Farmers markets and Food-Borne illness

Bellemare, Marc F. and King, Robert P. and Nguyen, Ngoc (Jenny)

University of Minnesota

17 July 2015

Farmers Markets and Food-Borne Illness[*]

Marc F. Bellemare[†] *Robert P. King*[‡] *Ngoc (Jenny) Nguyen*[§]

July 17, 2015

Abstract

We study the relationship between farmers markets and food-borne illness in the United States. Using a state-level panel data set for the period 2004-2011, we find a positive relationship between the number of farmers markets per capita on the one hand and, on the other hand, the number of reported (i) outbreaks of food-borne illness, (ii) cases of food-borne illness, (iii) outbreaks of *Campylobacter jejuni*, and (iv) cases of *Campylobacter jejuni*. Our estimates indicate that a 1% increase in the number of farmers markets is associated with a 0.7% (3.9%) increase in the total number of reported outbreaks of food-borne illness (*Campylobacter jejuni*), and a 3.9% (2.1%) increase in the total number of reported cases of food-borne illness (*Campylobacter jejuni*) in the average state-year. Our estimates also suggest that a doubling of the number of farmers markets in the average state-year would be associated with an economic cost of over $900,000 in additional cases of food-borne illness. When controlling simultaneously for both the number of farmers markets and the number of farmers markets that accept SNAP benefits (i.e., food stamps), we find that they are respectively associated positively and negatively with reported food-borne illness outbreaks and cases. Our results are robust to different specifications and estimators, and falsification and placebo tests indicate that they are unlikely to be spurious.

Key words: Food Safety, Food-Borne Illness, Local Foods, Farmers Markets, Local Procurement

JEL Classification Codes: I12, I18, Q13

[*] We thank the Healthy Foods, Healthy Lives Institute at the University of Minnesota for its financial support of this project. We are also grateful to Ed Ragland and Shelley Pierce, from the USDA's Agricultural Marketing Service, for sharing with us the farmers markets data, and to Shelly Pierce, from the USDA's Food and Nutrition Service, for sharing with us the data on the number of farmers markets that accept SNAP. We also thank Tim Beatty, Francisco Diez-Gonzalez, and Joe Ritter for conversations that led to a substantially improved manuscript, as well as seminar participants at Ohio State and Oklahoma State for helpful suggestions. All remaining errors are ours.

[†] Corresponding Author and Assistant Professor, Department of Applied Economics, University of Minnesota, 1994 Buford Avenue, Saint Paul, MN 55108, Email: mbellema@umn.edu.

[‡] Professor, Department of Applied Economics, University of Minnesota, 1994 Buford Avenue, Saint Paul, MN 55108, Email: rking@umn.edu.

[§] MS Student, Department of Applied Economics, University of Minnesota, 1994 Buford Avenue, Saint Paul, MN 55108, Email: nguy1648@umn.edu,

Since the mid-1990s, the number of farmers markets has increased by almost 500 percent in the United States, rising steadily from 1,755 farmers markets in 1994 to 8,268 farmers markets in 2014 (USDA Agricultural Marketing Service, 2015).

Given that farmers markets often sell foods from producers who are subject to a less stringent set of regulations than the foods sold at convenience stores, grocery stores, super markets, and big-box stores, what does the recent rise in popularity of farmers markets mean for food-borne illness? Is the presence of farmers markets in a given state associated with food-borne illness in any systematic way? On this, there is little to no empirical evidence. Sivapalasingam et al. (2004), although they do not specifically look at foods sold at farmers markets, document how fresh produce has been a growing cause of food-borne illness outbreaks (i.e., *Salmonella*, *Cyclospora*, and *E. coli*) in the United States. Francis et al. (1999) note that minimally processed vegetables provide new ecosystems within which pathogens (i.e., *Listeria monocytogenes*, *Aeromonas hydrophila*, and *Clostridium botulinum*) can emerge and evolve. Only two studies look at food sold at farmers markets. The first is by Park and Sanders (1992), who analyze over 1,500 samples of 10 different types of vegetables at both farmers markets and supermarkets and find that vegetables from farmers markets are much more likely to contain *Campylobacters*, and thus much more likely to pose health hazards. The second is a recent study by Scheinberg et al. (2013), who find that chicken sold at farmers markets is more likely to test positive for *Salmonella* or *Campylobacter* than chicken, either organic or non-organic, sold at supermarkets.

On the one hand, the typically remotely produced and procured foods sold at convenience stores, grocery stores, supermarkets, and big-box stores are produced in the context of agricultural value chains by large, often multinational firms who face serious scrutiny from food-safety authorities. Those firms have serious incentives to apply the strictest possible protocols, which would lead one to believe that remotely produced foods could lead to fewer, albeit more widespread, outbreaks of food-borne illness. On the other hand, the typically locally produced and procured foods sold at farmers markets travel much shorter distances, are handled by fewer people, and are generally consumed more quickly. This would lead one to believe that locally produced foods could lead to fewer but more geographically concentrated outbreaks of food-borne illness. In other words, there is no *a priori* reason to believe there is any systematic relationship between farmers markets and food-borne illness, and even if there is such a relationship, it is not *a priori* obvious whether it should be positive or negative.

We study the relationship between farmers markets and food-borne illness. Specifically, we look at the relationship between the number of farmers markets per capita in a given state in a given year on the one hand and, on the other hand, the number of reported (i) outbreaks of food-borne illness, (ii) cases of food-borne illness,[1] (iii) outbreaks of *Campylobacter jejuni*, and (iv) cases of *Campylobacter jejuni* per capita for the period 2004, 2006, and 2008-2011. In addition to the ambiguous relationship between farmers markets and food-borne illness discussed above, there is no *a priori* reason to believe that, should there be a systematic relationship between farmers markets and food-borne illness, it would show up as statistically significant when looking at such an aggregate level as the state level. Consequently, finding any statistically significant relationship in this context should constitute *prima facie* evidence in favor of a potentially causal relationship between farmers markets and food-borne illness.

In order to help disentangle a potential causal relationship from the correlation between food-borne illness outbreaks and farmers markets, we exploit the longitudinal nature of our data by including state and year fixed effects as well as state-specific controls, by controlling for spillovers from farmers markets in neighboring states to make sure that our results are not driven by a violation of the stable unit treatment value assumption (SUTVA; cf. Pearl, 2009), by controlling for region-spillover interactions

[1] For the sake of brevity, we will talk throughout this paper of “outbreaks of food-borne illness” and “cases of food-borne illness” to refer to all reported outbreaks or cases of food-borne illness. When referring to specific illnesses, we will refer to them by name. It should be implicit throughout this paper that we only refer to reported outbreaks or cases of food-borne illness.

to make sure that our result are not driven by the closeness of states in certain regions of the country, by controlling for region-year fixed effects, and by conducting robustness checks in which we look at the results of alternative estimators, both parametric estimators accounting for the limited-dependent nature of our dependent variables (i.e., tobits) and semiparametric estimators accounting for potential nonlinearities between farmers markets and food-borne illness (i.e., splines). Though we cannot claim to identify a causal relationship flowing from farmers markets to food-borne illness, our results are suggestive that there is such a relationship, and therefore we lay the foundation for future such research on this topic in agricultural and applied economics, in health economics, and in public health.

Ultimately, we find a positive, statistically significant relationship between the number of farmers markets per capita and the number of reported (i) outbreaks of food-borne illness, (ii) cases of food-borne illness, (iii) outbreaks of *Campylobacter jejuni*, and (iv) cases of *Campylobacter jejuni*. Just as important, we find no statistically significant relationship for the other major reported outbreaks or cases of food-borne illnesses in the United States, viz. norovirus, *Salmonella enterica*, *Clostridium perfringens*, *E. coli*, *Staphylococcus* (i.e., staph), or scombroid food poisoning.[2] When controlling simultaneously for both the number of farmers markets per capita and the number of farmers markets that accept Supplemental Nutrition Assistance Program benefits (SNAP, or "food stamps"), we find that they are, respectively, associated positively and negatively with food-borne illness. The magnitudes of estimated coefficients suggest that when a new farmers market opens that accepts SNAP benefits, the overall association—an additional market, but an additional market that accepts SNAP benefits—is slightly positive.

[2] These, along with *Campylobacter jejuni*, constitute the top seven types of food-borne illness in the US. Though we were initially interested in studying the top 10 types of food-borne illness in the US, it turns out that four illnesses among the top 10 are variants of norovirus, which we combined into one category for our empirical analysis.

From an economic perspective, our findings are important given that food-borne illness is estimated to cost $51 billion annually in the United States, with an average cost of $1,068 per case of food-borne illness (Scharff, 2012).[3] From a public health perspective, this matters because food-borne illness causes over 55,000 hospitalizations and almost 1,400 deaths annually in the United States (Centers for Disease Control and Prevention, 2014). Using Scharff's $1,068-per-case figure, we estimate that a doubling of the number of farmers markets in the average state-year would be associated with an economic cost of over $900,000.

The remainder of this paper is organized as follows. Section 2 presents the data and discusses some descriptive statistics. In section 3, we lay out our empirical framework and discuss our identification strategy. Section 4 presents and discusses our estimation results and, perhaps more importantly, includes an extensive discussion of the limitations of our findings and of how they should not be interpreted. We conclude in section 5 by discussing the policy implications of our findings and by providing directions for future research.

2. Data and Descriptive Statistics

The data used in this paper come from several sources. The data on food-borne illness outbreaks and cases come from the US Centers for Disease Control and Prevention's (CDC) Foodborne Outbreak Online Database (FOOD) and they cover the years 1998 to 2011. All types of outbreaks included in the data are retained for analysis. We also include multi-state outbreaks by ascribing them to the relevant states, but those were only available upon request from the CDC, and only for the years 2009-2011 as well as only for the total number outbreaks, and not for outbreaks of specific illnesses or for cases of food-borne illness.

[3] These are Scharff's more conservative estimates. The estimates from what he dubs his "enhanced" model are for a total cost of food-borne illness of $77 billion, and an average cost per case of $1,626.

Before we further discuss the data used in this paper, an important clarification is needed. At this point, it would be natural for the reader to ask whether it is possible to actually link an outbreak or case of food-borne illness to the specific point of purchase of the contaminated food. This is unfortunately not possible, because the data contained in the CDC's FOOD reports the place where the food that (is suspected to have) caused an outbreak or a case of food-borne illness was *consumed*—for example, at home, at a restaurant, at school, and so on—but *not where it was purchased*. Moreover, the CDC data only report the location of consumption in some cases. This means two things: First, it is not possible to ascribe an outbreak or a case of food-borne illness to a specific point of purchase—for example, a supermarket, a grocery store, a farmers market, and so on. Second, this highlights the importance of the fact that foods consumed at home, at a restaurant, or at school can be purchased anywhere (including farmers markets), which makes it even more difficult to ascertain what one might refer to as a "hard link" between farmers markets and food-borne illness.

The data on farmers markets come from the USDA's Agricultural Marketing Service and include all farmers markets listed in the USDA's Farmers Markets Directory for the years 2004, 2006, and 2008-2013 (those data were not available for the years 2005 and 2007). Likewise, the data on the number of farmers markets that accept SNAP benefits come from the USDA's Food and Nutrition Service, and those cover the period 2004-2013. The overlap between the food-borne illness data and the farmers markets data thus covers all 50 states and the District of Columbia for six years (i.e., 2004, 2006, and 2008-2011), for a total of 306 observations.

The number of food-borne illness outbreaks in a given state in a given year is almost surely underreported. Indeed, for an outbreak to be recorded in the CDC's FOOD, it has to be reported to the CDC by the relevant county authorities, who rely on medical personnel reports, who in turn rely on people deciding to go to medical facilities for treatment. Often, however, people suffering from food-borne illness might not consult medical personnel for their illness, and the medical personnel they interact with might not report it to county authorities, who may or may not report it to the CDC. The likely systematic underreporting of the dependent variable is discussed below, when we discuss our identification strategy, as a possible source of bias.

When unbundling food-borne illness by type, we initially chose to retain the top 10 food-borne illnesses. But because the top 10 includes four different varieties of norovirus, we chose to aggregate all types of norovirus into one “all-norovirus” category. Starting from the top 10 food-borne illnesses, we thus end up with the top seven food-borne illnesses, viz. norovirus, *Salmonella enterica*, *Clostridium perfringens*, shiga toxin-producing *E. coli*, *Staphylococcus aureus*, *Campylobacter jejuni*, and the scombroid toxin, in order of importance.

Regarding our control variables, state gross domestic product (GDP) figures are from the US Bureau of Economic Analysis. State population figures for 2004, 2006, and 2008-2009 are from the US Census Bureau's Population Division, but the figures for 2010-2011 are from the Census Bureau's American Community Survey (ACS). Likewise, college graduation rates are from the US Census Bureau's Current Population Survey (CPS) for 2004, but from the ACS for 2006, 2008, and 2008-2011, since the CPS data are not available for 2004. The data on the number of restaurants per state are from the US Census Bureau.[4] We include proxies for education and income given that those have been found to explain the location of farmers markets (Berning et al., 2013), and we include the number of restaurants per capita given that those account for the number of meals eaten away from home. Finally, when it comes to the data we use for our placebo test, the number of bankruptcy filings per state are from the American Bankruptcy Institute.

[4] For those variables coming from more than one source, our use of year fixed effects should obviate concerns about comparability between sources.

Table 1 presents descriptive statistics for all 50 states and the District of Columbia for the years 2004, 2006, and 2008-2011 for the dependent variables (i.e., the total reported number of food-borne illness outbreaks and cases as well as the number of reported outbreaks and cases for the seven most common illnesses), for the variable of interest (i.e., the number of farmers markets), and for the control variables.

The average state-year experienced 19 outbreaks and 372 cases of food-borne illness per million, which included about seven outbreaks and 83 cases of norovirus, two outbreaks and 42 cases of *Salmonella enterica*, and fewer than one outbreak of *Clostridium perfringens* (31 cases), *E. coli* (five cases), *Staphylococcus aureus* (five cases), *Campylobacter jejuni* (11 cases), and scombroid (one case) per million. The average state-year also has 102 farmers markets per million people. Finally, the average state-year has a GDP of $270 billion, a little over one fourth of its population is composed of college graduates, it has a little over 4,000 restaurants per million people, and a population of almost 6 million. In what follows, we express all variables in per capita terms, save for the proportion of college graduates, and we use the expression "per capita" as shorthand for variables that are expressed per million individuals.

3. Empirical Framework

We begin this section by discussing our core equation of interest, which relies on standard linear methods. We then discuss our identification strategy, which exploits the longitudinal nature of the data in an effort to purge the error term of our core equation from as much correlation as possible with the explanatory variables and, in so doing, make a statement that is as close to causal as possible. Finally, we discuss the additional estimation strategies, both parametric and semiparametric, we rely on in order to assess the robustness of our findings.

3.1. Estimation Strategy

The core equation of interest in this paper is such that

$$y_{it} = \alpha + \beta x_{it} + \gamma D_{it} + \delta_i + \tau_t + \epsilon_{it}, \quad (1)$$

where y is the outcome of interest, i.e., the number of reported food-borne illness outbreaks or cases (or the number of reported outbreaks or cases of a specific type) per capita in state i in year t; x is a vector of control variables that vary by state and by year; D is the treatment variable, i.e., the number of farmers markets per capita in state i in year t; δ is a vector of state fixed effects, which control for all the time-invariant factors within each state; τ is a vector of year fixed effects, which control for all the state-invariant factors within each year; and ϵ is an error with mean zero.

The goal of this paper is to estimate γ which, if D were randomly assigned, would measure the causal effect of farmers markets per capita on the number of outbreaks or cases of food-borne illness per capita in the average state-year. The statistical test of interest thus consists in testing the null hypothesis $H_0: \gamma = 0$ versus the alternative hypothesis $H_A: \gamma \neq 0$.

Given how unlikely it is that there exists a relationship between farmers markets and food-borne illness at such an aggregated level as the state level, a rejection of the null in either direction should already provide some evidence in favor of the hypothesis that there might well be a causal relationship between farmers markets and food-borne illness. Yet several issues arise that compromise the identification of such a causal relationship. The next section discusses these issues, and the attempt made in this paper at disentangling causation from correlation.

3.2. Identification Strategy

Many factors can compromise the identification of γ in equation 1. Those factors can be grouped under the three broad categories of (i) reverse causality, (ii) unobserved heterogeneity, and (iii) measurement error. In what follows, we first discuss our identification strategy, and we then discuss each of those potential sources of bias in turn.

Recall that equation 1 includes a vector δ of state fixed effects, which controls for all the time-invariant factors in a given state, and a vector τ of year fixed effects, which controls for all the state-invariant factors in a given year.

State fixed effects in equation 1 allow purging the error term of its prospective endogeneity due to unobserved, time-invariant heterogeneity between states. Likewise, year fixed effects allow purging the error term of its prospective endogeneity due to unobserved, state-invariant heterogeneity between years. So to bias our estimate of γ, any remaining heterogeneity must either (i) vary systematically over time between states, or (ii) vary systematically across states between years, and (iii) not accounted for by state-year specific control variables on the right-hand side (RHS) of equation 1.

We now turn to the sources of bias that compromise the identification of γ and discuss them in turn. In the case of reverse causality, though there is no doubt that y and D are jointly determined, i.e., they are both affected by factors which go unobserved in equation 1, it is possible that the number of farmers markets per capita in a state-year is caused by the number of reported outbreaks of food-borne illness per capita in the same state-year. For one, Bond et al. (2006, 2008, and 2009), Smithers et al. (2008), and Thilmany et al. (2008) all note that consumers often shop at farmers markets because they believe that the foods they purchase there are safer. Intuitively, those results would make it more likely that more consumers would shop at existing farmers markets because of safety concerns (i.e., the intensive margin within each farmers market) than it would drive the demand for farmers markets enough so as to increase the actual number of farmers markets (i.e., the extensive margin).

Moreover, the rise in popularity of farmers markets over the last 10 to 20 years was due almost entirely to a growing taste for freshness, to a preference for spending money locally, and to the belief that local foods are more healthful as far as long-term health consequences go, whether that belief is right or wrong, rather than because of a belief that local foods are less likely lead to outbreaks of food-borne illness. In their study of food hygiene and safety at farmers markets, Worsfold et al. (2004) found that consumers mainly care about product quality, and show little to no concern about food safety. Similarly, Lusk (2015) finds that almost 45 percent of respondents have no opinion as to whether the foods from farmers markets increase or decrease the risk of food-borne illness, about 27 percent of respondents believe that the foods from farmers markets are more risky than other foods, and about 27 percent of respondents believe the contrary. In other words, respondent beliefs in one direction appear to cancel respondent beliefs in the other direction, which means that the overall effect of reverse causality is in principle nil if one is to take Lusk's sample as representative. But given that Lusk's sample is meant to be representative of the US population, it appears unlikely that reverse causality from food-borne illness to farmers markets would bias our results, especially given that we control for state fixed effects, year fixed effects, and other state-year-specific controls.

In the case of unobserved heterogeneity, the combined use of state fixed effects and year fixed effects should eliminate most unobserved heterogeneity between state-year observations. Indeed, state fixed effects purge the error term of its correlation with the treatment variable due to things that remain constant over the period 2004-2011 for a given state (e.g., each individual state's proclivity to have fewer or more farmers markets), and year fixed effects purge the error term of its correlation with the treatment variable due to things that remain constant across all states in a given year (e.g., a legislative change that makes farmers markets more easily established across the country, or a countrywide outbreak of a specific food-borne illness). The identifying assumption we make here is thus that whatever unobserved heterogeneity is left does not significantly bias our estimate of γ.

Lastly, in the case of measurement error, recall that the number of food-borne illness outbreaks and cases in a given state in a given year almost surely goes underreported, for the reasons discussed above. Although systematic measurement error is a threat to the identification of γ, note that in this case, this would mean that our estimate $\hat{\gamma}$ of γ would be such that $|\hat{\gamma}| < |\gamma|$. Indeed, if the number of outbreaks or cases of food-borne illness is underreported, the estimated relationship between the number of farmers markets and outbreaks would suffer from attenuation bias (i.e., it would be biased toward zero), because it would fail to account for a number of missing instances of the outcome variable. In other words, the measurement error just described would make one less likely to reject the null hypothesis $H_0: \gamma = 0$, which means that a rejection of the null in either direction would constitute a strong result in this context, and that $\hat{\gamma}$ is a lower bound on the true effect γ.

To recapitulate, reverse causality should not be an issue in this context, unobserved heterogeneity is largely controlled for by the combined use of state and year fixed effects, and although there is measurement error in the dependent variable, that measurement error would tend to bias the estimate of the average treatment effect in equation 1 toward zero, which means that a rejection of the null hypothesis that $\gamma = 0$ makes for a strong statement regarding the true relationship and that the estimated γ is a lower bound on the true effect of farmers markets on food safety.

There remains one last source of statistical endogeneity, and that source is a potential violation of the stable unit treatment value assumption (SUTVA; cf. Pearl, 2009). In this context, SUTVA states that the number of farmers markets in given state-year should have no impact on the number of food-borne illness outbreaks in another state-year. In order to partially control for violations of SUTVA, we estimate specifications wherein we control for the number of farmers markets in neighboring states, and we then estimate specifications wherein we control for the number of farmers markets in neighboring states interacted with the region of the country in which each state is located. The former controls for within-year spillovers. For example, residents of western Wisconsin often shop in the Twin Cities of Minneapolis—Saint Paul given the relatively short distance between the two, and it is not completely unlikely that foods purchased in Saint Paul, MN might cause a case or outbreak of food-borne illness in Hudson, WI. The latter controls for within-year spillovers that might be more likely in specific regions of the country. For example, the District of Columbia is surrounded by several states, and its residents often tend to shop outside of the District itself. Contrast this with the state of New Mexico, where people tend to shop outside of the state far less often. So to eliminate the possibility that our results are driven by spillover effects specific to certain regions (e.g., the DC-Maryland-Northern Virginia region, the tristate area of New York, New Jersey, and Connecticut, etc.), we interact region-specific dummies with the number of farmers markets in neighboring states. That being said, the foregoing only controls for SUTVA violations that might occur between states within a given year, and not for SUTVA violations that might occur between states over time. This is a clear shortcoming of our analysis, but given the relatively small sample size of 306 state-year observations, it is best not to attempt to model those dynamics.

Finally, in line with the findings of Bertrand et al. (2004) and the recommendations in Angrist and Pischke (2009, 2014) and Cameron and Miller (2015), we cluster standard errors at the state level throughout so as to make our results robust to general forms of heteroskedasticity and autocorrelation. We also conduct placebo and falsification tests by respectively (i) regressing each of our outcome variables on a fake treatment, viz. the number of bankruptcies per capita in a given state, and (ii) regressing the number of bankruptcies per capita in a given state on the RHS variables in equation 1.

3.3. Alternative Estimators

After presenting the results of the linear model in equation 1 and various robustness checks, we estimate two additional versions of our core equation. The first additional version of our core equation consists of tobit models for each of the reported number of (i) outbreaks of food-borne illness, (ii) cases of food-borne illness, (iii) outbreaks of *Campylobacter jejuni*, and (iv) cases of *Campylobacter jejuni*. Because the tobit model is a common estimator, we do not present a separate equation for it in the interest of brevity—we simply note that we modify equation 1 to account for the censoring at zero in all of our dependent variables.

The second alternative version of our core equation consists of a semiparametric specification wherein we allow for potential nonlinearities in the relationship between the number of farmers markets and each of the reported number of (i) outbreaks of food-borne illness, (ii) cases of food-borne illness, (iii) outbreaks of *Campylobacter jejuni*, and (iv) cases of *Campylobacter jejuni*. Specifically, we estimate a spline regression, which entails estimating the following modified version of equation 1:

$$y_{it} = \alpha + \beta x_{it} + \gamma f(D_{it}) + \delta_i + \tau_t + \epsilon_{it}. \tag{2}$$

All variables in equation 2 are the same as in equation 1, with the only difference being that our variable of interest D now enters through a nonlinear function $f(\cdot)$ instead of linearly. The function $f(\cdot)$ we choose to estimate here is a spline with seven knots, which affords a greater amount of flexibility than specifications with fewer knots while largely avoiding the curse of dimensionality. Given that this is a nonlinear procedure, for each semiparametric regression, we present a figure showing the estimated nonlinear relationship between the number of farmers markets and food-borne illness rather than a table of result.

4. Estimation Results and Discussion

We begin this section by discussing our core estimation results, viz. our results for the linear, parametric specifications of equation 1, for all four outcomes of interest. We then discuss our estimation results for the tobit models and the semiparametric regressions discussed in the previous section. We then present estimation results for our placebo and falsification tests before concluding this section with a discussion of the limitations of our findings.

4.1. Linear Regressions

Tables 2 to 5 present estimation results for equation 1 for our four outcomes of interest, viz. reported (i) outbreaks of food-borne illness, (ii) cases of food-borne illness, (iii) outbreaks of *Campylobacter jejuni*, and (iv) cases of *Campylobacter jejuni*. The results in table 2 show that there is a remarkably consistent relationship between the number of farmers markets per capita and all reported outbreaks of food-borne illness in the average state-year for the period 2004, 2006, and 2008-2011. On average, 10 more farmers market per million individuals in the average state-year over that period are associated with one more reported outbreak of any kind of food-borne illness. In terms of elasticity, using the results in the first column of table 2 to calculate the elasticity at means, we estimate that a 1-percent increase in the number of farmers markets per capita is associated with a 0.66 percent increase in the number of reported outbreaks of food-borne illness.

Table 2 also indicates that the positive and statistically significant relationship we estimate between farmers markets and reported outbreaks of food-borne illness is robust to controlling for SUTVA violations via the number of farmers markets in neighboring states, to controlling for SUTVA violations via interacting the number of farmers markets in neighboring states with region-specific dummies, and to region-year fixed effects. In other words, the estimated relationship appears robust to different specifications of equation 1, all the more so given that the estimated coefficient for the relationship between farmers markets and food-borne illness barely changes as we estimate the various specifications in table 2.

The results in table 3 also show a positive and statistically significant relationship between the number of farmers markets per capita and the number of reported cases of food-borne illness in the average state-year for the period 2004, 2006, and 2008-2011. On average, 10 more farmers market per million individuals in the average state-year over that period are associated with 14 to 20 additional reported cases of any kind of food-borne illness. In terms of elasticity, using the results in the first column of table 3 to calculate the elasticity at means, we estimate that a 1-percent increase in the number of farmers markets per capita is associated with a 0.52 percent increase in the number of reported cases of food-borne illness. Moreover, we can use the results in table 3 to come up with an estimate of the presumed economic costs of farmers markets in terms of food-borne illness, if the relationship we estimate were causally identified. Indeed, Scharff (2012) estimates that each case of food-borne illness has a cost of $1,068 to the US economy. In the average state-year, there were 102.454 farmers markets, and the average-state year had a population of 5.961 million individuals. Note that the estimated coefficient in the first column of table 3 is equal to 1.422, which suggests that if the number of farmers markets were to double (i.e., increase by 100 percent) in the average state-year, the economic cost would be equal to 1.422 cases per additional market × 102.454 additional markets per million × 5.961 million individuals × $1,068 per individual case = $927,510—and that is for the *average* state-year, i.e., a doubling of the number of farmers markets in the entire US would lead to a much bigger economic cost.

The results for reported outbreaks and cases of *Campylobacter jejuni* in tables 4 and 5 show a similar positive, significant relationship between the number of farmers markets per capita and the dependent variables. In the case of reported outbreaks of *Campylobacter jejuni* in table 4, we note that the estimated coefficients are once again remarkably consistent across specifications. In terms of elasticity, using the results in the first column of table 4 to calculate the elasticity at means, we estimate that a 1-percent increase in the number of farmers markets per capita is associated with a 3.86 percent increase in the number of reported outbreaks of *Campylobacter jejuni*.

Likewise for the reported cases of *Campylobacter jejuni* in table 5, where the estimated coefficient is stable across all four specifications, and where the estimated elasticity at means using the results in the first column show that for a 1-percent increase in the number of farmers markets per capita, there is an associated 2.1 percent increase in the number of reported cases of *Campylobacter jejuni*.

Tables A1 to A4 of the appendix estimate the same specifications as in tables 2 to 5, but following the suggestion in Angrist and Pischke (2014), the results in tables A1 to A4 weight each state-year observation by its relative population. The results in tables A1 to A4 show that our results are robust to weighting by population.

Recall that multistate outbreaks were only available for the period 2009-2011. In order to ensure that our results for all reported outbreaks of food-borne illness (i.e., table 2 and table A1) are not driven by the fact that multistate outbreaks are only available for part of our sample, we estimated a specification similar to that in table 2, but which also controlled for an interaction term between the number of farmers markets in each state-year and a dummy variable for whether the number of multistate outbreaks was unavailable for that year (i.e., a variable equal to one for the years 2004, 2006, and 2008, and equal to zero for the years 2009-2011). The results of those specifications are presented in table A5. In each column, all variables on the right-hand side of equation 1 were interacted with the dummy variable for whether the number of multi-state outbreaks was unavailable for that year.[5] Looking at the heterogeneity between years where the number of multi-state outbreaks was available and years where that number was not available, we find that in years where multi-state outbreaks are available, the estimated marginal effect of one more farmers market per million is equal to about 0.14 on average (e.g., $0.149 + (0 \times -0.049) = 0.149$, in column 1), and in years where multi-state outbreaks are available, that estimated marginal effect is equal to about 0.09 on average (e.g., $0.149 + (1 \times -0.049) = 0.1$, in column 1). Once again, our results show a remarkably consistent positive and statistically significant relationship between the number of farmers markets per capita and the number of reported outbreaks of food-borne illness per capita in the average state-year in the data.

What about other forms of food-borne illness in the top seven food-borne illnesses in the data, viz. norovirus, Salmonella enterica, *Clostridium perfringens*, *E. coli*, *Staphylococcus aureus*, and scombroid? There is no systematic statistically significant relationship between the number of farmers markets per capita and the number of either outbreaks or cases per capita for any of those illnesses. This is not to say that farmers markets do not cause changes in those illnesses—it could simply be that farmers markets do cause such changes, but we do not have the statistical power to detect them. The lack of statistical significance here could be evidence of the absence of such effects (i.e., of a lack of relationship between farmers markets and those other illnesses), or it could be the result of an absence of evidence (i.e., a consequence of our relatively small sample size, and thus of a lack of statistical power). Given the lack of statistical significance, the results of those additional regressions are not shown, but they can be found in the replication materials.

---

[5] In order not to lose too much statistical power, we did not estimate specifications where we interacted each state fixed effect with the dummy for whether the number of multi-state outbreaks was unavailable in a given year.

Tables 6 to 9 show results similar to those in tables 2 to 5, but controlling for the number of farmers markets that accept SNAP benefits per capita in addition to the overall number of farmers markets per capita. In the case of all reported instances—that is, both outbreaks and cases—of food-borne illness in tables 6 and 7, though the inclusion of markets that accept SNAP benefit as a variable on the RHS of equation 1 does not make the positive relationship between farmers markets and food-borne illness go away. In fact, relative to the results in table 2, the inclusion of this new variable strengthens our core estimated relationship. More surprisingly, the inclusion of the number of markets that accept SNAP benefits uncovers a *negative* relationship between the number of farmers markets that accept SNAP and food-borne illness. In other words, though the overall number of farmers markets per capita is associated positively with cases and outbreaks of food-borne illness per capita, the number of farmers markets that accept SNAP per capita is associated negatively with cases and outbreaks of food-borne illness per capita. If one were to interpret our estimated coefficients for those two variables as causal (which, to reiterate, one should not do given the endogeneity issues discussed in section 3), this might mean that when a new market opens that accepts SNAP benefits, the customers it draws in were more likely to suffer from food-borne illness when they shopped elsewhere. Whether this would mean something about the inherent safety of the foods sold at those markets or about the handling of those foods by customers at SNAP and non-SNAP markets is impossible to know, however, and we return to this and other limitations in section 4.4.

The opposing results for the number of farmers markets and the number of farmers markets that accept SNAP are only found for all reported cases and outbreaks of food-borne illness, and not for reported cases or outbreaks of *Campylobacter jejuni*. Thus, whatever could cause farmers markets that accept SNAP to reduce the extent of food-borne illness, if our results were causally identified, is not operating through fewer cases of *Campylobacter jejuni*. In fact, tables A7 to A10 of the appendix show that these opposing estimated relationships between the overall number of farmers markets and the number of farmers markets that accept SNAP benefits seem to be driven by outbreaks of norovirus and *Clostridium perfringens*.

4.2. Alternative Estimators

The results discussed in section 4.1 show a positive and statistically significant relationship between farmers markets and food-borne illness, but they fail to account for the fact that our four outcomes of interest—all reported outbreaks and cases of food-borne illness, and all reported outbreaks and cases of *Campylobacter jejuni*—are censored at zero. That is, there are nine state-year observations where the number of reported outbreaks of food-borne illness is equal to zero, 20 state-year observations where the number of reported cases of food-borne illness is equal to zero, 231 state-year observations where the number of reported outbreaks of *Campylobacter jejuni* is equal to zero, and 231 state-year observations where the number of reported cases of *Campylobacter jejuni* is equal to zero. To assess whether this censoring of our dependent variables might be driving our core results, we thus estimated tobit models for the column 1 specifications of tables 2 to 5. We present estimation results for those tobits in table A6 of the appendix. Once again, the estimated relationship between the number of farmers markets and food-borne illness—all reported outbreaks in column 1, all reported cases in column 2, reported outbreaks of *Campylobacter jejuni* in column 3, and reported cases of the same in column 4—are positive and statistically significant. This suggests that the presence of censoring in our dependent variables does not drive our core results.

Lastly, figures 1a, 1b, 2a, and 2b show estimation results for the semiparametric (i.e., spline) regressions discussed in section 3, respectively plotting the estimated nonlinear relationship between the number of farmers markets per capita and all reported outbreaks of food-borne illness, all reported cases of food-borne illness, all reported outbreaks of *Campylobacter jejuni*, and all reported cases of the same, along with confidence intervals. In all cases, there is a generally monotonically increasing relationship between the number of farmers markets and the dependent variable.

4.3. Falsification and Placebo Tests

In order to ensure that our results are not spurious, table 10 presents the results of falsification and placebo tests.

Column 1 of table 10 conducts a falsification test by regressing the number of bankruptcies per capita in each state-year on the RHS variables in equation 1. Columns 2 to 5 of table 10 conduct four placebo tests—one for each of all reported outbreaks and cases of food-borne illness and all reported outbreaks and cases of *Campylobacter jejuni*—on the RHS variables in equation 1, but substituting the number of bankruptcies per capita for the number of farmers markets per capita.

The results of the falsification test and the four placebo tests show no statistically significant association between the number of farmers markets and the number of bankruptcies on the one hand and between the number of bankruptcies and the number of reported outbreaks and cases of food-borne illness, either overall or *Campylobacter jejuni*, on the other hand. This suggests that our core results are unlikely to be spurious.

4.4. Limitations

While the foregoing suggests that farmers markets play a role in causing outbreaks of food-borne illness (specifically, the total reported number of outbreaks and cases of food-borne illness, and the reported number of outbreaks and cases of *Campylobacter jejuni*), there are a number of ways in which our results could be misinterpreted, and we want to clarify just how one should interpret our results. This section thus discusses the limitations of our results.

It would be a mistake to interpret our results as saying that the foods purchased at farmers markets are somehow worse (i.e., more likely to make consumers ill) than the foods purchased at grocery stores because of our results. This is especially important given that even if what we have identified is a causal relationship rather than a correlation, our results do not allow studying the precise causal mechanisms through which farmers markets may increase the number of cases and outbreaks of food-borne illness. Indeed, most food safety problems come from the mishandling of foods by consumers or by restaurant staff who prepare those foods for consumers (Paarlberg, 2013). As such, it is easy to imagine cases where consumers are more or less neglectful with foods purchased from farmers markets (e.g., by being less likely to wash produce from the farmers market, or by cooking eggs from the farmers market more thoroughly than eggs from the grocery store), which could explain our results.

In other words, although the presence of farmers markets in a given state might well lead to more cases and outbreaks of food-borne illness, this paper cannot pinpoint the precise causal mechanisms through which this occurs.

Moreover, our results are robust to different specifications and estimators, but only up to a point. Indeed, when controlling for state-specific trends, the estimated coefficient of interest (i.e., the association between farmers markets and food-borne illness) was no longer statistically significant. Looking at the magnitude of the estimated coefficient when state-specific trends are included (those results are not shown, but they are available upon request), we note that it is close to the estimated coefficients in tables 2 to 5, but the standard errors are much larger, being practically double what they are in tables 2 to 5. It thus looks as though this seeming lack of robustness is due to the fact that the inclusion of 51 additional state-time interactions is too taxing on the statistical power afforded by our relatively small sample of 306 observations.

Lastly, recall that our results included a number of what Sherlock Holmes would have referred to as “dogs that did not bark,” i.e., there was no significant relationship between farmers markets and outbreaks or cases of norovirus, *Salmonella enterica*, *Clostridium perfringens*, *E. coli*, *s*taph, or scombroid food poisoning. For those illnesses, it is impossible to tell whether this represented evidence in favor of an absence of any relationship between farmers markets and cases or outbreaks, or whether this was due to an absence of evidence. As such, one should be cautious when interpreting those null results.

5. Summary and Conclusions

Using data on the number of food-borne illness outbreaks and cases and the number of farmers markets per capita across the entire United States for the period 2004, 2006, and 2008-2011, we have explored the relationship between farmers markets and food-borne illness. Our results indicate that once the unobserved heterogeneity between states, and the unobserved heterogeneity between years are taken into account, there is a positive relationship between the number of farmers markets per capita in a given state and the reported number of all outbreaks and cases of food-borne illness per capita as well as the reported number of outbreaks and cases of *Campylobacter jejuni* in the same state. Moreover, our results indicate that the number of farmers markets and the number of farmers markets that accept SNAP are related in opposite ways to overall food-borne illness in the average state-year.

Although the causal identification of the estimated relationship is threatened by a number of factors in this context, the fact that it was *a priori* unlikely that there existed a statistically significant relationship between the treatment and outcome variables at such an aggregate level as the state level but that such a relationship was nevertheless found (and found to be robust), combined with our falsification test, placebo tests, alternative specifications, and alternative estimators all enhance the credibility of our finding. Still, given that the gold standard of a randomized controlled trial is not available in this context, further research should focus on better causal identification, perhaps via instrumental variables or a difference-in-difference design at the county level, which might require original data collection.

From a policy perspective, it would be a mistake to take the results in this paper and discourage or encourage people to purchase food from farmers markets on the basis of our results. Indeed, even if our estimated relationships between farmers markets and food-borne illness were causal beyond all reasonable doubt, we cannot determine the precise mechanisms through which those relationships operate. This points to a direction in which researchers interested in studying the relationship between farmers markets and food-borne illness should go—that is, the mechanisms whereby farmers markets might cause food-borne illness.

References

Angrist, Joshua D., and Jörn-Steffen Pischke (2009), *Mostly Harmless Econometrics*, Princeton, NJ: Princeton University Press.

Angrist, Joshua D., and Jörn-Steffen Pischke (2014), *Mastering 'Metrics*, Princeton, NJ: Princeton University Press.

Berning, Joshua P., Alessandro Bonanno, and Etemaadnia Hamideh (2013), "Farmers' Markets Location Determinants: An Empirical Analysis in New England," Working Paper, University of Georgia.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan (2004), "How Much Should We Trust Differences-in-Differences Estimates?," *Quarterly Journal of Economics* 119(1): 249-275.

Bond, Craig A., Dawn Thilmany, and Jennifer K. Bond (2008), "Understanding Consumer Interest in Product and Process-Based Attributes for Fresh Produce," *Agribusiness* 24(2): 231-252.

Bond, Jennifer K., Dawn Thilmany, and Craig A. Bond (2006), "Direct Marketing of Fresh Produce: Understanding Consumer Purchasing Decisions," *Choices* 21(4): 229-235.

Bond, Jennifer K., Dawn Thilmany, and Craig A. Bond (2009), "What Influences Consumer Choice of Fresh Produce Purchase Location?," *Journal of Agricultural and Applied Economics* 41(1): 61-74.

Cameron, A. Colin, and Douglas L. Miller (2015), "A Practitioner's Guide to Cluster-Robust Inference," *Journal of Human Resources* 50(2): 317-372.

Centers for Disease Control and Prevention (2014), "CDC Estimates of Food-Borne Illness in the United States," http://www.cdc.gov/foodborneburden/questions-and-answers.html last accessed June 17, 2014.

Francis, Gillian A., Christopher Thomas, and David O'Beirne, (1999) “The Microbiological Safety of Minimally Processed Vegetables,” *International Journal of Food Science & Technology* 34(1): 1-22.

Lusk, Jayson (2015), “Food Demand Survey (FooDS) – March 2015,” http://jaysonlusk.com/blog/2015/3/12/food-demand-survey-foods-march-2015 last accessed July 16, 2015.

Paarlberg, Robert (2013), *Food Politics*, 2nd edition, Oxford: Oxford University Press.

Pearl, Judea (2009), *Causality*, 2nd ed., Cambridge University Press.

Park, C.E., and G.W. Sanders (1992), “Occurrence of Thermotolerant Campylobacters in Fresh Vegetables Sold at Farmers' Outdoor Markets and Supermarkets,” *Canadian Journal of Microbiology* 38(4): 313-316.

Scharff, Robert L. (2012), “Economic Burden from Health Losses Due to Foodborne Illness in the United States,” *Journal of Food Protection* 75(1): 123-131.

Scheinberg, Joshua, Stephanie Doores, and Catherine N. Cutter (2013), “A Microbiological Comparison of Poultry Products Obtained from Farmers' Markets and Supermarkets in Pennsylvania,” *Journal of Food Protection* 33(3): 259-264.

Sivapalasingam, Sumathi, Cindy R. Friedman, Linda Cohen, and Robert V. Tauxe (2004), “Fresh Produce: A Growing Cause of Outbreak of Foodborne Illness in the United States, 1973 through 1997,” *Journal of Food Protection* 10: 2092-2353.

Smithers, John, Jeremy Lamarche, and Alun E. Joseph (2008), “Unpacking the Terms of Engagement with Local Food at the Farmers’ Market: Insights from Ontario,” *Journal of Rural Studies* 27: 337-350.

Thilmany, Dawn, Craig A. Bond, and Jennifer K. Bond (2008), "Going Local: Exploring Consumer Behavior and Motivations for Direct Food Purchases," *American Journal of Agricultural Economics* 90(5): 1303-1309.

Worsfold, Denise, Philip M. Worsfold, and Christopher J. Griffith (2004), "An Assessment of Food Hygiene and Safety at Farmers' Markets," *International Journal of Environmental Health Research* 14(2): 109-119.

United States Department of Agriculture Agricultural Marketing Service (2015), "Farmers Markets and Local Food Marketing," http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateS&leftNav=WholesaleandFarmersMarkets&page=WFMFarmersMarketGrowth&description=Farmers+Market+Growth last accessed June 10, 2015.

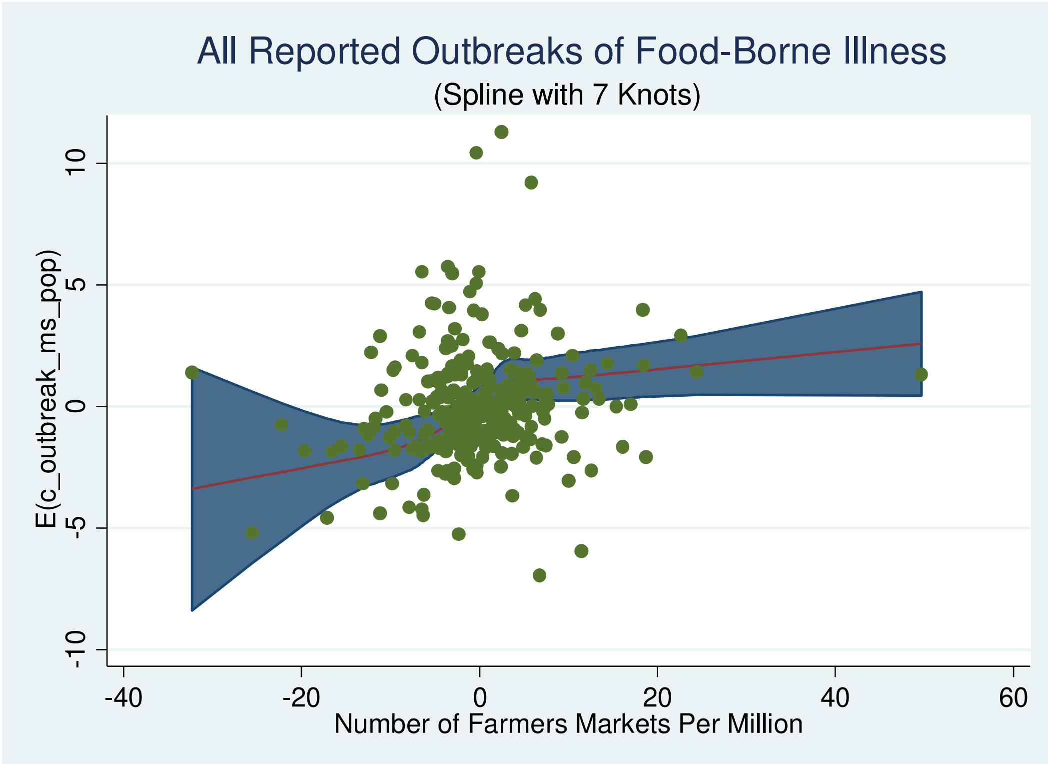

Figure 1a. Semiparametric Regression of All Reported Outbreaks of Food-Borne Illness on the Number of Farmers Markets.

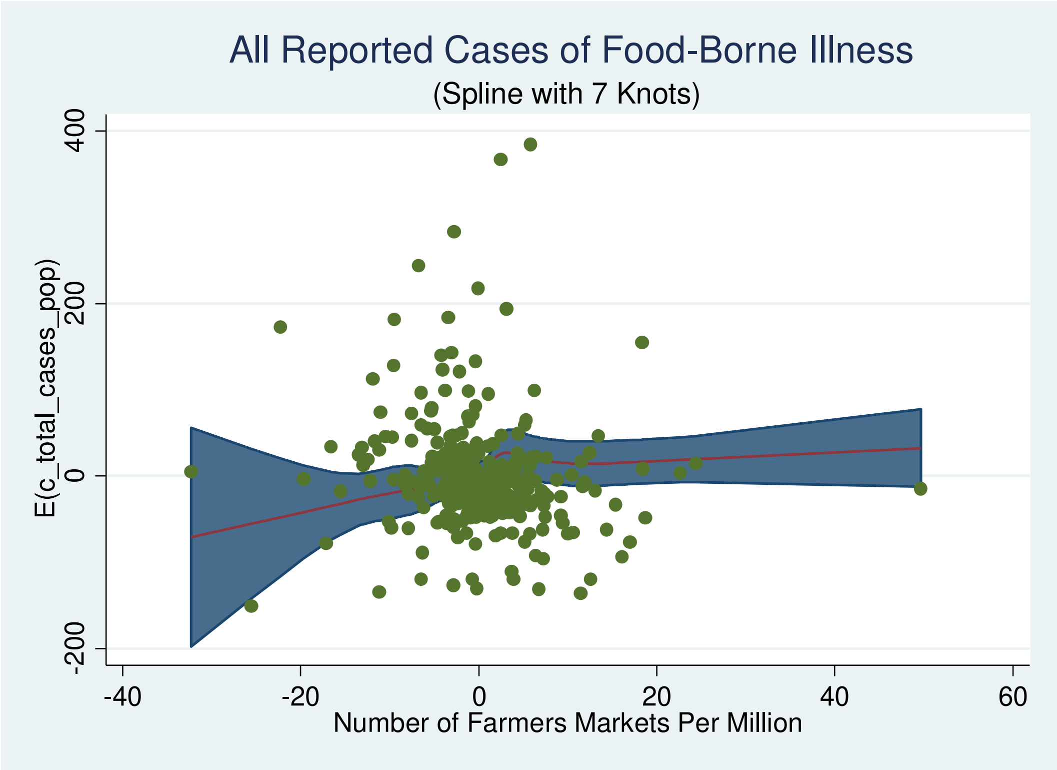

Figure 1b. Semiparametric Regression of All Reported Cases of Food-Borne Illness on the Number of Farmers Markets.

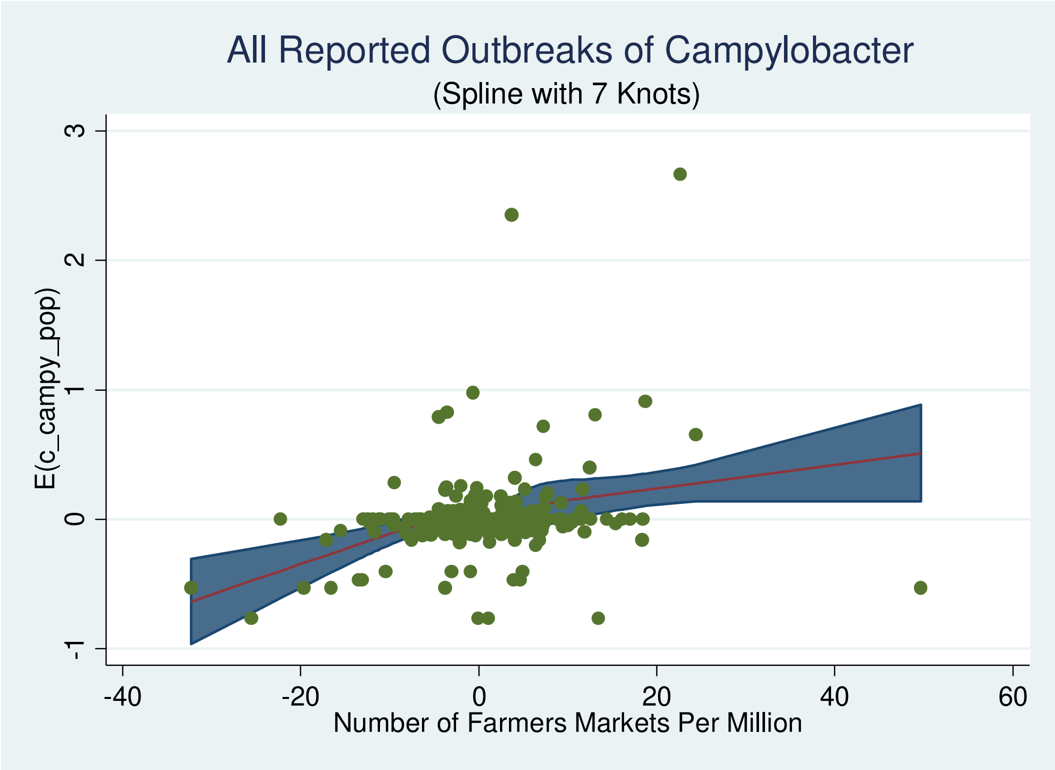

Figure 2a. Semiparametric Regression of All Reported Outbreaks of Campylobacter on the Number of Farmers Markets.

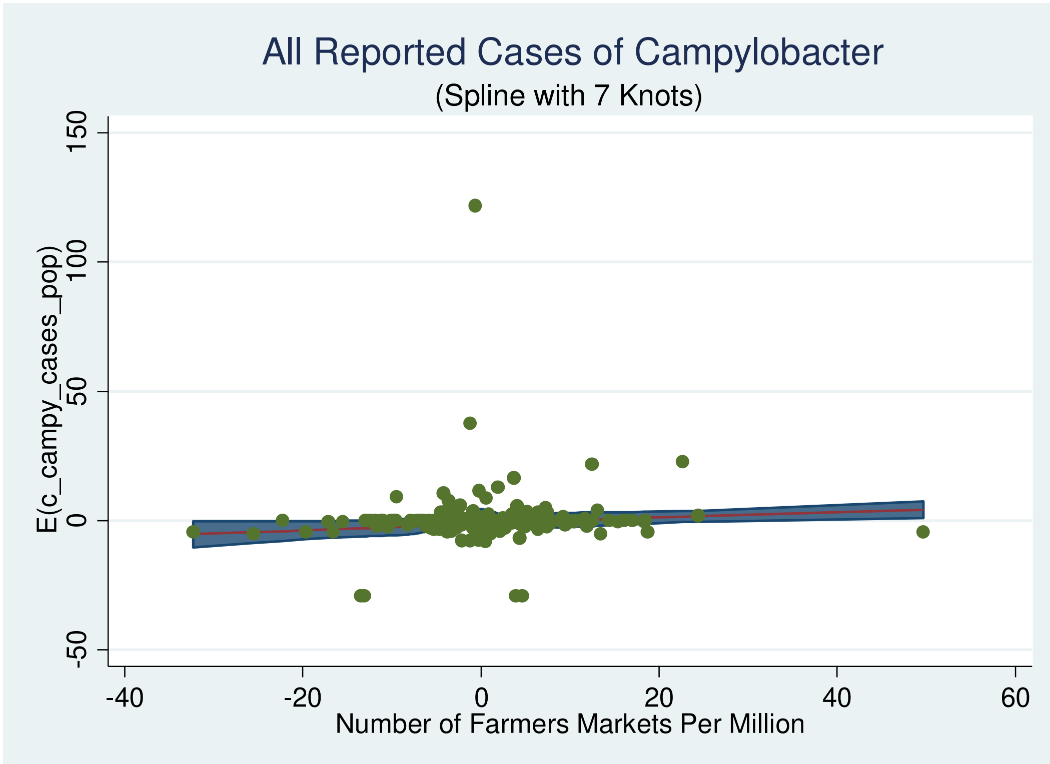

Figure 2b. Semiparametric Regression of All Reported Cases of Campylobacter on the Number of Farmers Markets.

Table 1. Descriptive Statistics (n=306)

Variable	Mean	(Std. Dev.)
Reported Outbreaks of Food-Borne Illness		
All Reported Outbreaks	18.967	(27.403)
Norovirus	6.775	(11.296)
Salmonella enterica	2.186	(2.971)
Clostridium perfringens	0.670	(1.209)
E. coli	0.435	(0.871)
Staphylococcus aureus	0.333	(1.043)
Campylobacter jejuni	0.330	(0.672)
Scombroid	0.301	(0.920)
Reported Cases of Food-Borne Illness		
All Food-Borne Illnesses	371.644	(519.825)
Norovirus	83.853	(228.158)
Salmonella enterica	42.539	(80.602)
Clostridium perfringens	30.846	(86.607)
E. coli	4.464	(21.650)
Staphylococcus aureus	5.425	(17.969)
Campylobacter jejuni	10.631	(95.849)
Scombroid	1.092	(3.646)
Number of Farmers Markets Per Million	102.454	(98.406)
GDP (USD Million)	269526.300	(323736.200)
College Graduation Rate	0.275	(0.056)
Number of Restaurants Per Million	4086.908	(4564.552)
Number of Bankruptcies Per Million	25356.76	(31779.19)
Population (Million)	5.961	(6.664)

Table 2. Estimation Results for Ordinary Least Squares Regressions of All Reported Outbreaks of Food-Borne Illness in the US for the Period Covering 2004, 2006, and 2008-2011

Variables	(1)	(2)	(3)	(4)
Dependent Variable: All Reported Outbreaks of Food-Borne Illness Per Million				
Farmers Markets Per Million	0.104**	0.092**	0.107**	0.097**
	(0.042)	(0.037)	(0.040)	(0.047)
Farmers Markets Per Million, Neighboring States		0.024**		
		(0.011)		
GDP Per Million	15.480	11.110	7.281	11.813
	(77.881)	(71.867)	(69.765)	(88.012)
College Graduation Rate	-35.822	-32.503	-32.254	-20.196
	(26.472)	(24.851)	(25.192)	(24.540)
Restaurants Per Million	-0.013	-0.013	-0.014	-0.019
	(0.012)	(0.011)	(0.013)	(0.012)
Constant	20.393**	17.963**	17.924*	20.423**
	(9.459)	(8.176)	(9.570)	(10.041)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.114	0.136	0.174	0.273

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table 3. Estimation Results for Ordinary Least Squares Regressions of All Reported Cases of Food-Borne Illness in the US for the Period Covering 2004, 2006, and 2008-2011

Variables	(1)	(2)	(3)	(4)
Dependent Variable: All Reported Cases of Food-Borne Illness Per Million				
Farmers Markets Per Million	1.422*	1.497	1.871*	1.977
	(0.837)	(0.895)	(1.038)	(1.311)
Farmers Markets Per Million, Neighboring States		-0.155		
		(0.291)		
Restaurants Per Million	-3,439.924	-3,412.083	-3,560.601*	-4,120.363*
	(2,391.242)	(2,427.942)	(2,090.470)	(2,321.812)
GDP Per Million	-688.510	-709.655	-768.820	-795.848
	(662.915)	(676.814)	(685.977)	(670.245)
College Graduation Rate	-0.221	-0.222	-0.349	-0.295
	(0.279)	(0.282)	(0.272)	(0.283)
Constant	555.355**	570.830**	649.235***	610.915**
	(238.135)	(243.292)	(234.670)	(239.903)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.181	0.182	0.229	0.323

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table 4. Estimation Results for Ordinary Least Squares Regressions of All Reported Outbreaks of Campylobacter in the US for the Period Covering 2004, 2006, and 2008-2011

Variables	(1)	(2)	(3)	(4)
Dependent Variable: All Reported Outbreaks of Campylobacter Per Million				
Farmers Markets Per Million	0.013***	0.013***	0.013***	0.015***
	(0.003)	(0.003)	(0.003)	(0.004)
Farmers Markets Per Million, Neighboring States		0.000		
		(0.001)		
GDP Per Million	8.389	8.317	7.957	3.937
	(12.526)	(12.575)	(13.568)	(12.880)
College Graduation Rate	-0.699	-0.644	-0.819	-0.292
	(3.370)	(3.366)	(3.752)	(3.916)
Restaurants Per Million	-0.000	-0.000	-0.000	0.000
	(0.001)	(0.001)	(0.002)	(0.002)
Constant	-0.304	-0.344	-0.175	-0.177
	(1.363)	(1.322)	(1.654)	(1.760)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.114	0.136	0.174	0.273

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table 5. Estimation Results for Ordinary Least Squares Regressions of All Reported Cases of Campylobacter in the US for the Period Covering 2004, 2006, and 2008-2011

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Dependent Variable: All Reported Cases of Campylobacter Per Million				
Farmers Markets Per Million	0.129***	0.130***	0.128***	0.120*
	(0.043)	(0.041)	(0.045)	(0.071)
Farmers Markets Per Million, Neighboring States		-0.003		
		(0.018)		
Restaurants Per Million	691.914	692.452	738.917	737.659
	(678.057)	(677.963)	(722.451)	(618.594)
GDP Per Million	-45.260	-45.668	-51.393	-87.898
	(46.638)	(45.609)	(52.398)	(58.856)
College Graduation Rate	-0.006	-0.006	-0.012	-0.035
	(0.019)	(0.019)	(0.026)	(0.032)
Constant	-13.721	-13.422	-10.470	16.925
	(30.130)	(29.833)	(34.124)	(25.280)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.056	0.056	0.059	0.200

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table 6. Estimation Results for Ordinary Least Squares Regressions of All Reported Outbreaks of Food-Borne Illness in the US for the Period Covering 2004, 2006, and 2008-2011

Variable	(1)	(2)	(3)	(4)
Dependent Variable: All Reported Outbreaks of Food-Borne Illness Per Million				
Farmers Markets Per Million	0.142***	0.129***	0.140***	0.139***
	(0.039)	(0.037)	(0.038)	(0.040)
Farmers Markets that Accept SNAP Per Million	-0.078**	-0.071**	-0.070**	-0.100***
	(0.030)	(0.030)	(0.029)	(0.028)
Farmers Markets Per Million, Neighboring States		0.021*		
		(0.011)		
GDP Per Million	6.954	3.888	-2.363	-8.051
	(68.151)	(64.033)	(63.793)	(77.394)
College Graduation Rate	-30.582	-28.146	-26.986	-12.049
	(26.069)	(24.844)	(25.776)	(22.691)
Restaurants Per Million	-0.013	-0.013	-0.014	-0.018
	(0.011)	(0.011)	(0.012)	(0.012)
Constant	18.842**	16.863**	16.999*	16.107*
	(8.560)	(7.549)	(8.821)	(8.956)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.146	0.163	0.198	0.317

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table 7. Estimation Results for Ordinary Least Squares Regressions of All Reported Cases of Food-Borne Illness in the US for the Period Covering 2004, 2006, and 2008-2011

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Dependent Variable: All Reported Cases of Food-Borne Illness Per Million				
Farmers Markets Per Million	2.604**	2.774**	3.173***	3.217**
	(1.105)	(1.193)	(1.170)	(1.283)
Farmers Markets that Accept SNAP Per Million	-2.389**	-2.474**	-2.750***	-2.955***
	(0.985)	(1.018)	(0.976)	(1.002)
Farmers Markets Per Million, Neighboring States		-0.265		
		(0.328)		
GDP Per Million	-3,701.249	-3,662.890	-3,940.342**	-4,707.853**
	(2,235.667)	(2,266.610)	(1,938.324)	(1,999.095)
College Graduation Rate	-527.896	-558.365	-561.374	-554.890
	(647.614)	(662.827)	(678.823)	(614.516)
Restaurants Per Million	-0.228	-0.230	-0.364	-0.275
	(0.272)	(0.278)	(0.257)	(0.280)
Constant	507.832**	532.598**	612.812***	550.656**
	(216.353)	(226.714)	(214.625)	(213.503)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.213	0.216	0.269	0.365

Standard errors clustered at the state level
*** p<0.01, ** p<0.05, * p<0.1

Table 8. Estimation Results for Ordinary Least Squares Regressions of All Reported Outbreaks of Campylobacter in the US for the Period Covering 2004, 2006, and 2008-2011

Variable	(1)	(2)	(3)	(4)
Dependent Variable: All Reported Outbreaks of Campylobacter Per Million				
Farmers Markets Per Million	0.013***	0.013***	0.013***	0.015***
	(0.004)	(0.005)	(0.005)	(0.005)
Farmers Markets that Accept SNAP Per Million	0.001	0.001	0.001	-0.000
	(0.005)	(0.005)	(0.005)	(0.006)
Farmers Markets Per Million, Neighboring States		0.000		
		(0.001)		
GDP Per Million	8.462	8.398	8.039	3.925
	(12.659)	(12.704)	(13.760)	(13.153)
College Graduation Rate	-0.744	-0.693	-0.863	-0.287
	(3.517)	(3.499)	(3.923)	(4.109)
Restaurants Per Million	-0.000	-0.000	-0.000	0.000
	(0.001)	(0.001)	(0.002)	(0.002)
Constant	-0.291	-0.332	-0.167	-0.339
	(1.423)	(1.370)	(1.695)	(1.893)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.099	0.100	0.106	0.191

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table 9. Estimation Results for Ordinary Least Squares Regressions of All Reported Cases of Campylobacter in the US for the Period Covering 2004, 2006, and 2008-2011

Variable	**(1)**	**(2)**	**(3)**	**(4)**
Dependent Variable: All Reported Cases of Campylobacter Per Million				
Farmers Markets Per Million	0.129**	0.130**	0.125*	0.110
	(0.062)	(0.063)	(0.062)	(0.086)
Farmers Markets that Accept SNAP Per Million	0.001	-0.000	0.007	0.024
	(0.084)	(0.085)	(0.083)	(0.076)
Farmers Markets Per Million, Neighboring States		-0.003		
		(0.019)		
GDP Per Million	691.980	692.415	739.944	742.341
	(679.931)	(679.878)	(726.499)	(621.686)
College Graduation Rate	-45.300	-45.646	-51.954	-89.819
	(46.713)	(45.807)	(52.810)	(59.354)
Restaurants Per Million	-0.006	-0.006	-0.012	-0.035
	(0.019)	(0.019)	(0.026)	(0.032)
Constant	-13.709	-13.428	-10.371	16.177
	(30.008)	(29.749)	(34.016)	(26.351)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.056	0.056	0.059	0.200

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10. Estimation Results for Falsification and Placebo Tests

Variables	(1) Bankruptcies	(2) All Outbreaks	(3) All Cases	(4) *C. jejuni* Outbreaks	(5) *C. jejuni* Cases
Farmers Markets Per Million	1.024				
	(6.783)				
Bankruptcies Per Million		-0.000	-0.005	0.000	0.000
		(0.000)	(0.005)	(0.000)	(0.001)
GDP Per Million	-101,391.982***	-33.221	-3,528.912	13.109	772.734
	(31,539.709)	(93.702)	(2,595.553)	(13.614)	(755.293)
College Graduation Rate	8,024.723	-17.247	-470.563	0.875	-32.686
	(10,122.773)	(22.797)	(615.848)	(3.596)	(46.829)
Restaurants Per Million	7.303*	-0.013	-0.288	-0.001	-0.019
	(4.170)	(0.012)	(0.287)	(0.002)	(0.023)
Constant	2,483.725	20.040**	597.828**	-0.048	-12.077
	(3,231.618)	(9.866)	(252.980)	(1.490)	(32.207)
Observations	306	306	306	306	306
R-squared	0.706	0.165	0.171	0.044	0.052
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix

Table A1. Estimation Results for Ordinary Least Squares Regressions of All Reported Outbreaks of Food-Borne Illness in the US for the Period Covering 2004, 2006, and 2008-2011, Weighted by Population

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Dependent Variable: All Reported Outbreaks of Food-Borne Illness Per Million				
Farmers Markets Per Million	0.102***	0.070**	0.097***	0.094**
	(0.035)	(0.030)	(0.032)	(0.038)
Farmers Markets Per Million, Neighboring States		0.027***		
		(0.010)		
GDP Per Million	220.306**	161.614*	138.223	176.353
	(107.415)	(86.726)	(84.549)	(125.367)
College Graduation Rate	-21.035	-22.432	-27.412	-22.278
	(19.347)	(18.040)	(17.067)	(25.511)
Restaurants Per Million	-0.009*	-0.015**	-0.017*	-0.013*
	(0.005)	(0.006)	(0.009)	(0.007)
Constant	5.451	11.684**	13.861*	12.704
	(5.160)	(5.029)	(7.467)	(7.797)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.760	0.772	0.789	0.812

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table A2. Estimation Results for Ordinary Least Squares Regressions of All Reported Cases of Food-Borne Illness in the US for the Period Covering 2004, 2006, and 2008-2011, Weighted by Population

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Dependent Variable: All Reported Cases of Food-Borne Illness Per Million				
Farmers Markets Per Million	1.512*	1.550*	2.298**	1.980*
	(0.822)	(0.922)	(0.954)	(1.094)
Farmers Markets Per Million, Neighboring States		-0.032		
		(0.243)		
GDP Per Million	2,145.122	2,215.440	1,059.785	548.750
	(2,222.016)	(2,398.580)	(2,227.680)	(3,137.894)
College Graduation Rate	-850.935*	-849.261*	-1,075.639**	-920.115
	(456.831)	(452.198)	(486.847)	(551.804)
Restaurants Per Million	-0.139	-0.133	-0.302	-0.211
	(0.143)	(0.171)	(0.294)	(0.200)
Constant	261.621**	254.153**	437.943**	388.672**
	(103.362)	(124.295)	(208.698)	(168.522)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.546	0.546	0.571	0.626

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table A3. Estimation Results for Ordinary Least Squares Regressions of All Reported Outbreaks of Campylobacter in the US for the Period Covering 2004, 2006, and 2008-2011, Weighted by Population

Variables	(1)	(2)	(3)	(4)
Dependent Variable: All Reported Outbreaks of Campylobacter Per Million				
Farmers Markets Per Million	0.007**	0.007**	0.007**	0.007*
	(0.003)	(0.003)	(0.003)	(0.004)
Farmers Markets Per Million, Neighboring States		0.000		
		(0.001)		
GDP Per Million	0.590	-0.362	-0.484	0.064
	(5.198)	(5.384)	(5.866)	(8.583)
College Graduation Rate	0.396	0.373	0.108	-0.084
	(0.962)	(0.940)	(1.029)	(1.408)
Restaurants Per Million	0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.001)
Constant	-0.427	-0.326	0.024	-0.268
	(0.270)	(0.322)	(0.488)	(0.483)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.307	0.308	0.313	0.353

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table A4. Estimation Results for Ordinary Least Squares Regressions of All Reported Cases of Campylobacter in the US for the Period Covering 2004, 2006, and 2008-2011, Weighted by Population

Variables	(1)	(2)	(3)	(4)
Dependent Variable: All Reported Cases of Campylobacter Per Million				
Farmers Markets Per Million	0.178	0.172	0.197	0.048
	(0.140)	(0.118)	(0.137)	(0.131)
Farmers Markets Per Million, Neighboring States		0.006		
		(0.033)		
GDP Per Million	1,050.965	1,039.002	1,157.245	1,005.241
	(812.388)	(761.853)	(769.789)	(630.172)
College Graduation Rate	-120.326	-120.610	-169.173	-143.060*
	(93.233)	(95.383)	(144.413)	(73.855)
Restaurants Per Million	-0.027	-0.028	-0.061	-0.042*
	(0.022)	(0.028)	(0.059)	(0.023)
Constant	9.566	10.836	40.240	30.992*
	(10.282)	(16.508)	(49.142)	(16.157)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.261	0.261	0.287	0.669

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table A5. Estimation Results for Ordinary Least Squares Regressions of All Reported Outbreaks of Food-Borne Illness in the US for the Period Covering 2004, 2006, and 2008-2011, Controlling for the Years for Which Multi-State Outbreaks Were Unavailable

Variables	(1)	(2)	(3)	(4)
Dependent Variable: All Reported Outbreaks of Food-Borne Illness Per Million				
Farmers Markets Per Million	0.149***	0.140***	0.143***	0.138***
	(0.040)	(0.040)	(0.041)	(0.048)
Farmers Markets Per Million x Multi-State Outbreaks Missing	-0.049***	-0.048***	-0.049**	-0.059***
	(0.018)	(0.018)	(0.019)	(0.019)
Farmers Markets Per Million, Neighboring States		0.017		
		(0.017)		
GDP Per Million	118.503	93.430	97.209	117.057
	(75.229)	(71.591)	(69.118)	(89.477)
College Graduation Rate	-27.257	-23.644	-24.285	-13.431
	(23.871)	(22.566)	(23.438)	(22.623)
Restaurants Per Million	-0.015	-0.015	-0.018	-0.022*
	(0.011)	(0.011)	(0.013)	(0.012)
Constant	14.701	13.529	14.867	16.265
	(10.250)	(9.392)	(10.380)	(10.721)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Controls x Multi-State Outbreaks Missing	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
Region-Year Fixed Effects x Multi-State Missing	No	No	No	Yes
Region-Spillover Interactions x Multi-State Missing	No	No	Yes	No
R-squared	0.180	0.205	0.230	0.328

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table A6. Estimation Results for Tobit Models of Food-Borne Illness in the US for the Period Covering 2004, 2006, and 2008-2011

Variables	(1) All Reported Outbreaks	(2) All Reported Cases	(3) Campylobacter Outbreaks	(4) Campylobacter Cases
Farmers Markets Per Million	0.104**	0.038***	1.546*	0.737**
	(0.042)	(0.010)	(0.865)	(0.302)
GDP Per Million	18.864	30.897	-3,997.072	3,536.813
	(76.214)	(47.726)	(2,724.881)	(3,079.365)
College Graduation Rate	-33.459	-1.854	-749.664	-24.766
	(27.152)	(12.417)	(698.010)	(237.342)
Restaurants Per Million	-0.013	0.002	-0.248	0.115
	(0.012)	(0.003)	(0.295)	(0.124)
Constant	16.562*	-3.490	499.896**	-210.926
	(8.642)	(3.997)	(248.066)	(175.849)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Pseudo R-squared	0.200	0.332	0.055	0.143

Standard errors clustered at the state level

*** p<0.01, ** p<0.05, * p<0.1

Table A7. Estimation Results for Ordinary Least Squares Regressions of All Reported Outbreaks of Norovirus in the US for the Period Covering 2004, 2006, and 2008-2011

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Dependent Variable: All Reported Outbreaks of Norovirus Per Million				
Farmers Markets Per Million	0.051**	0.050**	0.052**	0.048*
	(0.022)	(0.024)	(0.024)	(0.024)
Farmers Markets that Accept SNAP Per Million	-0.037***	-0.036**	-0.040***	-0.047***
	(0.013)	(0.014)	(0.014)	(0.013)
Farmers Markets Per Million, Neighboring States		0.001		
		(0.006)		
GDP Per Million	-131.506**	-131.705**	-132.888***	-144.952***
	(50.499)	(50.298)	(42.642)	(48.919)
College Graduation Rate	-4.698	-4.540	-4.111	-0.022
	(11.812)	(11.818)	(11.742)	(12.102)
Restaurants Per Million	-0.009	-0.009	-0.014*	-0.013*
	(0.007)	(0.007)	(0.008)	(0.007)
Constant	13.839**	13.711**	16.579**	14.943**
	(6.358)	(6.292)	(6.582)	(6.091)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.252	0.253	0.296	0.391

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A8. Estimation Results for Ordinary Least Squares Regressions of All Reported Outbreaks of Clostridium Perfringens in the US for the Period Covering 2004, 2006, and 2008-2011

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Dependent Variable: All Reported Outbreaks of Clostridium Perfringens Per Million				
Farmers Markets Per Million	0.009*	0.009*	0.010**	0.008*
	(0.005)	(0.005)	(0.005)	(0.004)
Farmers Markets that Accept SNAP Per Million	-0.007**	-0.007**	-0.007*	-0.006
	(0.003)	(0.003)	(0.004)	(0.004)
Farmers Markets Per Million, Neighboring States		0.000		
		(0.001)		
GDP Per Million	13.575	13.506	10.391	19.741
	(22.518)	(22.613)	(21.422)	(20.195)
College Graduation Rate	-5.130	-5.075	-4.405	-4.554
	(4.304)	(4.335)	(4.237)	(4.443)
Restaurants Per Million	0.000	0.000	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.857	0.813	0.387	0.819
	(0.952)	(0.994)	(1.090)	(1.134)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.072	0.073	0.090	0.246

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A9. Estimation Results for Ordinary Least Squares Regressions of All Reported Cases of Norovirus in the US for the Period Covering 2004, 2006, and 2008-2011

Variables	(1)	(2)	(3)	(4)
Dependent Variable: All Reported Cases of Norovirus Per Million				
Farmers Markets Per Million	0.959	0.961	1.101	1.384**
	(0.701)	(0.727)	(0.693)	(0.681)
Farmers Markets that Accept SNAP Per Million	-0.904	-0.905	-1.243***	-1.488***
	(0.541)	(0.549)	(0.441)	(0.438)
Farmers Markets Per Million, Neighboring States		-0.0014		
		-0.209		
GDP Per Million	-4,734.406***	-4,733.852***	-4,961.003***	-6,049.498***
	(1,460.166)	(1,460.208)	(1,207.983)	(1,365.308)
College Graduation Rate	216.793	216.353	253.210	269.475
	(460.848)	(465.048)	(474.547)	(501.612)
Restaurants Per Million	-0.243	-0.243	-0.357*	-0.212
	(0.211)	(0.211)	(0.200)	(0.203)
Constant	339.506**	339.863**	413.490***	328.012**
	(161.799)	(163.294)	(147.019)	(154.418)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.254	0.254	0.322	0.425

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A10. Estimation Results for Ordinary Least Squares Regressions of All Reported Cases of Clostridium Perfringens in the US for the Period Covering 2004, 2006, and 2008-2011

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Dependent Variable: All Reported Cases of Clostridium Perfringens Per Million				
Farmers Markets Per Million	0.430	0.509	0.574*	0.510
	(0.317)	(0.320)	(0.305)	(0.307)
Farmers Markets that Accept SNAP Per Million	-0.617	-0.656*	-0.711	-0.609
	(0.379)	(0.378)	(0.426)	(0.467)
Farmers Markets Per Million, Neighboring States		-0.124		
		(0.099)		
GDP Per Million	820.847	838.742	658.090	1,077.721
	(1,243.522)	(1,257.211)	(1,182.160)	(1,228.952)
College Graduation Rate	-209.873	-223.591	-197.110	-295.287
	(237.553)	(243.081)	(238.981)	(276.309)
Restaurants Per Million	0.010	0.009	0.016	-0.045
	(0.073)	(0.074)	(0.094)	(0.098)
Constant	19.883	31.421	25.887	71.303
	(56.582)	(61.616)	(71.691)	(81.281)
Observations	306	306	306	306
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Region-Year Fixed Effects	No	No	No	Yes
Region-Spillover Interactions	No	No	Yes	No
R-squared	0.041	0.047	0.059	0.200

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1