status (Lesshealthy)

VARIABLES	**Coefficient**
$I\{j = SCHIP\} \cdot I\{s = AZ\} \cdot I\{t \geq 2005\}$	0.323***
	(0.080)
Age	0.017
	(0.015)
Age squared	-0.000
	(0.001)
Male	0.039
	(0.048)
White (Hispanic)	-0.057
	(0.083)
Black	-0.061
	(0.049)
Others	0.079
	(0.114)
High School	-0.024
	(0.112)
College or above	0.017
	(0.165)
# of Male Adults	-0.070
	(0.053)
# of Female Adults	-0.032
	(0.040)
log(Household Income)	-0.024
	(0.023)
# of Children (<19)	-0.009
	(0.011)
MSA	0.040
	(0.070)
Observations	6,334

NOTE: Cluster-robust standard errors in parentheses. The dependent variable is health status according to the following categories: Definitely True (4), Mostly True (3), Mostly False (2), and Definitely False (1).
*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level

Table 3.6 Marginal Effects for Ordered Probit Regression Model (Lesshealthy)

	Definitely False	Mostly False	Mostly True	Definitely True
	(1)	(2)	(3)	(4)
$I\{j = SCHIP\} \cdot I\{s = AZ\} \cdot I\{t \geq 2005\}$	-0.096***	0.058***	0.024***	0.014***
Age	-0.005	0.003	0.001	0.001
Age squared	0	0	0	0
Male	-0.011	0.007	0.003	0.002
White (Hispanic)	0.017	-0.01	-0.004	-0.003
Black	0.018	-0.011	-0.005	-0.003
Other	-0.024	0.014	0.006	0.004
High School (Parents)	0.007	-0.004	-0.002	-0.001
College or above (Parents)	-0.005	0.003	0.001	0.001
# of Male Adults	0.021	-0.012	-0.005	-0.003
# of Female Adults	0.009	-0.006	-0.002	-0.001
ln (Household Income)	0.007	-0.004	-0.002	-0.001
# of Children (≤18)	0.003	-0.002	-0.001	0
MSA	-0.012	0.007	0.003	0.002

NOTE: *** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level

Next, Table 3.7 presents the regression results for health care utilization. Columns (1), (3) and (5) report the coefficients estimates and columns (2), (4), and (6) does the marginal effects (ME) from the negative binomial regression model. Table 3.8 through Table 3.10 show regression results for medical expenditure by service category. There, total expenditure refers to what is paid for medical care services. Expenditure variables in MEPS are the sum of direct payments including payments by private insurance, Medicaid, Medicare, out-of-pocket payments, and other sources during the year. Out-of-pocket expenditure means payments by the patient themselves. Poisson pseudo-maximum likelihood estimator (PPML) are used, which may provide consistent estimates of the nonlinear model (Shepherd, 2016; Silva and Tenreyro, 2006).

The coefficient of the number of visits to hospital outpatient department is negative and significant as expected. The policy change regarding SCHIP premiums was associated with 0.06 less visits to outpatient department. It might be noted that the coefficient of total medical expenses for hospital outpatient visits in Table 3.9 decreased by 74.75 dollars, but that of out-of-pocket

expenditure increased by 7.48 dollars. It can be interpreted that the individual burden for the health care service increased. However, the coefficient is much smaller than that of doctor's office visits because the average visits to the outpatient departments was 0.02 in Arizona, which would mean that there were few low-income children visiting outpatient clinics on average.

In contrast, the introduction of SCHIP premium had positive effect on the doctor's office visits for children in ill-health in Column (1) and (2) in Table 3.7. The medical expenses for the doctor's office visits increased by 97.22 dollars in column (2) in Table 3.8. As a matter of fact, it is hard to explain why it rose. One possible reason is due to the deterioration of the health condition, and outpatient department can be a substitute for the doctor's office, but hospital outpatient costs are much higher than the doctor's office (Reschovsky and White, 2014). Instead of visiting hospital outpatient department, children might go to doctor's office. Another possibility is a moral hazard. It is well-known that medical utilization is greater in the group of people with a public health insurance coverage than those who bought private insurance (Riphahn, Wambach, and Million, 2003). People publicly insured may have an incentive to visit the doctor's office more. Furthermore, if follow-up research is conducted, the possibility of more people going to hospitals when premiums rise could also be studied.

On the other hand, some of them may go to a hospital emergency room in a medical emergency. The policy change regarding SCHIP premiums was positive, but not significant in column (5) and (6) in Table 3.7. On the contrary, medical expenses for the emergency room visits fell after the policy. That is, an introduction of SCHIP decreased emergency room expenditure. I may find the reason in Emergency Medical Treatment & Labor Act (EMTALA) enacted in 1986. It requires hospital emergency departments to treat anyone coming to their rooms and to stabilize, regardless of their ability to pay or insurance status. Therefore, deterioration of the health condition

might cause low-income children to go to an emergency room, but they could not afford to pay it because of uninsured status. It may be inevitable for children with poor health status to use an emergency room when situations are urgent and they could not choose alternatives.

For demographic variables, there are several notable characteristics. First, male children increased to visit to outpatient departments or emergency rooms. Second, as children had grown up, they less visited doctor's offices, outpatient clinics, and emergency room. Third, white Hispanic and black children reduced their visits to the doctor's office, outpatient departments, and emergency rooms. Fourth, in Table 3.7, there are two parent education variables compared to "below high school." The higher parents' level of education is, the more children visit to medical facilities except emergency rooms. Fifth, household income increase the number of visits to doctor's office. Sixth, the number of male adults in a household lowered the doctor's office, and emergency room visits, where as that of female adults did not affect them. Seventh, the number of children under the age of 18 in a household decreased the visits to doctor's office, outpatient department, and emergency rooms. Lastly, children in metropolitan statistical area (MSA) increased their visits to the doctor's office by 0.29.

Table 3.7 Negative Binomial Regression Results on Medical Service Category

VARIABLES	(1) Office	(2) ME (Office)	(3) Outpatient	(4) ME(Outpatient)	(5) ER	(6) ME (ER)
Interaction	0.739***	1.771***	-0.703**	-0.055**	0.245	0.042
	(0.149)	(0.404)	(0.291)	(0.027)	(0.301)	(0.051)
Age	-0.146***	-0.350***	-0.158***	-0.012***	-0.118***	-0.020***
	(0.014)	(0.026)	(0.053)	(0.004)	(0.025)	(0.005)
Age squared	0.007***	0.017***	0.008***	0.001***	0.005***	0.001***
	(0.001)	(0.001)	(0.003)	(0.000)	(0.002)	(0.000)
Male	0.048	0.116	0.197**	0.015*	0.166**	0.028***
	(0.036)	(0.089)	(0.093)	(0.008)	(0.065)	(0.010)
White (Hispanic)	-0.361***	-0.865***	-0.436*	-0.034*	-0.149	-0.025
	(0.086)	(0.219)	(0.237)	(0.019)	(0.130)	(0.023)
Black	-0.658***	-1.578***	-1.103***	-0.086***	-0.229	-0.039
	(0.128)	(0.329)	(0.157)	(0.018)	(0.149)	(0.026)
Others	-0.402***	-0.964***	-0.871**	-0.068**	0.276	0.047
	(0.088)	(0.219)	(0.396)	(0.028)	(0.244)	(0.041)
High School	0.167***	0.401***	0.400**	0.031**	-0.009	-0.002
	(0.040)	(0.107)	(0.203)	(0.015)	(0.152)	(0.026)
College or above	0.422***	1.011***	0.691***	0.054***	-0.275	-0.047
	(0.074)	(0.196)	(0.162)	(0.013)	(0.206)	(0.036)
# of Male Adults	-0.259***	-0.620***	-0.155	-0.012	-0.198**	-0.034**
	(0.035)	(0.093)	(0.135)	(0.012)	(0.086)	(0.015)
# of Female Adults	-0.078	-0.186	-0.087	-0.007	0.041	0.007
	(0.056)	(0.138)	(0.171)	(0.014)	(0.080)	(0.014)
log(Household Income)	0.054*	0.129*	-0.029	-0.002	-0.032	-0.005
	(0.030)	(0.071)	(0.043)	(0.003)	(0.033)	(0.006)
# of Children (<19)	-0.113***	-0.270***	-0.146*	-0.011*	-0.098**	-0.017***
	(0.019)	(0.046)	(0.080)	(0.006)	(0.038)	(0.006)
MSA	0.120*	0.288*	0.180	0.014	-0.111	-0.019
	(0.068)	(0.170)	(0.153)	(0.011)	(0.085)	(0.015)
Constant	1.251***		-1.085**		-0.400	
	(0.258)		(0.511)		(0.575)	
Observations	6,730	6,730	6,730	6,730	6,730	6,730

NOTE: Cluster-robust standard errors in parentheses. Interaction means $I\{j = SCHIP\} \cdot I\{s = AZ\} \cdot I\{t \geq 2005\}$. The dependent variable is the number of visits.to the doctor's office (Office), the number of hospital outpatient visits (Outpatient), the number of hospital emergency room visits. Column (2), (4), and (6) show marginal effects (ME) of negative binomial regression model. All predictors are at their mean value. *** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level

Table 3.8 Poisson Pseudo Maximum Likelihood Estimation Results on Medical Expenses for Doctor's Office.

VARIABLES	(1) Total Expenses	(2) ME(Total Expenses)	(3) Out-of-pocket	(4) ME(Out-of-pocket)
Interaction	0.444**	97.218**	0.116	2.971
	(0.219)	(45.850)	(0.175)	(4.450)
Age	-0.174***	-38.179***	-0.098***	-2.523***
	(0.018)	(4.254)	(0.037)	(0.955)
Age squared	0.009***	1.947***	0.006***	0.150***
	(0.001)	(0.205)	(0.001)	(0.032)
Male	0.018	3.845	-0.017	-0.446
	(0.046)	(10.057)	(0.098)	(2.503)
White (Hispanic)	-0.368***	-80.471***	-0.323	-8.309
	(0.104)	(25.468)	(0.245)	(6.322)
Black	-0.740***	-161.922***	-1.300***	-33.418***
	(0.129)	(30.189)	(0.345)	(9.412)
Others	-0.020	-4.425	-0.079	-2.021
	(0.145)	(31.630)	(0.630)	(16.194)
High School	0.189	41.380	0.765***	19.662***
	(0.175)	(39.216)	(0.133)	(3.801)
College or above	0.361**	79.061**	1.293***	33.239***
	(0.168)	(37.550)	(0.157)	(4.682)
# of Male Adults	-0.105	-22.956	-0.205**	-5.263**
	(0.116)	(24.653)	(0.101)	(2.638)
# of Female Adults	-0.148**	-32.329**	-0.225**	-5.777***
	(0.060)	(13.911)	(0.088)	(2.119)
log(Household Income)	0.054	11.898	0.440***	11.299***
	(0.081)	(17.795)	(0.162)	(3.940)
# of Children (<19)	-0.142***	-31.149***	-0.123***	-3.159***
	(0.025)	(5.609)	(0.030)	(0.708)
MSA	0.214*	46.896*	0.173	4.459
	(0.125)	(28.352)	(0.142)	(3.590)
Constant	5.601***		-1.125	
	(0.687)		(1.923)	
Observations	6,730	6,730	6,730	6,730

NOTE: Cluster-robust standard errors in parentheses. Interaction means $I\{j = SCHIP\} \cdot I\{s = AZ\} \cdot I\{t \geq 2005\}$. The dependent variable is the amount of medical expenses of total expenditure and out-of-pocket expenditure for doctor's office visits. Column (2) and (3) show marginal effects (ME) of Poisson pseudo-maximum likelihood estimation. All predictors are at their mean value. *** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.

Table 3.9 Poisson Pseudo Maximum Likelihood Estimation Results on Medical Expenses for Hospital Outpatient Visits.

VARIABLES	(1) Total Expenses	(2) ME(Total Expenses)	(3) Out-of-pocket	(4) ME(Out-of-pocket)
Interaction	-1.566***	-74.746***	12.369***	7.478***
	(0.438)	(25.654)	(1.241)	(1.970)
Age	-0.100**	-4.753**	-0.143**	-0.087**
	(0.042)	(1.935)	(0.061)	(0.044)
Age squared	0.005	0.227	0.006	0.004
	(0.003)	(0.163)	(0.004)	(0.003)
Male	0.299*	14.256*	0.496	0.300
	(0.159)	(7.726)	(0.312)	(0.216)
White (Hispanic)	-0.470	-22.419	-2.170***	-1.312***
	(0.293)	(15.373)	(0.353)	(0.273)
Black	-0.679	-32.402*	-1.165***	-0.704***
	(0.421)	(19.659)	(0.275)	(0.233)
Others	-1.225***	-58.488***	-2.486***	-1.503***
	(0.339)	(19.157)	(0.500)	(0.339)
High School	0.655	31.288	1.182	0.714
	(0.432)	(21.463)	(0.842)	(0.508)
College or above	0.996**	47.543**	1.901**	1.149**
	(0.468)	(23.057)	(0.876)	(0.507)
# of Male Adults	-0.061	-2.935	-0.028	-0.017
	(0.125)	(6.007)	(0.126)	(0.076)
# of Female Adults	0.294	14.050	0.203	0.123
	(0.244)	(11.834)	(0.157)	(0.087)
log(Household Income)	0.053	2.551	0.976***	0.590***
	(0.111)	(5.250)	(0.245)	(0.119)
# of Children (<19)	-0.060	-2.847	-0.286*	-0.173*
	(0.119)	(5.735)	(0.150)	(0.093)
MSA	0.094	4.471	-0.028	-0.017
	(0.218)	(10.143)	(0.382)	(0.231)
Constant	3.115***		-9.976***	
	(1.005)		(2.551)	
Observations	6,730	6,730	6,730	6,730

NOTE: Cluster-robust standard errors in parentheses. Interaction means $I\{j = SCHIP\} \cdot I\{s = AZ\} \cdot I\{t \geq 2005\}$. The dependent variable is the amount of medical expenses of total expenditure and out-of-pocket expenditure for hospital outpatient visits. Column (2) and (4) show marginal effects (ME) of Poisson pseudo-maximum likelihood estimation model. All predictors are at their mean value. *** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level

Table 3.10 Poisson Pseudo Maximum Likelihood Estimation Results on Medical Expenses for the Emergency Room Visits.

VARIABLES	(1) Total Expenses	(2) ME(Total Expenses)	(3) Out-of-pocket	(4) ME(Out-of-pocket)
Interaction	-0.542	-30.653	-1.735*	-7.774
	(0.493)	(27.350)	(0.955)	(4.911)
Age	-0.095	-5.352	-0.034	-0.154
	(0.062)	(3.400)	(0.121)	(0.567)
Age squared	0.006	0.356	0.001	0.004
	(0.004)	(0.227)	(0.008)	(0.036)
Male	0.283*	16.019*	0.303**	1.356***
	(0.170)	(8.677)	(0.121)	(0.469)
White (Hispanic)	-0.220	-12.475	-0.288	-1.290
	(0.202)	(11.644)	(0.286)	(1.389)
Black	-0.631***	-35.722***	-0.429*	-1.921*
	(0.133)	(8.726)	(0.224)	(1.035)
Others	0.386	21.829	0.738***	3.307***
	(0.395)	(21.836)	(0.256)	(0.614)
High School	0.088	4.996	-0.069	-0.308
	(0.144)	(7.970)	(0.393)	(1.811)
College or above	0.078	4.401	-0.190	-0.853
	(0.155)	(8.575)	(0.429)	(2.063)
# of Male Adults	-0.235	-13.312	-0.414	-1.854
	(0.201)	(11.768)	(0.276)	(1.469)
# of Female Adults	-0.194***	-10.988***	-0.548***	-2.457***
	(0.070)	(3.670)	(0.125)	(0.752)
log(Household Income)	0.126	7.127	0.870***	3.899***
	(0.100)	(5.644)	(0.161)	(0.858)
# of Children (<19)	-0.111	-6.253	-0.292	-1.310*
	(0.073)	(4.335)	(0.212)	(0.752)
MSA	-0.326*	-18.421	-0.143	-0.640
	(0.196)	(11.222)	(0.129)	(0.639)
Constant	3.602***		-5.679***	
	(1.097)		(1.928)	
Observations	6,730	6,730	6,730	6,730

NOTE: Cluster-robust standard errors in parentheses. Interaction means $I\{j = SCHIP\} \cdot I\{s = AZ\} \cdot I\{t \geq 2005\}$. The dependent variable is the amount of medical expenses of total expenditure and out-of-pocket expenditure for the emergency room visits. Column (2) and (4) show marginal effects (ME) of Poisson pseudo-maximum likelihood estimation. All predictors are at their mean value. *** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level

One thing that can support these results is preventive care and appointment status with a doctor provided by SCHIP for children between the ages of 0 and 17. Children's experience with height or weight measurement can be considered preventive care in MEPS. An indicator variable for preventive care or an appointment with a doctor when people want to make is shown in Table

3.11[19]. Children were less likely to visits to medical facilities for preventive care, which may mean that the introduction of SCHIP premium in Arizona had negatively effect on preventive care regarding weight measurement, which may result in deterioration of their health status.

Table 3.11 Regression Results on Children's Preventive Care and Appointment

VARIABLES	**Preventive H**	**Preventive W**	**Appointment**
Interaction	-0.048	-0.043**	-0.040
	(0.040)	(0.021)	(0.030)
Age	0.032***	0.032***	-0.051***
	(0.006)	(0.005)	(0.005)
Age squared	-0.002***	-0.002***	0.002***
	(0.000)	(0.000)	(0.000)
Male	-0.001	0.000	-0.018***
	(0.004)	(0.005)	(0.006)
White (Hispanic)	-0.056***	-0.057***	-0.077*
	(0.013)	(0.009)	(0.041)
Black	-0.037*	-0.017	-0.078*
	(0.020)	(0.015)	(0.041)
Others	-0.056*	-0.038*	-0.061
	(0.030)	(0.021)	(0.055)
High School	0.034***	0.037***	0.078***
	(0.007)	(0.011)	(0.027)
College or above	0.100***	0.086***	0.197***
	(0.014)	(0.014)	(0.028)
# of Male Adults	-0.012	-0.012	-0.046***
	(0.016)	(0.011)	(0.016)
# of Female Adults	-0.018*	0.001	-0.032***
	(0.010)	(0.008)	(0.009)
log(Household Income)	0.006	0.004	0.003
	(0.004)	(0.003)	(0.007)
# of Children (<19)	-0.025***	-0.023***	-0.033***
	(0.006)	(0.005)	(0.009)
MSA	0.002	-0.010	0.045*
	(0.025)	(0.027)	(0.025)
Observations	6,730	6,730	6,375

NOTE: Cluster-robust standard errors in parentheses. Each column shows marginal effects of probit model. All predictors are at their mean value. The dependent variable is Preventive H (Preventive care for height), Preventive W (Preventive care for weight), Appointment. *** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.

[19] The MEPS questionnaires for Preventive Care and Appointment are as follows, respectively: "Has a doctor or other health provider ever measured (PERSON)'s height or weight within past 2 years," and "In the last 12 months, not counting the times (PERSON) needed health care right away, did you make any appointments for (PERSON)'s health care at a doctor's office or clinic?"

3.6. Conclusion

Many previous studies have focused on the expansion of public health insurance such as the Medicaid expansion. The results in the previous literature have shown that medical utilization increased after states extend public insurance coverage because people had an incentive to visit health care facilities more with their public insurance. On the other hand, people would reduce the number of visits to medical facilities if they lose their public insurance. This perspective is true to some extent, but there may be other effects in the long run and in some cases.

For one to three years after the introduction of SCHIP premiums in Arizona, eligible children for SCHIP reduced the probability of receiving preventive care. In addition, perceived health status was getting worse. When people feel ill, those who seek medical care normally have three options: doctor's office, hospital outpatient departments, or emergency room. In this study, more people chose the doctor's office instead of hospital outpatient services or emergency room.

For the outpatient department, I found a strong effect of the introduction of SCHIP on outpatient department visits and expenditure. Hospital outpatient visits and total expenditure for visits to hospital outpatient departments both decreased. However, out-of-pocket expenses rose by 7.48 dollars. In other words, low-income children could not receive the SCHIP benefits and may have to 7.48 more dollars for medical expenses with their own money. For emergency room visits, children visited emergency departments more despite insignificant, but out-of-pocket medical expenses fell because of the low possibility of non-payment without insurance coverage.

There are some issues that can be captured in future works. First, MEPS data have a small sample size, so that alternative medical data could be useful to compare. Other medical data such as National Center for Health Statistics (NCHS) would be helpful to figure it out in-depth for the future research. Second, the coefficient of the doctor's office visits and expenditure were positive.

It is difficult to understand these results, so that they would not be consistent with previous literature. However, there is little previous literature for medical utilization after Medicaid or SCHIP reduction although there are many of them for Medicaid or SCHIP expansion. Part of the reason is the deterioration of the health condition, lack of preventive healthcare, and increased physician office visits as a substitute for outpatient visits due to expensive hospital outpatient costs (Reschovsky and White, 2014). A moral hazard issue could also be possible because it is well-known that medical utilization is higher in the group of people with public health insurance coverage than those who purchased private insurance (Riphahn, Wambach, and Million, 2003). Follow-up studies would be able to shed light upon the etiology of moral hazard whether people publicly insured visit doctor's office more when premiums increase.

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