Food-borne Illnesses and Liability in the U.S.

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Abstract

Food contamination is one of the leading causes of illness and mortality worldwide. In 2018, 1,052 food-borne disease outbreaks were documented in the U.S. involving fresh fruits, vegetables, meat products, restaurants, schools, and food stores. This study investigates the impacts of product liability laws on the reported number of food-borne illness outbreaks and related cases in the U.S. during 1998-2018. Using state-level data and panel regression models we find a positive and statistically significant relationship between the application of strict liability with punitive damages and the reported number of food-borne illness outbreaks and related cases. However, we find no statistically significant effect of strict liability with punitive damages on the reported number of food-borne-illness-related hospitalizations and deaths. Implications from increased early reporting are twofold: 1) improved government estimates of financial and mortality-related costs due to food-borne illnesses; 2) prevention of severe cases of food-borne illnesses that can cause hospitalizations and deaths. Both help stakeholders expand resources and efforts in food-borne illness prevention.

Key words: Food safety, Food-borne illness, Punitive damages, Panel data estimation.

JEL Classification: I12, K13.

1. Introduction

Food contamination is one of the leading causes of illness and mortality worldwide (Havelaar et al., 2015). According to the Centers for Disease Control and Prevention (CDC), around 48 million people in the U.S. fall ill, 128,000 are hospitalized, and 3,000 die from food-borne diseases every year (CDC, 2010). In 2018, 1,052 food-borne disease outbreaks were documented in the U.S. involving fresh fruits, vegetables, meat products, restaurants, schools, and food stores (CDC, 2020). Food safety outcomes depend on product liability, market forces, environmental factors, and regulations (Buzby and Frenzen, 1999). The U.S. product liability laws allow the consumers affected by unsafe products to take legal action and seek compensation for damages and costs (Buzby and Frenzen, 1999).

The purpose of product liability laws is to improve food safety by enabling affected consumers to seek compensation (Buzby and Frenzen, 1999). Liability costs and potential damages to reputation are expected to serve as financial incentives for producers to ensure food safety (Pouliot and Sumner, 2008). Yet, studies have pointed out that product liability has unclear impacts on the reported accident rates[1]. Also, despite the burden that food-borne illnesses impose on public heath, there are limited studies on the relationship between food-borne incidents and legal structure (e.g., liability laws). We fulfill this void by investigating the impacts of product liability laws on the incidence of reported food-borne illnesses in the U.S. Our results shed light on the role of regulation in the reported incidence of food-borne illnesses. Understanding the impact of liability laws on reported food-borne illness incidents is an important element of evaluating the efficacy of food safety regulation. Garber (1998) demonstrates that product liability improves economic efficiency by supporting adequate food safety for underinformed consumers. On the other hand, product liability may result in excessive food safety efforts (Garber, 1998) and may inflate the cost of production (Viscusi, 2012). Product liability may also decrease economic activities by reducing production, innovation, and employment (Shepherd, 2013).

The U.S. food industry has undergone many changes regarding the safety of its products during the past two decades (Doyle et al., 2015). For instance, the introduction of Food Safety Modernization Act (FSMA) by the U.S. Food and Drug Administration (FDA) in 2011 could ease the transformation to more food safety improvements in the U.S. food industry. Enhancements in surveillance system enables earlier and better identification of food-borne outbreaks (Biggerstaff,

[1] For a review of these studies, see Faure (2016).

2016). Despite all the progresses in food safety management, other factors, such as pathogen evolution, can still increase food-borne diseases, counteracting the improvements mentioned in food safety handling. Due to all these changes, a more recent analysis for the impacts of product liability laws (as one of the potential contributors of these changes) on the incidence of reported food-borne illnesses in the U.S. during 1998-2018 is warranted.

This study aims to answer the following questions: i) Does the application of strict liability and punitive damages affect the actual incidents of food-borne illnesses outbreaks and cases?; ii) Does the application of strict liability and punitive damages affect reporting behavior of food-borne illnesses outbreaks and cases?; iii) Does the application of strict liability and punitive damages affect the food-borne-related hospitalizations and deaths? To answer these questions, Poisson and Ordinary Least Squares (OLS) regression models with state and year fixed effects are estimated. We find a positive and statistically significant relationship between the application of strict liability and the reported number of food-borne illnesses outbreaks (food-borne illness incidents) and related cases (affected individuals)[2]. The results of OLS and Poisson estimation show that the states that have adopted strict product liability with punitive damages experience more reported food-borne illness outbreaks and cases than those that have not. A better reporting behavior by the consumers could improve government estimates of financial and mortality-related costs due to food-borne illnesses, helping the federal government and industry in expanding resources and efforts in food-borne illness prevention. However, we find no statistically significant effect of provision of strict liability with punitive damages on the reported number of food-borne-illness-related hospitalizations and deaths.

2. Literature Review

In the Coasian bargaining framework, in competitive markets, consumers and producers can freely negotiate and the liability rule has no effect on the efficient level of output and efficient care (Polinsky, 1983). However, since there are transaction costs[3] and asymmetric information, legal interventions are necessary to achieve the optimal level of care by producers (Shavell, 1980).

[2] Each outbreak of food-borne illness can include multiple affected individuals. We differentiate between the outbreak events and illness cases to test the robustness of our results to different specifications of the dependent variable.

[3] Transaction costs involve administrative, legal, and third-party expenses that are experienced by the harmed consumers and the liable producers (Buzby et al., 2001).

Therefore, product liability is needed as it may improve efficiency of food safety in production if some sort of market failure exists (Viscusi, 2012).

Most legal cases that arise in response to food-borne illnesses are ruled by product liability laws, which differ across states in the U.S. According to Buzby and Frenzen (1999), food-borne disease lawsuits are based on negligence or strict liability doctrines. The strict liability rule is the most common legal framework in the U.S. (Pouliot and Sumner, 2008; Viscusi, 1991). Under this rule, a producer that causes a food-borne illness is fully responsible for the damages (Viscusi, 2012). Under the negligence rule, the regulator sets a legal safety standard. If a food-borne illness occurs, the producer is liable for damages if it can be shown that the producer violated the established safety standard. Some states also have the Veggie Libels laws, which enable the producer to sue for defamation (Blattner and Ammann, 2019).

The merits of regulatory vis-à-vis a free market-based approach to food safety is debated in the economic literature. Among the recent studies that question the efficacy of product liability rules is the review paper by Polinsky and Shavell (2010). In their paper, the authors believe that product liability in the U.S. legal system may be socially undesirable with its costs exceeding its benefits. Legal expenses exceed compensations received by victims of product-related accidents via the liability system (Polinsky and Shavell 2010). These authors argue that the use of market forces may be better suited to improve food safety rather than product liability. Even in the absence of product liability producers seek to provide safer products. Consumer compensation for damages due to defective products is only a partial benefit because some of the victims are compensated by insurance coverage for the injuries even without the product liability law (Polinsky and Shavell, 2010). Moreover, if producers increase the price of products to cover the liability costs, the demand for their products may decrease impacting social welfare. Chen and Hua arrive at a similar conclusion. Using a spatial oligopoly model, Chen and Hua (2017) study the relationship between product liability, competition, and product safety. They find that reputation concerns and partial liability increase firms' incentives to produce safer products. Their findings also show that competition stimulates production of safer products.

In turn, using a theoretical framework, Hua and Spier (2020) find that market forces have a limited impact on promoting food safety standards. By examining the optimal provision of product safety by firms that exert market power, they find that the dominant strategy for such firms is to under-provide product safety and disclaim responsibility for the consumer loss and harm. This is so, provided that the consumers that are more likely to suffer from damages are also those that have larger gross benefits of consumption.

Pouliot and Sumner (2008) set up a theoretical stylized model composed of marketers, farms, and consumers. They find that by making product liability more feasible, traceability increases food safety. Traceability from the marketers to the farms enables the marketers to pass some of the liability costs to farms and incentivize farms to provide safer food.

Using 1990-2000 data for the U.S., Loureiro (2008) finds that product liability with punitive damages decreases reported food-borne illnesses. Following Loureiro (2008), we focus on the strict product liability rule with the possibility of claiming punitive damages. We extend Loureiro's work by addressing this question using more recent and expanded data set and different estimations methods. Additional to Loureiro (2008), we also estimate the impacts of provision of product liability with punitive damages on the reported number of food-borne illness outbreaks, deaths, and hospitalization. We investigate the impacts of provision of strict liability and punitive damages on the hospitalizations and deaths to identify whether provision of strict liability and punitive damages affects reporting behavior or actual illness incidents.

3. Data and Descriptive Statistics

Data used in this study come from secondary sources. Reported cases of food-borne illness outbreaks and related cases are obtained from the National Outbreak Reporting System (NORS) developed by the CDC. NORS provides information on enteric disease outbreaks including food-borne, waterborne, person-to-person transmitted, animal contact related, environmental contamination related, and other enteric illness outbreaks. The CDC database includes all the reported food-borne disease outbreaks within the U.S. per state since 1998. We also include the multistate illness outbreaks and cases by ascribing them to the relevant states. However, due to data availability from the CDC, assigning multistate outbreak cases to the relevant states was possible only for after 2009. Hence, the data on the number of food-borne illness cases include multistate cases only after 2009, while the data on reported number of food-borne illness outbreaks include single as well as multi state outbreaks during 1998-2018. The CDC database also includes data on the number of food-borne-related deaths and hospitalizations per state since 1998. This database does not allow us to ascribe the multistate deaths and hospitalizations to the related states during 1998-2018. Therefore, only single-state-related reported number of deaths and hospitalizations are included in this study.

Figures (1) and (2) show the outbreaks of food-borne illness and related cases during 1998-2018. According to these figures, we see spikes in food-borne illnesses and outbreaks in 2004 and 2006 followed by period of stability in numbers between 2010 and 2016. Although food-borne-related cases and outbreaks have been relatively decreasing, there may be a potential increase in the years following 2017. This further highlights the need for a current analysis of the effects of application of strict liability and punitive damages on food-borne illness reporting.

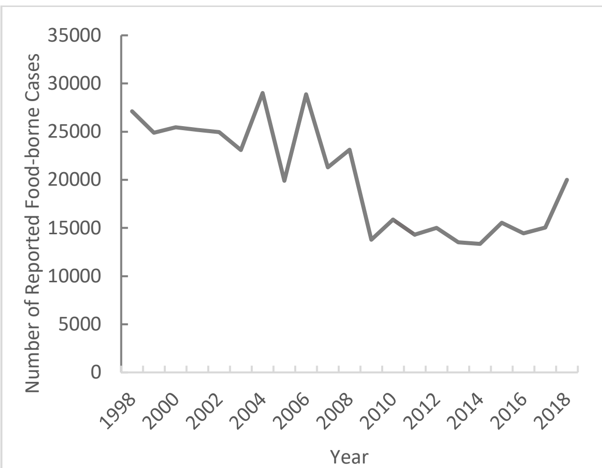

Figure 1: Reported number of food-borne illnesses cases in the U.S.

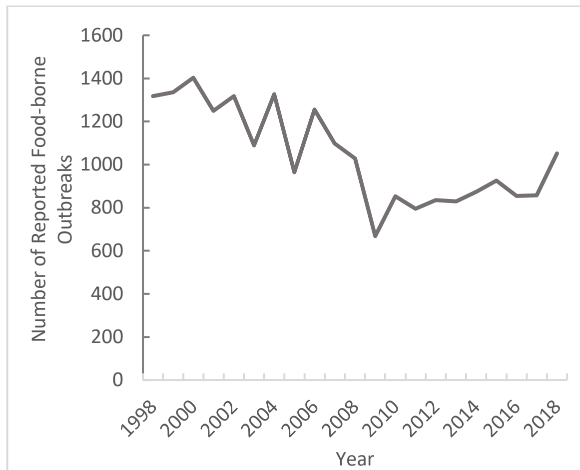

Figure 2: Reported number of food-borne illness outbreaks in the U.S.

Our variable of interest is strict product liability law with the possibility of claiming punitive damages. Punitive damages are penalties imposed on the producer in excess of compensation for damage and are intended to encourage safe practices. Following Loureiro (2008), we obtain the information on the application of product liability laws with punitive damages per state from annual issues of *Product Liability Desk Reference-A 50 State Compendium* (Daller, 1995). Another law-related variable included in this study is Veggie Libel. Veggie Libels are laws that make it easier for the producer to sue critics for defamation. Veggie Libels are included to control for lobbying efforts of the agricultural businesses to bring immunity to the producers against wrongful claims. To date, these laws exist in 13 states in the U.S.[4]

[4] The states are Alabama, Arizona, Colorado, Florida, Georgia, Idaho, Louisiana, Mississippi, North Dakota, Ohio, Oklahoma, South Dakota, and Texas (Blattner and Ammann, 2019).

The annual number of retail food stores and, eating and drinking places are included to account for food distribution and access. The number of eating and drinking places controls for the access to food consumed away from home. The data on retail food stores and, eating and drinking places per thousand people in each state is obtained from the *U.S. Statistical Abstracts*, 1998-2018.

Data on the percentage of the population living in the metropolitan areas, the percentage of people living below the poverty line, the percentage of non-white people, the number of lawyers per thousand people, and the number of Republican and Democratic representatives to Congress are obtained from the *US Statistical Abstracts*. The number of lawyers is included to represent access to legal services. Following Loureiro (2008), this variable is included to reflect political preferences. It is expected that as the number of Republican representatives to Congress increases, it becomes harder to pass laws and regulations that favor stricter food safety (Loureiro, 2008). Therefore, political preferences may affect the application of the product liability rule. Data on population is obtained from *U.S. Statistical Abstracts*. We control for population because the more populated states are expected to have higher numbers of reported food-borne illness incidents. Per capita expenditure on health care in real terms comes from *the Bureau of Economic Analysis*.

Table 1: Summary Statistics for U.S. 50 States Plus D.C. for the Period 1998-2018 (n=1,071)

VARIABLES	Variable Abb.	Mean	S.D.	Min	Max
Dependent variables:					
Number of total reported food-borne illness cases	Cases	379.9	506.3	0	4,633
Number of total reported food-borne illness outbreaks	Outbreaks	22.70	32.26	0	281
Number of total reported food-borne illness deaths	Death	0.217	0.718	0	8
Number of total reported food-borne illness hospitalizations	Hospital	0.127	1.522	0	45
Reported food-borne illness deaths (0:1)	Death_bin	0.128	0.334	0	1
Reported food-borne illness hospitalizations (0:1)	Hospital_bin	0.039	0.194	0	1
Explanatory variables:					
Strict liability law with punitive damages (0:1)	Law	0.746	0.435	0	1
Veggie Libel (0:1)	Veggie Libel	0.255	0.436	0	1
Average July temperature (Degree Fahrenheit)	July-Temp	53.66	8.338	38.52	81
Number of lawyers/thousand people	Lawyers	2.409	6.097	0.495	50.59
Annual per capita expenditure on health care in real terms ($)	Expenditures	2,415	536.5	1,142	4,592
Number of democratic representatives to the U.S. congress	Democrat	4.102	5.797	0	39
Number of republican representatives to the U.S. congress	Republican	4.400	4.672	0	25
Population per state (thousands of individuals)	Population	5,940	6,660	490.8	39,462
Number of eating and drinking places/thousand people	EatingPlaces	1.959	0.366	1.215	3.747
Number of food stores/thousand people	Foodstores	0.470	0.161	0.139	1.258
Percentage of people living under poverty line per state (%)	Poverty	13.32	3.306	5.900	24.70
Percentage of people living in a metropolitan area (%)	Metropolitan	52.28	26.85	1.429	100
Percentage of nonwhite people living in a specific state (%)	Non-White	19.54	13.60	1.908	74.40
Real GDP/thousand people (billions of dollars)	GDP	0.051	0.021	0.021	0.214

The average July temperature is obtained from the *National Oceanic and Atmospheric Administration (NOAA)*. According to the United States Department of Agriculture (USDA), the probability of food-borne illnesses increases during the summer mostly due to the faster growth of bacteria in warmer temperature and, because more food prepared outside of the home (USDA, 2021). However, it is also possible that the warmer weather causes more precautionary efforts to prevent food contamination (Loureiro, 2008).

Table 1 shows summary statistics for the fifty U.S. states and the District of Colombia (D.C.) for the outcome variables (reported number of single-state food-borne illness outbreaks and related cases, hospitalizations, and deaths), the variable of interest (application of strict product liability allowing for claiming punitive damages), and the control variables. The average state-year reported number of food-borne illness cases is around 380, the average state-year reported number of food-borne illness outbreaks is 22.7, average state-year reported number of food-borne-related hospitalization is 0.13, and average state-year reported number of food-borne-related deaths is 0.13. Seventy-five percent of state-year observations have strict liability with punitive damages.

4. Empirical Methods

Similar to Bellemare and Nguyen (2018), OLS regression is used to estimate the impacts from the application of strict liability and punitive damages on the reported number of food-borne illness outbreaks and related cases per thousand individuals. Additionally, as a robustness check, we use Poisson regression to estimate the impacts of the application of strict liability with punitive damages on the counts of reported number of food-borne illness outbreaks and related cases as the integer outcome variables[5].

In the OLS estimation, the equation of interest is

$$y_{it} = \alpha + x_{it}\beta + D_{it}\delta + \gamma_i + \mu_t + \epsilon_{it} \qquad (1)$$

where y_{it} is one of the dependent variables in state i in year t. x is the vector of control variables. D is treatment variable; it is one if the state has adopted strict product liability with punitive damages and zero otherwise. γ is a vector of state fixed effects. μ is a vector of year fixed effects. ϵ is the error term. We test the hypothesis of null effect of strict liability and punitive damages on reported food-borne illness incidents (H_0: $\delta = 0$) versus the alternative hypothesis H_A: $\delta \neq 0$.

[5] The dependent variable in the OLS estimation is calculated by dividing the reported number of food-borne illness cases or outbreaks by population measured in terms of thousand people. In the Poisson estimation, we use the reported number of food-borne illness cases or outbreaks as the integer outcome variable and control for the log of population in terms of a thousand people.

When the dependent variable is the reported number of food-borne illness cases per thousand people, following Bellemare and Nguyen (2018) we estimate two additional specifications of equation (1) to control for the effect of change in the data structure in 2009 when CDC started reporting differentiated number of food-borne illness cases for the states involved in multistate outbreaks[6]. The first specification assumes that the exclusion of the multistate illness cases only affects the intercept of equation (1):

$$y_{it} = \alpha + x_{it}\beta \ + D_{it}\delta + m_t\rho + \gamma_i + \mu_t + \epsilon_{it} \qquad (1')$$

where, m_t is an indicator variable equal to zero if multistate outbreak data are available in year t and one otherwise. This variable accounts for the missing multistate-related food-borne cases. In the second specification, it is assumed that the exclusion of the multistate cases affects the intercept as well as the slope of equation (1). Hence, in this specification we estimate

$$y_{it} = \alpha + x_{it}\beta \ + D_{it}\delta_D + (D_{it} * m_t)\delta_{Dm} + m_t\rho + \gamma_i + \mu_t + \epsilon_{it} \qquad (1'')$$

In the second specification (1''), the marginal effect of strict liability with punitive varies depending on pre versus post 2009 sample period. This marginal effect is provided by $\frac{\partial y}{\partial D} = \delta_D + \ \delta_{Dm} * \bar{m}$, where $\bar{m}$ refers to the sample mean of m_t and equals to 0.524 (given that multistate illness case data are missing for 11 out of 21 years in our sample). Following Bellemare and Nguyen (2018), the results of specification (1') are presented as the main results while the results of specifications in (1) and (1'') are shown for robustness. In turn, when the dependent variable is expressed in terms of outbreaks (i.e., the reported number of food-borne illness outbreaks per thousand people), we only provide the results of equation (1) since data on reported number of food-borne illness outbreaks include both single and multi-state data during 1998-2018.

Poisson regressions are estimated when the dependent variables are the number of food-borne illness outbreaks or related illness cases. Poisson and Negative Binomial regression models are most common techniques for non-negative integer dependent variable analysis (Cameron and Trivedi, 2013). The Poisson model restricts the conditional mean and conditional variance of the dependent variable to be equal. However, many count data models violate this variance-mean

[6] In other words, to the dependent variable for food-borne-illness-related outbreaks includes multistate outbreaks for 1998-2018. However, due to the availability of data from the CDC, the dependent variable for food-borne-illness-related cases contains multistate illness cases only for 2009-2018.

equality assumption. The violation of the equality of conditional mean and variance is referred to as over- or under-dispersion problem. One of the causes of the over- or under-dispersion problem is the existence of unobserved heterogeneity in individuals (Cameron and Trivedi, 2013). To overcome this problem, Negative Binomial models are commonly used. However, Wooldridge (1999) proves that, given that the conditional mean function is correctly specified for consistency, Poisson model produces consistent, efficient, and robust estimates of parameters, even when the response variable is over-dispersed. As such, the Poisson model is preferred over the Negative Binomial model for estimating the conditional mean parameters (Wooldridge, 2010). Therefore, in this paper the Poisson regression is used as the preferred method to estimate the impacts of strict liability and punitive damages on reported number of food-borne illness outbreaks and related cases[7].

In a Poisson model, the number of events *y* for individual *i* are assumed to be Poisson distributed with a conditional mean λ_{it} in state *i* and year *t*:

$$E(y'_{it}|x_{it}, D_{it}) = exp(x_{it}\beta\ + D_{it}\delta + \gamma_i + \mu_t + \epsilon_{it}) = \lambda_{it} \quad (2)$$

where the dependent variable, y'_{it}, is the count of reported food-borne illness outbreaks or number of illness cases in state *i* in year *t*. The corresponding probability density function of y' for individuals in state *i* in year *t* is

$$f(y'_{it}|x_{it}, D_{it}) = \frac{e^{-\lambda_{it}}\lambda_{it}^{y'_{it}}}{y'_{it}!} \quad (3)$$

Similar to the OLS estimations, we estimate equation (2'), an additional specification of equation (2) to account for lack of data on differentiated multistate-related food-borne illness cases pre-2009. Specification (2') assumes that the exclusion of multistate outbreaks data affects the slope of equation (2). In other words, we estimate

$$E(y'_{it}|x_{it}, D_{it}) = exp(x_{it}\beta\ + D_{it}\delta + (D_{it} * m_t)\delta_{Dm} + \gamma_i + \mu_t + \epsilon_{it}) = \lambda_{it} \quad (2')$$

[7] We estimated a Negative Binomial model for the outcome of interest (the reported number of outbreaks and related cases of food-borne illnesses), but the Law variable was not statistically significant in any of the estimations. Therefore, we did not report the results of a Negative Binomial model. The results of these regression models are available upon request.

The results of equations (2') and (3) are included as the main results of the Poisson estimation. The results of equations (2) and (3) are also shown for robustness. When the dependent variable is the count of reported food-borne illness outbreaks, we only provide the results of equations (2) and (3) since data on number of reported food-borne illness outbreaks include both single and multi-state data during 1998-2018.

All the specifications include state and year fixed effects. Year fixed effects are used to overcome unobserved and state-invariant heterogeneity correlated with the outcome of the interest. Year fixed effects represent technological and other improvement in food safety control systems such as the application of Hazard Analysis Critical Control Points (HACCAP). Similarly, state fixed effects are used to overcome unobserved and time-invariant heterogeneity correlated with the outcome of the interest[8]. We also estimate additional specifications that include a linear time trend, regional dummy variables, and spatial weight matrix[9] to account for spatial interdependencies as robustness checks.

Finally, the number of food-borne illness outbreaks and that of cases are usually underreported or underdiagnosed. This can introduce attenuation bias to the estimated relationship between the application of the food-safety-relevant laws and the food-borne diseases. As discussed by Bellemare and Nguyen (2018), this measurement error would make rejecting the null hypothesis ($H_0: \delta = 0$) less likely, meaning that a rejection of the null hypothesis, regardless of direction, would strengthen the results[10].

5. Results

This section presents the results of OLS and Poisson estimations. The dependent variables in the Poisson estimations are the counts of reported cases and outbreaks of food-borne illnesses, while in OLS estimations the dependent variables are continuous, expressed per thousand people. We also present the result for the impact of provision of strict liability and punitive damages on food-borne-related hospitalizations and deaths. The tables presented in this section show our main results and the relevant robustness checks. Additional results including specifications where we incorporate the reginal dummy variables, use random effects model, control for a linear time trend

[8] We also provide the results of the random effects models in appendix A as a robustness check.
[9] This is a matrix with elements equal to one if states *i* and *j* are neighbors and zero otherwise.
[10] The underreporting of food-borne outbreaks and cases would mean that the estimate $\hat{\delta}$ of δ is such that $|\hat{\delta}| < |\delta|$. In other words, $\hat{\delta}$ estimates the lower bound of δ, hence, a rejection of the null hypothesis in either direction will make a stronger result (Bellemare and Nguyen, 2018).

rather than year fixed effects, and include spatial weight matrixes for OLS and Poisson estimations are provided in the appendix.

5.1. Linear and Nonlinear Regressions

OLS estimates are shown in table 2. Columns (1) to (3) present estimates of equations (1'), (1), and (1") for the reported number of food-borne illness cases per thousand people, respectively. Column (4) shows estimation result of equation (1) for reported number of food-borne illness outbreaks per thousand people[11]. The models in equations (1') and (1") control for the effect of change in the data structure in 2009 when the CDC started reporting number of food-borne illness cases per each state involved in multistate outbreaks.

The results reported in all columns of table 2 tell the same story: after controlling for the year and state fixed effects as well as other control variables, there is a positive and statistically significant relationship between the provision of strict liability with punitive damages and the reported number of food-borne illness cases or outbreaks. A positive coefficient for the strict liability with punitive damages means that states that adopt strict liability have higher numbers of reported food-borne illnesses and outbreaks. For instance, from results in columns (1), (2), and (3) of table 2, the application of strict product liability and punitive damages is associated with about 6 percent additional reported food-borne illness cases per thousand individuals and around 0.2 percent more reported food-borne illness outbreaks per thousand individuals (column 4).

Similar to Alberini and Austin (1999), a possible explanation for the positive and statistically significant relationship between the presence of strict product liability with punitive damages and the reported number of food-borne illness cases or outbreaks is that the strict liability and punitive damages capture a reporting effect. In other words, the presence of strict liability laws that allow for punitive damages incentivizes individuals to report more food-borne illness incidents in order to be compensated for the damages and harms that they face. Food-borne illness outbreaks and cases generally suffer from underreporting by consumers and underdiagnosis by health officials (Arendt et al., 2013; Scallan et al., 2011; Mead et al., 1999). An increase in the reporting

[11] We only report estimates for equation (1) because data on the outbreaks includes both single and multistate outbreaks for 1998-2018. Hence, we ascribe the multistate outbreaks to the related states for these years. As such, no extra specifications for the outcome number of outbreaks is needed. Recall that in order to account for multistate-illness-outbreak-related cases pre-2009 we use additional specifications (i.e., equations 2 and 3).

of the number of food safety incidents could help to better understand the burden of food-borne incidents and improve food safety policy in the U.S. (Frenzen, 2004). A better reporting behavior by the consumers could improve government estimates of financial and mortality-related costs due to food-borne illnesses, helping the federal government and industry in expanding resources and efforts in food-borne illness prevention. Early reporting could also reduce the incidence of more serious incidences from food-borne cases and outbreaks that can cause hospitalizations and deaths.

Table 2: OLS Estimates for the Reported Number of Food-borne Illness Outbreaks and Related Cases Per Thousand People

	(1)	(2)	(3)	(4)
Dependent Variable:	*Reported Number of Cases of Food-borne Illnesses Per Thousand People*			*Reported Number of Outbreaks of Food-borne Illnesses Per Thousand People*
Law	0.06210**	0.06210**	0.05510*	0.00258**
	(0.02860)	(0.02860)	(0.03220)	(0.00103)
Non-White	-0.00264	-0.00264	-0.00268	-9.10e-05
	(0.00171)	(0.00171)	(0.00172)	(6.32e-05)
July-Temp	-0.00160	-0.00160	-0.00165	0.000245
	(0.00308)	(0.00308)	(0.00308)	(0.00022)
Poverty	0.00213	0.00213	0.00206	6.20e-05
	(0.00151)	(0.00151)	(0.00152)	(0.00012)
Expenditures	-4.64e-06	-4.64e-06	-6.04e-06	2.12e-06
	(2.87e-05)	(2.87e-05)	(2.91e-05)	(1.59e-06)
Metropolitan	0.00034	0.00034	0.00034	-3.06e-05
	(0.00039)	(0.00039)	(0.00036)	(2.23e-05)
Lawyers	-0.00682*	-0.00682*	-0.00681*	-0.00012
	(0.00407)	(0.00407)	(0.00399)	(0.00020)
EatingPlaces	-0.03200	-0.03200	-0.03230	-0.00377
	(0.0387)	(0.0387)	(0.0388)	(0.00238)
Foodstores	0.01370	0.01370	0.02460	0.00047
	(0.09840)	(0.09840)	(0.10300)	(0.00446)
Political	-0.02010	-0.02010	-0.01640	-0.00027
	(0.01570)	(0.01570)	(0.01590)	(0.00065)
GDP	1.59300***	1.59300***	1.51800***	0.00625
	(0.51700)	(0.51700)	(0.56700)	(0.03800)
Law#Lawerys	0.00046	0.00046	0.00043	-4.87e-05
	(0.00133)	(0.00133)	(0.00130)	(5.48e-05)
Multistate Outbreaks Not Recorded	-0.0244		-0.03390	
	(0.04260)		(0.04280)	
Law × Multistate Outbreaks Not Recorded			0.013000	
			(0.014100)	
Law (Marginal Effects)			0.06191**	
			(0.02962)	
Constant	0.178	0.154	0.187	-0.00485
	(0.19600)	(0.18700)	(0.19700)	(0.017300)
Observations	1,071	1,071	1,071	1,071
R-squared	0.06900	0.06900	0.06800	0.07100
State FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Notes:
Standard errors in parentheses are calculated by clustering over state.
***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.
In all the regressions Veggie Libel omitted because of collinearity.

Table 3 presents the results for Poisson estimations. Column (1) shows the results for equations (2') and (3) while columns (2) and (3) show the results for equations (2) and (3). Models

(2') and (3) control for the effect of change in the data structure related to multi-state illness cases in 2009 reported by the CDC. Consistent with the OLS results, we observe that after controlling for the year and state fixed effects and other control variables, there is a positive and statistically significant relationship between the reported number of food-borne illness outbreaks and related cases and the application of strict liability law with punitive damages.

Table 3: Poisson Estimation Results for the Reported Number of Food-borne Illness Outbreaks and Related Cases

	(1)	(2)	(3)
Dependent Variable:	*Reported Number of Cases of Food-borne Illnesses*		*Reported Number of Outbreaks of Food-borne Illnesses*
Law	0.47200*	0.52700**	0.48600***
	(0.26000)	(0.21500)	(0.15600)
Non-White	-0.00102	-0.00108	-0.02350**
	(0.00873)	(0.00871)	(0.0112)
July-Temp	-0.01120	-0.01060	0.01390
	(0.0183)	(0.0182)	(0.0123)
Poverty	-5.40e-05	0.000850	-0.0105
	(0.01320)	(0.01270)	(0.01620)
Expenditures	-0.00032	-0.00026	-0.00026
	(0.00025)	(0.00026)	(0.00032)
Metropolitan	0.000489	0.000463	-0.00890**
	(0.00256)	(0.00254)	(0.00363)
Lawyers	0.01410	0.01550	-0.09860
	(0.052200)	(0.052600)	(0.10700)
EatingPlaces	-0.92900***	-0.94600***	-1.10500*
	(0.32200)	(0.31200)	(0.57200)
Foodstores	0.63000	0.53500	0.65400
	(0.61100)	(0.59700)	(1.05600)
Political	-0.15600	-0.16100	0.003690
	(0.24700)	(0.24600)	(0.31300)
GDP	2.93800	4.08100	-23.54000
	(8.13400)	(8.13500)	(17.20000)
Law#Lawerys	0.00027	-0.00023	-0.00263
	(0.00894)	(0.00928)	(0.02010)
Population	0.10100	0.17700	-2.60200
	(1.19400)	(1.18200)	(2.73900)
Law × Multistate Outbreaks Not Recorded	0.07000		
	(0.11400)		
Observations	1,071	1,071	1,071
Wald	1,231	1,029	1,035
p-Value	0.00000	0.00000	0.00000
State FE	YES	YES	YES
Year FE	YES	YES	YES

Notes:
Standard errors in parentheses are calculated by clustering over state.
***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.
In all the regressions Veggie Libel dropped because it is constant within group.

Tables A1 to A8 in appendix A assess the robustness of the results presented in tables 2 and 3 by looking at the specifications where we incorporate the reginal dummy variables, use random effects model, control for a linear time trend rather than year fixed effects, and include spatial weight matrixes for OLS and Poisson estimations. Looking at these specifications, the positive and significant relationship between the application of strict liability and punitive damages and the reported number of food-borne illness outbreaks and related cases appear to be mostly stable. According to Altonji et al. (2005), this indicates that there is limited omitted variables bias in our estimations.

5.2. Hospitalizations and Deaths

Similar to food-borne illness outbreaks and related cases, food-borne-related deaths and hospitalizations suffer from underdiagnosis by health officials (Scallan et al., 2011; Mead et al., 1999). Since hospitalizations and deaths occur due to more severe and fatal food-borne-causing pathogens, they need serious medical attention. We investigate the impacts of the provision of strict liability and punitive damages on hospitalizations and deaths to determine whether provision of strict liability and punitive damages affects reporting behavior but not the actual illness incidents. A significant relationship between food-borne-related hospitalizations and deaths and provision of the strict liability with punitive damages would suggest that liability law with punitive damages affect the actual food-borne illnesses rather than reporting behavior. If there is no statistically significant relationship between provision of strict liability with punitive damages and the number of hospitalizations and deaths, we can conclude that the application of strict liability with punitive damages affects reporting behavior rather than actual illnesses.

Table 4 shows the results of OLS, Poisson, and Logit[12] models for outcome variable as the reported number of food-borne-related hospitalizations and deaths. Columns (1) and (4) present the results of OLS estimations where the dependent variables are the reported number of food-borne illness hospitalization and deaths per thousand people, respectively. Columns (2) and (5) show the results of Poisson estimations where the dependent variables are the reported number of food-borne-related hospitalization and deaths, respectively. Columns (3) and (6) present the results of Logit model where the dependent variables are indicator variables equal to one if there is reported food-borne illness hospitalization and death, and zero otherwise. Due to the availability of data from the CDC, the dependent variables in this table only include the single-state outbreaks hospitalizations and deaths.

[12] The frequency distribution plots presented in appendix figure A1 show that the distribution of food-related deaths and hospitalizations are left skewed. Due to the prevalence of observations with zero value, we created an indicator variable equal to one if there is reported food-borne illness hospitalization or death, respectively, and zero otherwise. We estimated a Logit model as a robustness check.

Table 4: Estimation Results for Reported Number of Food-borne Illness Hospitalizations and Deaths

	Food-borne Illness Hospitalizations			Food-borne Illness Deaths		
	(1)	(2)ǂ	(3)ǂ	(4)	(5)ǂ	(6)ǂ
Law	1.99e-05	7.94700	0.01160	1.26e-05	0.61800	0.00742
	(0.00010)	(5.76000)	(0.03290)	(6.37e-05)	(1.83800)	(0.01220)
Non-White	5.85e-08	1.18200***	0.00158	7.01e-07	0.04060	0.00026
	(5.12e-06)	(0.31600)	(0.00315)	(0.00000)	(0.03700)	(0.00030)
July-Temp	1.95e-06	0.62900***	0.00092	1.12e-05**	0.10100*	0.00083
	(8.72e-06)	(0.20600)	(0.00186)	(5.55e-06)	(0.05890)	(0.00085)
Poverty	4.03e-06	0.10900	-0.00024	2.90e-06	0.08690*	0.000461
	(5.82e-06)	(0.07400)	(0.000496)	(3.70e-06)	(0.04560)	(0.00050)
Expenditures	-2.79e-08	-0.007810**	-2.44e-05	7.29e-08	-0.000136	-1.60e-07
	(8.25e-08)	(0.00304)	(3.89e-05)	(5.25e-08)	(0.00095)	(4.88e-06)
Metropolitan	8.16e-07	0.15600***	0.00021	7.61e-07	0.02020*	3.54e-05
	(1.56e-06)	(0.04990)	(0.000464)	(9.93e-07)	(0.01200)	(7.22e-05)
Lawyers	-1.55e-05	-6.45400***	-0.01010	-1.53e-05	-1.50800*	-0.00262
	(2.45e-05)	(2.16700)	(0.02240)	(1.56e-05)	(0.77500)	(0.00487)
EatingPlaces	0.00021	10.65000***	0.00448	0.00015*	0.59400	-3.82e-06
	(0.00014)	(3.29200)	(0.01700)	(9.00e-05)	(1.26200)	(0.00718)
Foodstores	-0.00028	-25.15000***	-0.02250	-3.24e-05	-1.82400	-0.01270
	(0.00024)	(6.46200)	(0.04410)	(0.000152)	(2.10500)	(0.01720)
Political	7.13e-06	1.94900	0.00914	3.59e-05	0.91700	-0.00037
	(5.46e-05)	(2.13200)	(0.01620)	(3.47e-05)	(0.76200)	(0.00393)
GDP	0.002490	142.70000	-107.70000	0.00078	-41.02000	-0.17400
	(0.00186)	(103.30000)	(135.50000)	(0.00118)	(29.62000)	(0.10800)
Law#Lawerys	2.19e-07	2.348	0.00685	-8.80e-07	0.30300	-0.001850
	(9.64e-06)	(2.531)	(0.01730)	(6.13e-06)	(0.84400)	(0.00495)
Population		5.98500	-9.19200		-7.99500**	-0.02660***
		(10.11000)	(12.69000)		(3.44800)	(0.00666)
Constant	-0.00055			-0.00111***		
	(0.00059)			(0.00037)		
Observations	1,071	357	357	1,071	840	840
State FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Note:
Columns (1) and (4) show the estimation results of equation (1) with dependent variables as the reported number of food-borne illness hospitalization and deaths per thousand people, respectively. Columns (2) and (5) show the estimation results of equations (2) and (3) with dependent variables as the reported number of food-borne illness hospitalization and deaths, respectively. The dependent variables in columns (3) and (6) are indicator variables equal to one if there is reported food-borne illness hospitalization or death, respectively, and is zero otherwise. Standard errors in parentheses in columns (1), (2), (4), and (5) are calculated by clustering over state. Numbers reported in columns (3) and (6) are marginal effects. In all the regressions Veggie Libel dropped because it is constant within group. ***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.
ǂ Observations dropped because of all zero outcomes.

The results in table 4 indicate that there is no statistically significant relationship between the reported number of food-borne-related hospitalizations and deaths, and the provision of strict product liability and punitive damages. This result is robust across different specifications using reginal fixed effects and random effects models reported in appendix tables A9 and A10. We show that the relationship between the application of strict product liability and punitive damages and reported number of food-borne outbreaks and related cases is significantly positive, but such a relationship is inexistent for hospitalizations and deaths. Furthermore, these results leads us to conclude that legislation is not only increasing reporting behavior in the initial stages of the food-borne outbreaks but also potentially reducing the possibility for the outbreaks to lead to more severe cases (e.g., hospitalization and death).

6. Conclusions

Food contamination is one of the leading causes of illness and mortality worldwide. Food safety outcomes depend on product liability, market forces, environmental factors, and regulations. Most legal cases that arise in response to food-borne illnesses are governed by product liability laws, which differ across states in the U.S. The U.S. product liability laws allow consumers affected by unsafe products to take legal action and seek compensation for damages and costs.

This study investigates the impacts of product liability laws on the reported number of food-borne illness outbreaks and related cases in the U.S. during 1998-2018. We find a positive and statistically significant relationship between the application of strict liability and the reported number of food-borne illness outbreaks and related cases. The results of OLS and Poisson estimation show that the states that adopt strict product liability and allow for claiming punitive damages experience more reports of food-borne illness cases and outbreaks than those states that do not adopt neither strict liability, nor punitive damages, nor both. However, we find no statistically significant effect of strict liability with punitive damages on the reported number of food-borne-illness-related hospitalizations and deaths.

The results of this study are similar to Alberini and Austin (1999) who find a positive and significant relationship between the application of strict liability and reported number of toxic environmental incidents. The authors believe that residents in states which have adopted strict liability are more willing to report environmental spills. Hence, the positive correlation between the provision of strict liability and the reported number of environmental accidents may be due to an increase in reporting of these incidents. The results of our study are different to Loureiro (2008) we who show a negative and significant relationship between the application of strict liability and punitive damages and reported number of food-borne illnesses. Different to Loureiro (2008), we use more recent and expanded data set and different estimations methods.

The results are important from the policy perspective because they document the benefits of liability laws in terms of improved food safety reporting behavior. Given that food safety incidents are generally underreported (Bellemare and Nguyen, 2018; Arendt et al., 2013; Scallan et al., 2011; Loureiro, 2008; Mead et al., 1999), an improved reporting behavior helps public health agencies identify potential food-borne illness outbreaks. In identifying the outbreaks, sick individuals are required to provide information about their symptoms, where they ate and purchased food prior to sickness, and the foods they consumed. Accordingly, during investigations of food-borne disease outbreaks public health officials gain knowledge about problems in food preparation, production, processing, and distribution that may lead to diseases. By investigating food-borne illness outbreaks, public health officials can prevent further transmission of illnesses and learn how to prevent similar food-borne outbreaks from happening in the future. This can help prevention of severe incidents of food-borne illnesses that cause hospitalizations and deaths. Furthermore, an increase in reporting the number of food safety incidents can assist to better quantify the financial and mortality-related costs and burdens imposed by these diseases. It can also help in deciding whether further regulatory controls are required to prevent future food-borne outbreaks. Future studies may focus on the impacts of food-borne illness claims in addition to the product liability law on the reported number of food-borne diseases incidents.

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Appendix A: Estimation Results for Robustness Check

Table A1: OLS Estimates for the Reported Number of Food-borne Illness Outbreaks and Related Cases Per Thousand People Including Regional Dummy Variables

	(1)	(2)	(3)	(4)
Dependent Variable:	*Reported Number of Cases of Food-borne Illnesses Per Thousand People*			*Reported Number of Outbreaks of Food-borne Illnesses Per Thousand People*
Law	0.0200**	0.0200**	0.0146*	0.000985**
	(0.0080)	(0.00798)	(0.00847)	(0.000425)
Non-White	0.0002	0.000146	0.000170	2.44e-05
	(0.0005)	(0.000534)	(0.000537)	(3.09e-05)
July-Temp	-0.00252*	-0.00252*	-0.00254*	5.15e-05
	(0.00151)	(0.00151)	(0.00150)	(0.000153)
Poverty	0.000759	0.000759	0.000658	-1.98e-05
	(0.00114)	(0.00114)	(0.00114)	(7.68e-05)
Expenditures	-4.61e-06	-4.61e-06	-5.22e-06	2.66e-06**
	(1.46e-05)	(1.46e-05)	(1.43e-05)	(1.23e-06)
Metropolitan	0.000257	0.000257	0.000263	-2.74e-06
	(0.000200)	(0.000200)	(0.000207)	(1.18e-05)
Lawyers	-0.00430*	-0.00430*	-0.00409*	-0.000168
	(0.00244)	(0.00244)	(0.00249)	(0.000166)
EatingPlaces	0.0353	0.0353	0.0358*	0.000205
	(0.0217)	(0.0217)	(0.0217)	(0.00195)
Foodstores	0.00350	0.00350	0.00658	0.00225
	(0.0559)	(0.0559)	(0.0564)	(0.00359)
Political	-0.0324**	-0.0324**	-0.0311**	-0.000753
	(0.0150)	(0.0150)	(0.0148)	(0.000648)
Veggie Libel	0.00799	0.00799	0.00790	-0.000185
	(0.0115)	(0.0115)	(0.0116)	(0.000708)
GDP	1.377***	1.377***	1.321**	0.00229
	(0.492)	(0.492)	(0.519)	(0.0312)
Law#Lawyers	0.000924	0.000924	0.000856	5.71e-06
	(0.00102)	(0.00102)	(0.00101)	(3.95e-05)
West	-0.0145	-0.0145	-0.0148	0.00138
	(0.0134)	(0.0134)	(0.0134)	(0.00101)
South	-0.00620	-0.00620	-0.00623	-0.00229
	(0.0170)	(0.0170)	(0.0169)	(0.00166)
Northeast	-0.0442**	-0.0442**	-0.0446**	-0.00214
	(0.0217)	(0.0217)	(0.0216)	(0.00136)
Multistate Outbreaks Not Recorded	-0.0113		-0.0180	
	(0.0339)		(0.0327)	
Law × Multistate Outbreaks Not Recorded			0.0100	
			(0.0124)	
Law (Marginal Effects)			0.01987***	
			(0.008084)	
Constant	0.102	0.0909	0.108	-0.00368
	(0.0948)	(0.0938)	(0.0949)	(0.0122)
Observations	1,071	1,071	1,071	1,071
R-squared	0.0583	0.0583	0.0586	0.0514
State FE	NO	NO	NO	NO
Year FE	YES	YES	YES	YES

Notes:
Standard errors in parentheses are calculated by clustering over state.
***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.

Table A2: Poisson Estimation Results for the Reported Number of Food-borne Illness Outbreaks and Related Cases Including Regional Dummy Variables

	(1)	(2)	(3)
Dependent Variable:	*Reported Number of Cases of Food-borne Illnesses*		*Reported Number of Outbreaks of Food-borne Illnesses*
Law	0.473*	0.525**	0.458
	(0.264)	(0.221)	(0.317)
Non-White	-0.00125	-0.00129	-0.0202
	(0.00846)	(0.00839)	(0.0467)
July-Temp	-0.0116	-0.0110	0.0133
	(0.0182)	(0.0180)	(0.0258)
Poverty	0.000192	0.00104	-0.00714
	(0.0131)	(0.0126)	(0.0157)
Expenditures	-0.000283	-0.000261	8.30e-05
	(0.000272)	(0.000273)	(0.000550)
Metropolitan	0.000436	0.000415	-0.00821
	(0.00250)	(0.00247)	(0.0112)
Lawyers	0.0144	0.0156	-0.0182
	(0.0479)	(0.0475)	(0.266)
EatingPlaces	-0.896**	-0.913***	-0.797
	(0.360)	(0.347)	(1.081)
Foodstores	0.642	0.551	1.046
	(0.612)	(0.596)	(1.115)
Political	-0.153	-0.158	0.0235
	(0.245)	(0.244)	(0.314)
Veggie Libel	0.173	0.154	0.162
	(0.724)	(0.665)	(2.113)
GDP	-0.524	5.506	-5.023
	(0.412)	(9.300)	(42.13)
Law#Lawyers	0.000637	0.000164	0.00919
	(0.00870)	(0.00902)	(0.0354)
West	-0.262	-0.244	0.377
	(0.509)	(0.552)	(0.581)
South	-0.575	-0.592	-0.266
	(0.524)	(0.519)	(2.679)
Northeast	-0.388	-0.359	-0.458
	(0.329)	(0.355)	(0.715)
Population	0.371	0.433	0.265
	(1.512)	(1.381)	(6.230)
Law × Multistate Outbreaks Not Recorded	0.0669		
	(0.113)		
Observations	1,071	1,071	1,071
Wald	33,965	44,380	6,799
p-Value	0	0	0
State FE	NO	NO	NO
Year FE	YES	YES	YES

Notes:
Standard errors in parentheses are calculated by clustering over state.
***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.

Table A3: Random Effects OLS Estimates for the Reported Number of Food-borne Illness Outbreaks and Related Cases Per Thousand People

	(1)	(2)	(3)	(4)
Dependent Variable:	*Reported Number of Cases of Food-borne Illnesses Per Thousand People*			*Reported Number of Outbreaks of Food-borne Illnesses Per Thousand People*
Law	0.0190**	0.0190**	0.0141*	0.00128**
	(0.00780)	(0.00780)	(0.00838)	(0.000503)
Non-White	0.000355	0.000355	0.000372	2.63e-05
	(0.000506)	(0.000506)	(0.000509)	(3.60e-05)
July-Temp	-0.00250**	-0.00250**	-0.00252**	-1.42e-05
	(0.00127)	(0.00127)	(0.00127)	(0.000132)
Poverty	0.000743	0.000743	0.000676	-2.04e-05
	(0.00121)	(0.00121)	(0.00121)	(7.42e-05)
Expenditures	-5.97e-06	-5.97e-06	-6.40e-06	2.36e-06*
	(1.55e-05)	(1.55e-05)	(1.54e-05)	(1.30e-06)
Metropolitan	0.000122	0.000122	0.000127	5.68e-06
	(0.000196)	(0.000196)	(0.000204)	(8.93e-06)
Lawyers	-0.00329	-0.00329	-0.00310	-0.000176
	(0.00230)	(0.00230)	(0.00236)	(0.000203)
EatingPlaces	0.0277	0.0277	0.0278	0.000657
	(0.0238)	(0.0238)	(0.0239)	(0.00258)
Foodstores	-0.0481	-0.0481	-0.0453	-0.000559
	(0.0554)	(0.0554)	(0.0576)	(0.00353)
Political	-0.0276*	-0.0276*	-0.0259*	-0.000550
	(0.0141)	(0.0141)	(0.0140)	(0.000629)
Veggie Libel	0.0143	0.0143	0.0141	-0.000323
	(0.0143)	(0.0143)	(0.0145)	(0.000970)
GDP	1.480***	1.480***	1.437**	0.0131
	(0.539)	(0.539)	(0.564)	(0.0318)
Law#Lawyers	0.000648	0.000648	0.000580	-1.15e-06
	(0.000999)	(0.000999)	(0.000987)	(3.93e-05)
Multistate Outbreaks Not Recorded	-0.0189		-0.0251	
	(0.0359)		(0.0350)	
Law × Multistate Outbreaks Not Recorded			0.00921	
			(0.0125)	
Law (Marginal Effects)			0.01896**	
			(0.007909)	
Constant	0.124	0.105	0.129	-0.00122
	(0.0951)	(0.0919)	(0.0961)	(0.0130)
Observations	1,071	1,071	1,071	1,071
R-squared	0.0579	0.0579	0.0583	0.0480
State FE	NO	NO	NO	NO
Year FE	YES	YES	YES	YES

Notes:
Standard errors in parentheses are calculated by clustering over state.
***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.

Table A4: Random Effects Poisson Estimation Results for the Reported Number of Food-borne Illness Outbreaks and Related Cases

	(1)	(2)	(3)
Dependent Variable:	*Reported Number of Cases of Food-borne Illnesses*		*Reported Number of Outbreaks of Food-borne Illnesses*
Law	0.473*	0.525**	0.464*
	(0.264)	(0.219)	(0.280)
Non-White	-0.00133	-0.00138	-0.0207
	(0.00865)	(0.00861)	(0.0387)
July-Temp	-0.0118	-0.0113	0.0128
	(0.0184)	(0.0183)	(0.0134)
Poverty	0.000174	0.00102	-0.00732
	(0.0130)	(0.0125)	(0.0155)
Expenditures	-0.000285	-0.000263	5.45e-05
	(0.000274)	(0.000274)	(0.000608)
Metropolitan	0.000424	0.000402	-0.00827
	(0.00253)	(0.00250)	(0.00915)
Lawyers	0.0137	0.0148	-0.0305
	(0.0482)	(0.0481)	(0.227)
EatingPlaces	-0.897**	-0.913***	-0.812
	(0.355)	(0.344)	(1.110)
Foodstores	0.640	0.548	0.985
	(0.614)	(0.600)	(1.219)
Political	-0.154	-0.159	0.0241
	(0.246)	(0.245)	(0.305)
Veggie Libel	0.109	0.0837	0.129
	(0.660)	(0.626)	(1.883)
GDP	4.338	5.364	-6.345
	(8.900)	(8.479)	(39.25)
Law#Lawyers	0.000661	0.000188	0.00886
	(0.00873)	(0.00904)	(0.0407)
Population	0.350	0.411	0.0732
	(1.356)	(1.239)	(5.989)
Law × Multistate Outbreaks Not Recorded	0.0672		
	(0.113)		
Observations	1,071	1,071	1,071
Wald	24,026	26,995	4,032
p-Value	0	0	0
State FE	NO	NO	NO
Year FE	YES	YES	YES

Notes:
Standard errors in parentheses are calculated by clustering over state.
***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.

Table A5: OLS Estimates for the Reported Number of Food-borne Illness Outbreaks and Related Cases Per Thousand People

	(1)	(2)	(3)	(4)
Dependent Variable:	*Reported Number of Cases of Food-borne Illnesses Per Thousand People*			*Reported Number of Outbreaks of Food-borne Illnesses Per Thousand People*
Law	0.0528*	0.0497*	0.0453	0.00219**
	(0.0280)	(0.0265)	(0.0312)	(0.000965)
Non-White	-0.000865	-0.00155**	-0.000911	-8.37e-05*
	(0.000804)	(0.000741)	(0.000806)	(4.97e-05)
July-Temp	0.000987	0.000779	0.000911	0.000171
	(0.00171)	(0.00177)	(0.00173)	(0.000171)
Poverty	0.000863	-0.000774	0.000826	-5.48e-05
	(0.00128)	(0.000894)	(0.00128)	(7.17e-05)
Expenditures	-2.11e-05	-8.81e-06	-2.19e-05	1.74e-06
	(2.00e-05)	(2.28e-05)	(2.01e-05)	(1.28e-06)
Metropolitan	0.000150	0.000166	0.000170	-3.30e-05
	(0.000294)	(0.000295)	(0.000300)	(2.27e-05)
Lawyers	-0.00720*	-0.00876**	-0.00719*	-0.000172
	(0.00405)	(0.00361)	(0.00399)	(0.000167)
EatingPlaces	-0.0235	0.00690	-0.0232	-0.00188
	(0.0349)	(0.0332)	(0.0345)	(0.00178)
Foodstores	-0.00375	-0.0104	0.00707	0.000923
	(0.113)	(0.116)	(0.119)	(0.00429)
Political	-0.0138	-0.00898	-0.0103	-0.000204
	(0.0158)	(0.0154)	(0.0153)	(0.000666)
GDP	1.389***	1.453***	1.315***	0.00827
	(0.435)	(0.442)	(0.477)	(0.0359)
Law#Lawyers	0.000464	0.000420	0.000415	-3.65e-05
	(0.00122)	(0.00127)	(0.00119)	(4.34e-05)
Year	0.00419**	0.000441	0.00413***	-1.76e-05
	(0.00158)	(0.00170)	(0.00152)	(0.000122)
Multistate Outbreaks Not Recorded	0.0429*		0.0324*	
	(0.0220)		(0.0171)	
Law × Multistate Outbreaks Not Recorded			0.0138	
			(0.0132)	
Law (Marginal Effects)			0. 05256**	
			(0. 02908)	
Constant	-8.404***	-0.893	-8.269***	0.0325
	(3.119)	(3.368)	(2.997)	(0.237)
Observations	1,071	1,071	1,071	1,071
R-squared	0.0484	0.0380	0.0493	0.024
State FE	YES	YES	YES	YES
Year FE	NO	NO	NO	NO

Notes:
Standard errors in parentheses are calculated by clustering over state.
***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.
In all the regressions Veggie Libel omitted because of collinearity.

Table A6: Poisson Estimation Results for the Reported Number of Food-borne Illness Outbreaks and Related Cases with Linear Time Trend

	(1)	(2)	(3)
Dependent Variable:	*Reported Number of Cases of Food-borne Illnesses*		*Reported Number of Outbreaks of Food-borne Illnesses*
Law	0.467*	0.450**	0.434***
	(0.245)	(0.209)	(0.164)
Non-White	0.00151	-0.00434	-0.0285***
	(0.00814)	(0.00884)	(0.0105)
July-Temp	0.0109	0.00642	0.0161
	(0.0113)	(0.0115)	(0.0101)
Poverty	-0.00911	-0.0253**	-0.0297**
	(0.0125)	(0.0114)	(0.0147)
Expenditures	-0.000295*	-2.68e-05	-0.000167
	(0.000174)	(0.000194)	(0.000217)
Metropolitan	0.000234	0.000275	-0.00931***
	(0.00254)	(0.00246)	(0.00343)
Lawyers	0.00804	-0.0217	-0.121
	(0.0561)	(0.0641)	(0.105)
EatingPlaces	-1.034***	-0.480*	-0.774
	(0.329)	(0.270)	(0.476)
Foodstores	0.0369	-0.186	0.370
	(0.711)	(0.733)	(1.043)
Political	-0.0739	0.0352	0.0616
	(0.235)	(0.224)	(0.282)
GDP	-3.815	-3.103	-25.23
	(7.907)	(8.110)	(16.28)
Law#Lawyers	-0.00511	-0.00536	-0.00487
	(0.00925)	(0.00996)	(0.0206)
Population	-0.680	-0.232	0.0732
	(1.208)	(1.222)	
Year	0.0401**	-0.0215	0.0208
	(0.0170)	(0.0160)	(0.0174)
Law × Multistate Outbreaks Not Recorded	0.0701		-2.722
	(0.113)		(2.725)
Observations	1,071	1,071	1,071
Wald	192.9	190.8	48.12
p-Value	0	0	0
State FE	YES	YES	YES
Year FE	NO	NO	NO

Notes:
Standard errors in parentheses are calculated by clustering over state.
***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.
In all the regressions Veggie Libel omitted because of collinearity.

Table A7: OLS Estimates for the Reported Number of Food-borne Illness Outbreaks and Related Cases Per Thousand People Including Spatial Weight Matrix

	(1)	(2)	(3)	(4)
Dependent Variable:	*Reported Number of Cases of Food-borne Illnesses Per Thousand People*			*Reported Number of Outbreaks of Food-borne Illnesses Per Thousand People*
Law	0.0516*	0.0516*	0.0450	0.00190**
	(0.0286)	(0.0286)	(0.0327)	(0.000958)
Non-White	0.000118	0.000118	0.000130	8.71e-05**
	(0.000820)	(0.000820)	(0.000834)	(3.46e-05)
July-Temp	0.000421	0.000421	0.000411	0.000375*
	(0.00260)	(0.00260)	(0.00258)	(0.000197)
Poverty	0.00203	0.00203	0.00197	5.60e-05
	(0.00147)	(0.00147)	(0.00147)	(0.000113)
Expenditures	-2.66e-05	-2.66e-05	-2.83e-05	7.03e-07
	(2.65e-05)	(2.65e-05)	(2.70e-05)	(1.57e-06)
Metropolitan	0.000530	0.000530	0.000551	-1.80e-05
	(0.000423)	(0.000423)	(0.000432)	(1.96e-05)
Lawyers	-0.00631	-0.00631	-0.00629	-8.55e-05
	(0.00389)	(0.00389)	(0.00384)	(0.000202)
EatingPlaces	-0.0310	-0.0310	-0.0313	-0.00370
	(0.0387)	(0.0387)	(0.0387)	(0.00243)
Foodstores	-0.0101	-0.0101	-0.000640	-0.00107
	(0.0989)	(0.0989)	(0.103)	(0.00478)
Political	-0.0262	-0.0262	-0.0230	-0.000670
	(0.0167)	(0.0167)	(0.0171)	(0.000617)
Veggie Libel	-0.0219	-0.0219	-0.0211	-0.00883***
	(0.03837)	(0.03711)	(0.03716)	(0.00270)
GDP	1.320***	1.320***	1.247**	-0.0114
	(0.449)	(0.449)	(0.509)	(0.0380)
Law#Lawyers	0.00102	0.00102	0.001000	-1.28e-05
	(0.00137)	(0.00137)	(0.00135)	(4.91e-05)
Multistate Outbreaks Not Recorded	-0.0540		-0.0631	
	(0.0384)		(0.0389)	
Law × Multistate Outbreaks Not Recorded			0.0118	
			(0.0144)	
Law (Marginal Effects)			0.05122**	
			(0.02968)	
Constant	0.122	0.0681	0.129	-0.00835
	(0.202)	(0.188)	(0.204)	(0.0175)
Observations	1,071	1,071	1,071	1,071
R-squared	0.0633	0.0633	0.0640	0.0601
State FE	NO	NO	NO	NO
Year FE	YES	YES	YES	YES

Notes:
Standard errors in parentheses are calculated by clustering over state.
***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.

Table A8: Poisson Estimation Results for the Reported Number of Food-borne Illness Outbreaks and Related Cases Including Spatial Weight Matrix

	(1)	(2)	(3)
Dependent Variable:	*Reported Number of Cases of Food-borne Illnesses*		*Reported Number of Outbreaks of Food-borne Illnesses*
Law	0.472*	0.525**	0.469
	(0.262)	(0.218)	(0.454)
Non-White	0.000646	0.000642	-0.0149
	(0.0327)	(0.0343)	(0.221)
July-Temp	-0.00943	-0.00879	0.0198
	(0.0360)	(0.0373)	(0.154)
Poverty	-0.000138	0.000747	-0.0102
	(0.0132)	(0.0128)	(0.0164)
Expenditures	-0.000327	-0.000304	-0.000308
	(0.000292)	(0.000305)	(0.00141)
Metropolitan	0.000704	0.000684	-0.00801
	(0.00487)	(0.00504)	(0.0236)
Lawyers	0.0150	0.0164	-0.0937
	(0.0548)	(0.0553)	(0.159)
EatingPlaces	-0.913**	-0.928**	-1.025
	(0.444)	(0.451)	(2.115)
Foodstores	0.622	0.529	0.640
	(0.636)	(0.617)	(1.124)
Political	-0.166	-0.171	-0.0313
	(0.313)	(0.317)	(0.967)
Veggie Libel	-1.749	-1.705	-4.003
	(2.352)	(2.422)	(17.04)
GDP	3.444	4.586	-21.28
	(12.75)	(12.88)	(59.99)
Law#Lawyers	0.000628	0.000150	0.00132
	(0.0112)	(0.0118)	(0.105)
Population	0.219	0.297	-2.722
	(2.567)	(2.644)	(2.725)
Law × Multistate Outbreaks Not Recorded	0.0690		
	(0.117)		
Observations	1,071	1,071	1,071
Wald	42,061	23,045	9,376
p-Value	0	0	0
State FE	NO	NO	NO
Year FE	YES	YES	YES

Notes:
Standard errors in parentheses are calculated by clustering over state.
***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.

Table A9: Estimation Results for Reported Number of Food-borne illness Hospitalizations and Deaths Including Regional Dummy Variables

	Food-borne Illness Hospitalizations			Food-borne Illness Deaths	
	(1)	(2)	(3)ǂ	(4)	(5)
Law	-3.12e-05	-2.159	0.0474	5.98e-06	-0.438
	(2.70e-05)	(2.862)	(1.777)	(1.70e-05)	(0.831)
Non-White	4.15e-07	0.0440	0.0230	-8.43e-07	-0.00677
	(1.19e-06)	(0.0546)	(0.0287)	(7.47e-07)	(0.0133)
July-Temp	1.44e-06	0.0907	0.0685	2.80e-06*	0.0195
	(2.59e-06)	(0.116)	(0.0564)	(1.62e-06)	(0.0281)
Poverty	8.46e-06**	0.229***	0.0794	2.12e-06	0.0895**
	(3.94e-06)	(0.0691)	(0.0850)	(2.49e-06)	(0.0431)
Expenditures	-1.99e-08	-0.00336**	0.000885	2.38e-08	0.000243
	(4.20e-08)	(0.00170)	(0.00129)	(2.64e-08)	(0.000554)
Metropolitan	3.25e-07	-0.00296	-0.00157	4.39e-07	0.00821
	(4.92e-07)	(0.0169)	(0.0109)	(3.08e-07)	(0.00526)
Lawyers	-1.19e-05	-4.349***	-0.269	-4.49e-06	-0.324
	(9.62e-06)	(1.449)	(1.125)	(6.11e-06)	(0.505)
EatingPlaces	7.48e-05	9.101***	0.786	6.40e-05**	1.189*
	(4.92e-05)	(2.125)	(1.419)	(3.08e-05)	(0.625)
Foodstores	-6.62e-05	-17.13***	1.450	9.50e-05	3.096**
	(0.000117)	(5.163)	(2.479)	(7.31e-05)	(1.383)
Political	1.25e-05	-1.173	1.128	-2.40e-05	-0.333
	(3.61e-05)	(1.496)	(1.369)	(2.28e-05)	(0.499)
Veggie	8.08e-06	-0.841	-1.387**	-6.15e-06	-0.0490
	(2.59e-05)	(1.953)	(0.630)	(1.62e-05)	(0.291)
West	-3.17e-05	-2.652	0.730	1.36e-05	0.454
	(3.27e-05)	(2.278)	(0.846)	(2.04e-05)	(0.371)
South	6.86e-06	3.692*	-0.240	-1.20e-05	0.00646
	(3.57e-05)	(2.155)	(0.800)	(2.23e-05)	(0.409)
Northeast	1.65e-05	3.697	-0.691	-2.55e-05	-1.099**
	(4.16e-05)	(2.321)	(0.932)	(2.60e-05)	(0.501)
GDP	0.00204*	124.2***	-54.86	-0.000549	-1.185
	(0.00118)	(41.77)	(36.71)	(0.000747)	(15.43)
Law#Lawerys	2.95e-06	2.463*	0.296	-4.76e-07	0.174
	(8.52e-06)	(1.460)	(1.117)	(5.43e-06)	(0.501)
Population		3.917***	1.811***		0.957***
		(1.084)	(0.343)		(0.141)
Constant	-0.000371*			-0.000304**	
	(0.000198)			(0.000124)	
Observations	1,071	1,071	1,020	1,071	1,071
State FE	NO	NO	NO	NO	NO
Year FE	YES	YES	YES	YES	YES

Note:

The dependent variable in columns (1) and (4) is the reported number of food-borne illness hospitalization and deaths per 1000 people, respectively. The dependent variable in column (2) is the reported number of food-borne illness hospitalizations. The dependent variable in columns (3) and (5) is an indicator variable equal to one if there is reported food-borne illness hospitalization or death, respectively, and is zero otherwise. The Poisson model with dependent variable as the reported number of food-borne illness deaths did not converge, hence, it is not reported here. Numbers reported in columns (3) and (5) are marginal effects. Standard errors in parentheses in columns (1), (2), and (4) are calculated by clustering over state. ***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.

ǂ Observations dropped because of all zero outcomes.

Table A10: Random Effects Estimation Results for Reported Number of Food-borne Illness Hospitalizations and Deaths

	Food-borne Illness Hospitalizations			Food-borne Illness Deaths		
	(1)	(2)	(3)	(4)	(5)	(6)ǂ
Law	-3.21e-05	0.00563	0.151	6.45e-06	-0.680	-0.341
	(2.65e-05)	(3.107)	(2.242)	(1.69e-05)	(0.761)	(0.798)
Non-White	2.56e-08	0.111	0.0231	-5.05e-07	-0.00672	0.00381
	(1.10e-06)	(0.0810)	(0.0320)	(7.03e-07)	(0.0116)	(0.0133)
July-Temp	2.35e-06	0.304***	0.0577	2.02e-06	0.0279	0.00440
	(2.25e-06)	(0.107)	(0.0516)	(1.44e-06)	(0.0211)	(0.0250)
Poverty	8.44e-06**	0.227***	0.0792	2.10e-06	0.0681**	0.0853**
	(3.87e-06)	(0.0752)	(0.0890)	(2.47e-06)	(0.0332)	(0.0434)
Expenditures	-4.22e-09	-0.00266	0.000295	1.49e-08	0.000338	-0.000240
	(3.92e-08)	(0.00177)	(0.00135)	(2.50e-08)	(0.000460)	(0.000588)
Metropolitan	1.45e-07	-0.00763	0.00474	5.09e-07*	0.0106**	0.0104**
	(4.25e-07)	(0.0195)	(0.00922)	(2.71e-07)	(0.00438)	(0.00503)
Lawyers	-1.14e-05	-4.192***	-0.199	-4.57e-06	-0.658	-0.185
	(9.47e-06)	(1.381)	(1.462)	(6.04e-06)	(0.463)	(0.487)
EatingPlaces	5.64e-05	9.457***	1.260	7.43e-05**	1.507***	1.458**
	(4.53e-05)	(2.511)	(1.434)	(2.89e-05)	(0.529)	(0.638)
Foodstores	-5.66e-06	-17.47***	-0.257	3.51e-05	0.754	0.617
	(9.08e-05)	(5.581)	(2.091)	(5.79e-05)	(1.035)	(1.169)
Political	6.80e-06	-0.808	0.457	-1.84e-05	-0.0432	-0.270
	(3.48e-05)	(1.567)	(1.328)	(2.22e-05)	(0.424)	(0.521)
Veggie Libel	9.41e-06	-4.865*	-1.521**	-4.96e-06	-0.0361	-0.000955
	(2.46e-05)	(2.798)	(0.767)	(1.57e-05)	(0.276)	(0.306)
GDP	0.00166	127.6***	-42.47	-0.000258	4.288	3.257
	(0.00113)	(42.26)	(37.32)	(0.000721)	(13.23)	(16.57)
Law#Lawerys	3.04e-06	1.658	0.206	-6.17e-07	0.448	0.0497
	(8.49e-06)	(1.544)	(1.433)	(5.42e-06)	(0.467)	(0.483)
Population		4.523***	1.823***		0.908***	0.978***
		(1.185)	(0.333)		(0.128)	(0.143)
Constant	-0.000399**			-0.000277**		
	(0.000192)			(0.000123)		
Observations	1,071	1,071	1,071	1,071	1,071	1,020
State FE	NO	NO	NO	NO	NO	NO
Year FE	YES	YES	YES	YES	YES	YES

Note:
The dependent variables in columns (1) and (4) are the reported number of food-borne illness hospitalization and deaths per 1000 people, respectively. The dependent variables in columns (2) and (5) are the reported number of food-borne illness hospitalization and deaths, respectively. The dependent variables in columns (3) and (6) are indicator variables equal to one if there is reported food-borne illness hospitalization or death, respectively, and is zero otherwise. Standard errors in parentheses in columns (1), (2), (4), and (5) are calculated by clustering over state. Numbers reported in columns (3) and (6) are marginal effects. ***, **, and * indicate the significance levels at 1%, 5%, and 10%, respectively.
ǂ Observations dropped because of all zero outcomes.

Figure A1. Distribution Frequency of Food-Safety-Related Hospitalizations and Deaths